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SUPERIOR COURT OF THE STATE OF CALIFORNIA
COUNTY OF SAN MATEO

COUNTY OF SAN MATEO, TOWN OF ATHERTON, CITY OF EAST PALO ALTO, CITY OF FOSTER CITY, CITY OF MENLO PARK, TOWN OF PORTOLA VALLEY, CITY OF REDWOOD CITY, CITY OF SAN CARLOS, CITY OF SAN MATEO, and TOWN OF WOODSIDE, both individually and on behalf of THE PEOPLE OF THE STATE OF CALIFORNIA,

Plaintiffs,

vs.

MONSANTO COMPANY, SOLUTIA, INC., PHARMACIA, LLC, and DOES 1-100,

Defendants.

Case No. 22-CIV-01667

COMPLAINT FOR:

1. REPRESENTATIVE PUBLIC NUISANCE ON BEHALF OF THE PEOPLE OF THE STATE OF CALIFORNIA;
2. NON-REPRESENTATIVE PUBLIC NUISANCE;
3. PRIVATE NUISANCE; AND
4. TRESPASS.

JURY TRIAL DEMANDED

Judge:
Department:

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I. INTRODUCTION

1. Plaintiffs are the People of the State of California (the "People"), the County of San Mateo (the "County"), and the following municipalities in the County's geographic boundaries: the Town of Atherton, the City of East Palo Alto, the City of Foster City, the City of Menlo Park, the Town of Portola Valley, the City of Redwood City, the City of San Carlos, the City of San Mateo, and the Town of Woodside (collectively, the "Municipalities," and together with the People and the County, "Plaintiffs").

2. The County and the Municipalities represent the People under California Code of Civil Procedure section 731.

3. Plaintiffs sue Defendants Monsanto Company ("Current Monsanto"), Solutia, Inc. ("Solutia"), Pharmacia LLC ("Pharmacia"), and Does 1–100. Current Monsanto, Solutia, and Pharmacia (collectively, "Defendants") have succeeded to or have agreed to bear the liabilities of an earlier Monsanto entity that also was known as the Monsanto Company ("Original Monsanto," or "Monsanto").

4. This lawsuit arises out of the contamination of the County, the Municipalities, and the San Francisco Bay ("Bay") by polychlorinated biphenyls ("PCBs"), a group of human-made chemical pollutants. PCBs are ubiquitous contaminants that are detected in human, animal, and plant tissue around the world. PCBs are dangerous to human health, animal health, and the environment.

5. Monsanto made, promoted, marketed, distributed, and sold PCBs and products containing PCBs for a wide range of commercial, household, and industrial uses starting in the 1920s and ending in 1977 after Congress banned PCBs in the Toxic Substances Control Act of 1976.

a. During this period, Monsanto made about 1.4 billion pounds of PCBs.

b. Monsanto made about 99% of the PCBs ever used in the United States.

6. Monsanto promoted, marketed, distributed, and sold PCBs and/or products containing PCBs in and/or near the County and the Municipalities. Third parties also sold PCBs and/or products containing PCBs in and/or near the County and the Municipalities. PCBs made by

Monsanto have been disposed and/or released into the environment in and near the County and the Municipalities.

7. During the period it made, promoted, marketed, distributed, and sold PCBs, Monsanto knew that PCBs were dangerous to human health, animal health, and the environment. Monsanto knew that PCBs' physical attributes magnified those risks and meant they would persist for many decades after PCBs were disposed and/or released into the environment. Monsanto knew that PCBs were being disposed and/or released into the environment (including in and near the County, the Municipalities, and the Bay) in massive quantities. Monsanto knew its PCBs were creating a widespread environmental and public health problem that has injured, injures, and will continue to injure the Plaintiffs.

8. Monsanto disseminated disinformation about the dangers of PCBs. Monsanto's internal communications and public statements were severely inconsistent: even as Monsanto internally acknowledged the pervasive risks posed by its large-scale manufacture, distribution, and sale of PCBs, Monsanto minimized or denied those risks in its public statements. For example, Monsanto provided false and/or misleading information to federal, state, and local government authorities that were investigating PCB risks. Monsanto provided false and/or misleading information and improper instructions about PCBs, including disposal instructions, to its customers, distributors, and salespeople.

9. Monsanto's wrongful conduct was designed to maximize the company's profits at the expense of its customers, workers exposed to PCBs, and the public at large.

10. PCBs have contaminated the County's and the Municipalities' buildings, roadways, infrastructure, inland waters, soils, flora, and fauna.

11. PCBs also have contaminated the waters, tidal lands, submerged lands, flora, and fauna of the Bay. PCB contamination of the Bay includes areas within the County's geographic boundaries, and areas where the County and certain of the Municipalities hold tidelands or submerged lands.

12. The PCB contamination problems in the County (including the Municipalities) and the Bay are interconnected. Perhaps most significantly, several municipal stormwater systems in the

County—including those operated by the Municipalities—collect stormwater and dry-weather runoff. PCB-laden water and sediment are carried into and collected in the stormwater systems. Water and sediment containing PCBs are discharged from these stormwater systems into the Bay, exacerbating the Bay's PCB contamination. Stormwater and dry-weather runoff, as well as sediment, also are discharged from the County and the Municipalities into the Bay through pathways other than stormwater systems.

13. To prevent further PCB contamination of the Bay, discharges of PCBs into the Bay are limited by stringent regulations. To comply, the County and the Municipalities are required to drastically reduce the PCBs discharged from the County (including the Municipalities in it) to the Bay through stormwater and dry-weather runoff.

14. The County and the Municipalities have incurred and will incur substantial costs to comply with these regulations that reduce the harms of PCB contamination. The County and the Municipalities will continue incurring these costs for at least the next several decades.

15. Monsanto foresaw, or could have foreseen, that its PCBs and PCB-containing products would pollute the Bay Area including the County, and that PCB contamination would require governments to adopt regulations to curb PCB discharges into waterways like the Bay. Monsanto foresaw, or could have foreseen, that these regulatory requirements would be costly for local governments like Plaintiffs.

16. Defendants, not taxpayers, should bear these costs and Plaintiffs' other damages.

II. PARTIES

A. Plaintiffs

17. The County is a political subdivision of the State of California. It is located in the San Francisco Bay Area, immediately south of the City and County of San Francisco. The County seat is in Redwood City. The County's geographic boundaries include a large portion of the Bay.

18. Each of the Municipalities is a political subdivision of the State of California. Each of the Municipalities is an incorporated city or town within the County's geographic boundaries.

19. The People bring suit by and through the County and the Municipalities under California Code of Civil Procedure section 731.

B. Defendants

20. Current Monsanto is a Delaware corporation with its principal place of business in Missouri. It is a wholly owned subsidiary of Bayer AG.

21. Solutia is a Delaware corporation with its principal place of business in Missouri. It is a wholly owned subsidiary of Eastman Chemical Company.

22. Pharmacia is a Delaware limited liability company with its principal place of business in New Jersey. It is a wholly owned subsidiary of Pfizer Inc.

23. Does 1–100 are currently unknown potential defendants that have succeeded to and/or have agreed to bear the liabilities of Original Monsanto that relate to PCBs, and/or are otherwise liable to the Plaintiffs for the claims and/or injuries alleged in this complaint. Plaintiffs will amend this Complaint to allege their true names and capacities when ascertained.

C. Defendants' Liability for Original Monsanto's Acts and Omissions

24. All three Defendants have succeeded to, and/or have agreed to bear, the liabilities of Original Monsanto that relate to PCBs.

25. Beginning in 1997, Original Monsanto underwent a series of several transactions. The effect of these transactions was to spin off Original Monsanto into three entities: Current Monsanto, which took on Original Monsanto's agricultural business; Solutia, which took on the chemical business, and Pharmacia, which took on the pharmaceutical business.

26. Current Monsanto, Solutia, and Pharmacia have entered into various agreements regarding indemnification and the sharing and apportionment of liabilities. These agreements include ones entered when Solutia underwent a Chapter 11 bankruptcy reorganization between 2003 and 2008.

III. JURISDICTION

27. The Superior Court of California for San Mateo County is a court of general jurisdiction and therefore has subject-matter jurisdiction over this action.

28. This court has personal jurisdiction over Defendants because each Defendant maintains substantial contacts with California, and also because they have succeeded to, or have agreed to bear, the liabilities of Original Monsanto, which maintained substantial contacts with California including the wrongful conduct that gave rise to Plaintiffs' claims.

IV. FACTUAL BACKGROUND

A. Chemical Properties of PCBs

29. PCBs are a group of chlorinated hydrocarbons: organic compounds that consist of carbon, hydrogen, and chlorine atoms. Generally, PCBs are categorized based on the number of chlorine atoms in their chemical structure (i.e., their degree of "chlorination"). PCBs range from a thin liquid to a waxy consistency. There are no known natural sources of PCBs.

30. Although different PCBs exhibit somewhat different physical properties, all PCBs have common properties that make them especially problematic pollutants:

a. PCBs are lipophilic (i.e., tend to be soluble in oils, fats, or lipids).

b. PCBs are highly stable, durable, and resistant to thermal and chemical degradation.

c. Most organisms cannot easily metabolize PCBs.

31. Although all PCBs are resistant to degradation, more heavily chlorinated PCBs tend to be more durable (and therefore more persistent in the environment) than more lightly chlorinated ones. Once PCBs enter living tissue, more heavily chlorinated PCBs tend to have longer half-lives than less heavily chlorinated PCBs.

B. Release and Transport of PCBs

32. PCBs have been released into the environment in many ways. For example:

a. Because Monsanto produced and sold PCBs in massive quantities without adequate warnings and instructions about how they should be properly disposed, PCBs and PCB-containing products were routinely dumped or disposed in landfills, which are not suitable means of disposal. Monsanto knew that PCBs and PCB-containing products were routinely dumped or disposed in landfills, and Monsanto at times advised its customers to dump

PCBs or dispose them in landfills. Monsanto did so despite knowing that these were not suitable means of disposal.

b. PCBs entered the environment from accidental spills and leaks of the chemicals, and from accidental spills and leaks of products containing the chemicals. These spills and leaks were exacerbated by Monsanto's failure to provide adequate warnings and instructions. For example, liquid PCBs were frequently used as dielectric (i.e., non-conductive) oil inside electrical transformers. Although electrical transformers were supposed to remain sealed, transformers leaked, PCBs would be spilled from transformers during maintenance, and PCBs also were released when transformers were improperly disposed. Monsanto knew that because of its inadequate warnings and instructions about spills and leaks, and because of its marketing and promotion of PCBs for unsuitable applications where they would inevitably be spilled or leaked, PCBs and products containing the chemicals were being spilled and leaked into the environment in large quantities.

c. Because PCBs are semi-volatile, they routinely vaporized into the air. For example, PCB-containing building materials can vaporize, expose occupants to PCBs through inhalation, and escape buildings. Monsanto knew that because of its marketing, promotion, and sale of PCBs for unsuitable applications where the chemicals could readily volatilize, PCBs were being released into the environment through volatilization.

d. PCBs also entered the environment because of deliberate application of PCBs. For example, Monsanto at times encouraged customers to use PCBs as organic solvents or extenders for pesticides that were sprayed onto crops.

33. PCBs continue to be released into the environment today. Among other sources, PCBs are released from contaminated sites, improperly disposed PCB-laden waste, PCB-containing products that are still in service, landfills, and soils and sediment that contain PCBs.

34. Once released into the environment, PCBs cycle in the environment between air, water, and soil.

35. These principles hold true for areas within the County and the Municipalities. PCBs were released into the environment within and near the County and the Municipalities from a wide range of sources. These sources include, but are not limited to, building and construction materials like caulk, roadway paint, dielectric fluid in electrical transformers, and fluorescent light ballasts. Once released, PCBs have cycled and transported within and between land, air, and water in and near the County and the Municipalities.

C. Risks to the Environment

36. PCBs create numerous environmental risks.

37. For example, PCBs can enter aquatic fauna such as zooplankton and bottom-grazing fish when they eat materials containing PCBs. These fauna readily absorb PCBs but do not easily metabolize them. In part because PCBs are lipophilic, they tend to "bioaccumulate," or build up, in living tissue.

38. PCBs, like many other persistent pollutants, are known to "biomagnify" at higher levels of the food chain. Over its lifespan, a predator organism like a bird or carnivorous fish will eat numerous smaller organisms containing PCBs, and the PCBs will build up in that predator organism's tissue.

39. PCBs have been shown to be toxic, cause cancer, and cause numerous other health harms in many non-human living organisms.

40. Some scientific studies—including studies of Bay ecosystems—have found that PCBs are especially harmful to birds that eat fish and/or other aquatic organisms contaminated with PCBs. In such birds, PCBs can cause infertility, developmental problems, eggshell thinning, and other harms.

41. PCB exposure has been linked to myriad adverse effects in various other non-human animals.

D. Risks to Human Health

42. Humans can be exposed to PCBs through ingestion, inhalation, and dermal contact.

43. Today, the most common way people are exposed to PCBs is through ingestion of contaminated fish or shellfish.

44. The principles of bioaccumulation and biomagnification apply to humans. Once PCBs enter the human body, they tend to build up in skin, fatty tissue, and the liver.

45. PCB contamination is one of the main reasons why federal, state, and local governments often advise Americans to avoid eating large quantities of certain types of fish, and fish and/or shellfish from certain PCB-impacted waters.

46. PCBs are acutely toxic.

47. Chronic exposure to PCBs is known or suspected to cause a range of cancers including non-Hodgkin's lymphoma, breast cancer, liver cancer, gallbladder cancer, gastrointestinal cancers, pancreatic cancer, and skin cancer.

48. Chronic exposure to PCBs is known or suspected to cause numerous non-cancer health effects including cardiovascular, dermal, endocrine, gastrointestinal, hepatic (liver), immune, neonatal, neurological, ocular, and reproductive harm.

E. Monsanto's PCB Manufacturing and Sales – In General

49. The Swann Chemical Company ("Swann") started manufacturing PCBs in 1929. Monsanto purchased Swann in or around 1935.

50. Monsanto's manufacturing of PCBs peaked in 1970, and the company continued manufacturing PCBs until 1977.

51. Monsanto made about 1.4 billion pounds of PCBs.

52. Monsanto made about 99% of the PCBs ever used in the United States.

53. Most of Monsanto's PCB sales were under the trade name "Aroclor." Monsanto also sold PCBs—both alone and mixed with other chemicals—under other trade names like Pydraul, a line of hydraulic fluids.

54. Monsanto categorized many of its Aroclor products (in plural form, "Aroclors") according to their degree of chlorination. For example, Aroclor 1248 was approximately 48% chlorine by mass, while Aroclor 1254 was approximately 54% chlorine.

55. Monsanto aggressively and successfully promoted and marketed Aroclors and other PCBs and PCB-containing products. Monsanto successfully recommended to its customers that PCBs be incorporated into a breathtakingly wide range of commercial, household, and industrial products.

F. Monsanto's Knowledge of PCB Risks and Actions to Downplay Them

56. The allegations in this section are illustrative and represent only a small portion of Monsanto's long history of misconduct that undergirds the Plaintiffs' claims.

57. Monsanto learned about PCB risks early. Swann observed during the early 1930s that workers at its PCB manufacturing facility often developed dermatitis (skin irritation). Swann nevertheless marketed PCBs for a wide array of commercial, household, and industrial uses.

58. In 1936, the Halowax Corporation reported severe chloracne (an acne-like skin irritation that can be caused by exposure to PCBs) among many of its workers using chlorinated biphenyls. Also, three of Halowax's workers died with symptoms of jaundice. Autopsies showed that two of the three decedents had severe liver damage. Halowax subsequently commissioned a study. Its author warned that PCBs could cause "systemic" toxic effects. Monsanto closely followed the Halowax workers' deaths and the study.

59. By 1944, Monsanto had started to advise its salespeople that PCBs were toxic and could cause liver damage.

60. In the mid-1950s, Monsanto commissioned a study by researchers at the University of Cincinnati College of Medicine that exposed animals to Aroclor vapors for extended periods of time. This study raised concerns about PCBs' carcinogenicity.

61. Monsanto nevertheless continued to sell PCBs and PCB-containing products without adequate warnings, and continued to recommend their use in a wide range of commercial, household, and industrial applications. Even worse, in and/or around the 1950s, Monsanto promoted using Aroclors as a solvent or extender for powdered DDT (dichloro-diphenyl-

trichloroethane, the organochloride Rachel Carson wrote about in *Silent Spring*) and other pesticides to be applied to crops.

62. In September 1955, Monsanto's medical director, Dr. Emmet Kelly, authored an internal memorandum "summariz[ing]" "[Monsanto's] position" about Aroclors.[1] Kelly wrote, "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 develops 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 concentrations]."[2]

63. Between 1956 and 1957, Monsanto tried to sell Pydraul 150, a hydraulic fluid containing PCBs, to the U.S. Navy for use in submarines. The Navy resisted because it disfavored using toxic compounds like PCBs in confined environments.[3] The Navy conducted an animal experiment with Pydraul 150; all the rabbits the Navy exposed to the fluid's vapors died.[4]

64. Monsanto nevertheless concealed the risks of Pydraul:

a. When Monsanto learned that the Navy planned to publish the results of its Pydraul 150 experiment, the company encouraged the Navy to avoid referring to Monsanto trade names.

b. In an April 1957 letter to the Standard Oil Company summarizing toxicity data for four Pydraul products, Monsanto wrote that "the toxicity report on Pydraul 150 indicates that it is practically innocuous when fed orally to rats . . . . In rabbit skin and eye irritation studies, Pydraul 150 was no more irritating than a 10% soap solution tested similarly."[5] Monsanto's letter did not mention the Navy's dead rabbits. Monsanto's letter also did not mention the numerous other studies demonstrating PCB risks that the company had conducted, commissioned, or known about.

[1] Ex. 1 at 1.
[2] *Id.* at 2.
[3] Ex. 2.
[4] Ex. 3.
[5] Ex. 4 at 1.

65. Monsanto's practice of downplaying and concealing PCB risks was not limited to the Pydraul product line. In a May 1957 technical bulletin about Aroclors, Monsanto included only a short section on toxicity. Monsanto claimed, "Animal toxicity studies and 20 years of manufacturing and use experience indicate that Aroclor compounds are not serious industrial health hazards."[6]

66. However, some Monsanto employees tried to pressure the company to attend to PCB risks. For example, one Monsanto scientist warned in a 1957 internal memorandum about the company's practice of promoting PCBs for use as an organic solvent or extender for DDT and other pesticides that were sprayed on crops. The scientist noted that PCBs were toxic and suggested that their application to crops could pose legal risks.[7]

67. In a 1960 brochure, Monsanto touted Aroclors as "among the most unique, most versatile chemically-made materials in the industry."[8] Monsanto marketed Aroclors as suitable for a wide range of commercial, household, and industrial applications.[9]

68. Meanwhile, Monsanto failed to adopt safeguards, provide instructions, and issue warnings relating to PCBs and PCB-containing products. In many instances, Monsanto took affirmative action to downplay and/or conceal the mounting evidence about PCB dangers. For example:

a. Monsanto advised customers that PCBs and PCB-containing products should be dumped or disposed in landfills (and was aware its customers followed that advice), even though Monsanto's own research had already demonstrated that this was not an appropriate means of disposal.

b. In 1962, Monsanto represented to the U.S. Public Health Service that "[the company's] experience and the experience of our customers over a period of nearly 25 years, has been singularly free of difficulties."[10]

[6] Ex. 5 at 12.
[7] Ex. 6.
[8] Ex. 7 at 3.
[9] *See generally id.*
[10] Ex. 8 at 1.

69. In 1963, Monsanto received additional empirical evidence that PCBs were—as expected from its inertness and resistance to degradation—highly persistent in the environment. In 1939, Aroclors had been applied to test plots at the University of Florida, Gainesboro to determine whether the compounds could be used for termite-proofing. Monsanto documents from 1963 indicate that a researcher revisiting those sites observed "visual evidence of the presence of Aroclor."[11]

70. In 1966, Søren Jensen and Gunnar Widmark of the University of Stockholm published a landmark study about PCBs. Jensen and Widmark had set out to identify the prevalence of DDT and other pesticides in the environment. However, Jensen and Widmark identified unexpected compounds that they eventually determined to be PCBs. Jensen and Widmark located PCBs in fish, sea birds, conifer needles, and human fat tissue. In their study, Jensen and Widmark expressed concern that PCBs were spreading widely throughout the environment due to high production volumes, their durability, and their tendency to bioaccumulate and biomagnify. The Jensen and Widmark study prompted substantial internal conversations and correspondence in Monsanto.

71. Despite these red flags, Monsanto's board approved in November 1967 the appropriation of $2.9 million (about $23 million in 2022 dollars) to expand production at two PCB manufacturing facilities.[12]

72. In early 1968, PCBs caused a mass poisoning in Japan. PCBs leaked from a heat exchanger used in the processing of rice bran oil, contaminating that oil with PCBs. This oil was both consumed directly and fed to poultry. Hundreds of thousands of birds and at least 500 people died.

73. Monsanto's internal memoranda discussed the mass poisoning and the risks associated with Monsanto's PCB-containing products, which also were used inside heat exchangers in food processing plants. Although Monsanto knew it was "a matter of time until the regulatory agencies will be looking down [its] throats," Monsanto did not withdraw its PCB-

[11] Ex. 9.
[12] Ex. 10.

containing products from this use. Instead, Monsanto planned to put customers' "mind[s] at ease . . . by playing down the medical reports."[13]

74. In December 1968, University of California, Berkeley researcher R.W. Risebrough and others published a landmark study about PCBs in *Nature*. Risebrough and his co-authors found that PCBs were toxic, spread easily and widely once released into the environment, and posed a significant threat to humanity. Risebrough's study, which partly focused on Bay ecosystems, reported high concentrations of PCBs in peregrine falcons and dozens of other local bird species. The article linked this contamination to eggshell thinning in peregrine falcons and consequent population declines.

75. Monsanto decided to respond combatively to the Risebrough article. As W.R. Richard, the manager of Research and Development of Monsanto's Organics Division, wrote in an internal memorandum, "Either [Risebrough's] position is attacked and discounted or we will eventually have to withdraw product from end uses which have exposure problems."[14]

76. For example, Monsanto issued a press release about the Risebrough article that cast doubt on whether the chemicals Risebrough identified were PCBs, even though the company's internal memoranda acknowledged they were. Monsanto also claimed it was surprised that PCBs were being widely released and dispersed into the environment. Monsanto made similar representations to the U.S. government, feigning surprise at the widespread release and dispersal of PCBs.

77. Around the same time, Monsanto retained University of Illinois researcher Robert Metcalf to assess the PCB problem. Metcalf warned that PCBs were being released to the environment in massive quantities, that these PCBs were circulating and transporting in the environment, and "there is an important environmental quality problem involved in wastes of PCB."[15] Metcalf advised that "the evidence regarding PCB effects on environmental quality is sufficiently substantial, widespread, and alarming to require immediate corrective action on the

[13] Ex. 11 at 1.
[14] Ex. 12 at 2.
[15] Ex. 13 at 1–2 (underlining in original).

part of Monsanto. The defensive measures presently underway will do little if anything to refute the evidence already presented."[16]

78. Monsanto nevertheless continued to pursue greater PCB sales. For example, in April 1969, Monsanto's president requested its board of directors to approve $1.1 million in appropriations to expand the production of solid Aroclors at its Anniston, Alabama facility. These solid Aroclors were more heavily chlorinated PCBs that Monsanto knew to be more problematic pollutants.

79. In August 1969, Monsanto held a meeting of its "PCB Committee." Handwritten notes from the meeting read, "Subject is snowballing." The handwritten notes identified three "Alternatives": (1) "go out of business"; (2) "sell the hell out of them as long as we can and do nothing else"; and (3) "try to stay in business in controlled applications – control contamination levels."[17]

80. In or around September 1969, Monsanto formed an Aroclor Ad Hoc Committee. At its first meeting, the Ad Hoc Committee "[a]greed to" three "[o]bjectives": (1) "[p]ermit continued sales and profits of Aroclors and Terphenyls" (another type of organic compound); (2) "[p]ermit continued development of uses and sales"; and (3) "[p]rotect image of Organic Division and of the Corporation."[18] None of Monsanto's three "objectives" involved protecting the public or the environment from the dangers of PCBs.

81. Monsanto's Aroclor Ad Hoc Committee produced voluminous reports and correspondence. These reports and correspondence showed the Committee knew PCBs were being released to the environment in massive volumes, and they had become a truly global contaminant. The Committee knew PCBs had been tied especially closely to aquatic organisms and birds that consumed aquatic organisms. The Committee knew PCBs were toxic to humans and animals, PCBs could be harmful even at low concentrations, and PCBs were contaminating human food. The Committee knew the company's products would be scrutinized by regulators and the public.

[16] *Id.* at 2–3.
[17] Ex. 14 at 5.
[18] Ex. 15 at 1.

But the Committee pushed Monsanto to prolong PCB sales for as long as possible because they were profitable.

82. In or around 1970, Monsanto achieved record production and sales of PCBs.

83. As part of its strategy to prolong PCB sales at the public's expense, Monsanto misled the public by representing that PCBs were not being released into the environment at high rates, that PCBs were not being used in household products, and that PCBs were not very toxic. For example, in April 1970, Monsanto released a press release "repl[ying] to [a] charge that PCB threatens the environment" by U.S. Representative William F. Ryan.[19] Monsanto insisted that "PCB is not a household product," despite the company's knowledge that Aroclors were used in carbonless copy paper and numerous other household products.[20] Monsanto also suggested that PCBs were mostly used in "closed systems" (i.e., systems from which PCBs could not escape) despite its knowledge that PCBs were used in open systems, and its knowledge that PCBs were routinely released even from so-called "closed systems."[21]

84. In 1970, Monsanto decided to discontinue Aroclors 1254 and 1260, which were the most heavily chlorinated Aroclors that were widely distributed. By this point, Monsanto had known for many years that more chlorinated PCBs were especially problematic pollutants. A February 1970 interoffice memorandum provided talking points for company representatives' conversations with consumers of these Aroclors. Monsanto stressed to its representatives that the company had decided not to recall these heavier Aroclors: "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] Monsanto suggested that customers should be grateful: "We certainly have no reason to be defensive or apologetic about making this change. . . . [O]ur customers should commend us . . . ."[23]

[19] Ex. 16 at 1.
[20] *See id.* at 2.
[21] *See id.* at 2.
[22] Ex. 17 at 1.
[23] *Id.*

85. Despite Monsanto's best efforts, a scandal occurred in 1971. Large volumes of poultry feed marketed in the southeastern United States were found contaminated with PCBs. In turn, this feed had contaminated numerous chickens and chicken eggs. Also in the early 1970s:

a. Monsanto's customers started to express more and more concerns about PCBs.

b. Monsanto learned about long-term animal studies of chronic PCB exposure that further demonstrated that the chemicals were toxic.

c. Monsanto learned about detections of PCBs in cow milk traced to Aroclor-containing paint in feed silos.

d. Further research by Monsanto identified PCBs in a wide range of samples including in human tissue.

86. In September 1971, the United States formed an interagency task force to review existing data about PCBs and coordinate further government investigations. The *New York Times* published an article about the task force's formation. The newspaper reported, "The Monsanto Company of St. Louis, which is the only American manufacturer of PCB, has been conducting a two-year study of the effects of the chemical on rats and dogs. A company spokesman said that no ill effects had yet been detected."[24] However, Monsanto's contemporaneous internal memoranda suggested that Monsanto's experiments on rats, dogs, and chickens had demonstrated adverse effects, especially reproductive harm in rats and chickens.[25]

87. In May 1972, the federal task force concluded that "PCB's [sic] were highly persistent, could bioaccumulate to relatively high levels in fish and could have serious adverse effects on human health."[26] The task force recommended discontinuing "all PCB uses except in closed electrical systems."[27]

[24] Richard L. Lyons, *Panel Organized to Study DDT-Like Compound for Environmental Hazards*, N.Y. Times (Sept. 23, 1971), *available at* https://www.nytimes.com/1971/09/23/archives/panel-organized-to-study-ddtlike-compound-for-environmental-hazards.html.

[25] Ex. 18 at 2–3.

[26] *Review of PCB Levels in the Environment*, U.S. Envtl. Protection Agency, at 1 (January 1976), *available at* https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000I3HT.TXT (describing the task force's May 1972 findings).

[27] *Id.*

88. Over the next few years, the U.S. government continued to sample soils, waters, birds, and fish across the United States. PCBs were found to be ubiquitous throughout the United States including in the Bay. Federal and other researchers also developed even more evidence in animal experiments that PCBs were toxic and carcinogenic.

89. Even as Monsanto came under a regulatory microscope, the company did not relent in its efforts to mislead the public. For example, Monsanto in 1975 manipulated a study it had commissioned by Industrial Biotest Laboratories ("IBL"). IBL had written a report about a two-year Aroclor feeding study involving rats. IBL had concluded that Aroclors were "slightly tumorigenic." Monsanto asked IBL to change this language to "does not appear to be carcinogenic." IBL complied.[28]

90. Ultimately, Monsanto knew the time window for selling PCBs was ending.

91. In December 1975, Monsanto's PCB Study Group addressed in a memorandum the question, "Is the adverse impact now, or in the future, likely to be greater than the benefits derived from staying in the business?"[29] Focusing solely on its own interests and disregarding the adverse effects of its products on public welfare, the PCB Study Group concluded, "in answer to the question at hand, *the negative impact on Monsanto's image* will, indeed, exceed the benefits derived from staying in the business."[30]

92. Knowing that a PCB ban was imminent, the PCB Study Group recommended that Monsanto should phase out PCBs before it was forced to do so.[31] "Principally, Monsanto must, not be viewed as being forced into a decision to withdraw from PCB manufacture by either government action or public pressure. Rather, key audiences must perceive Monsanto as having initiated responsible action . . . ."[32]

93. In early 1976, Monsanto, consistent with this recommendation, announced the company planned to phase out its production of PCBs.

[28] *See* Ex. 19; Ex. 20.
[29] Ex. 21 at 2.
[30] *Id.* at 3 (emphasis added).
[31] *Id.* at 3.
[32] *Id.* at 3.

94. Several weeks later, in March 1976, the Toxic Substances Control Act passed the Senate. The Act was signed into law in October 1976.

95. Monsanto nevertheless continued to sell PCBs until approximately October 31, 1977.

96. The Toxic Substances Control Act's PCB manufacturing ban became effective on January 1, 1979.

G. PCB Contamination in San Mateo County and the Bay

97. The Bay is a shallow estuary where the Pacific Ocean's saline waters mix with freshwater. It covers approximately 1,600 square miles and is the largest estuary on the United States' West Coast. A large portion of the Bay lies within the County's geographic boundaries.

98. The Bay supports a diverse ecosystem. Year-round, the Bay supports aquatic and wetland plants, crabs, clams, fish, birds, other aquatic life, and marine and terrestrial mammals. During certain seasons, the Bay provides critical habitat for migratory birds and anadromous fish, some of which spawn in the Bay. The Bay also is important for human and economic activity including recreational fishing, commercial fishing, shipping, watersports, swimming, and boating.

99. The Bay receives substantial inflow from tributaries in, and runoff from, the County: the eastern part of the County borders and drains into the Bay.

100. Because buildings, roadways, infrastructure, inland waters, flora, and fauna in the County (including the Municipalities) are contaminated with PCBs, inflows of water and sediment from the County to the Bay often contain PCBs. This includes inflows originating from landlocked Municipalities that are not directly adjacent to the Bay. These PCBs contribute to the Bay's already-severe PCB contamination problem. Every segment of the Bay is considered impaired by PCB contamination under Section 303(d) of the Clean Water Act.

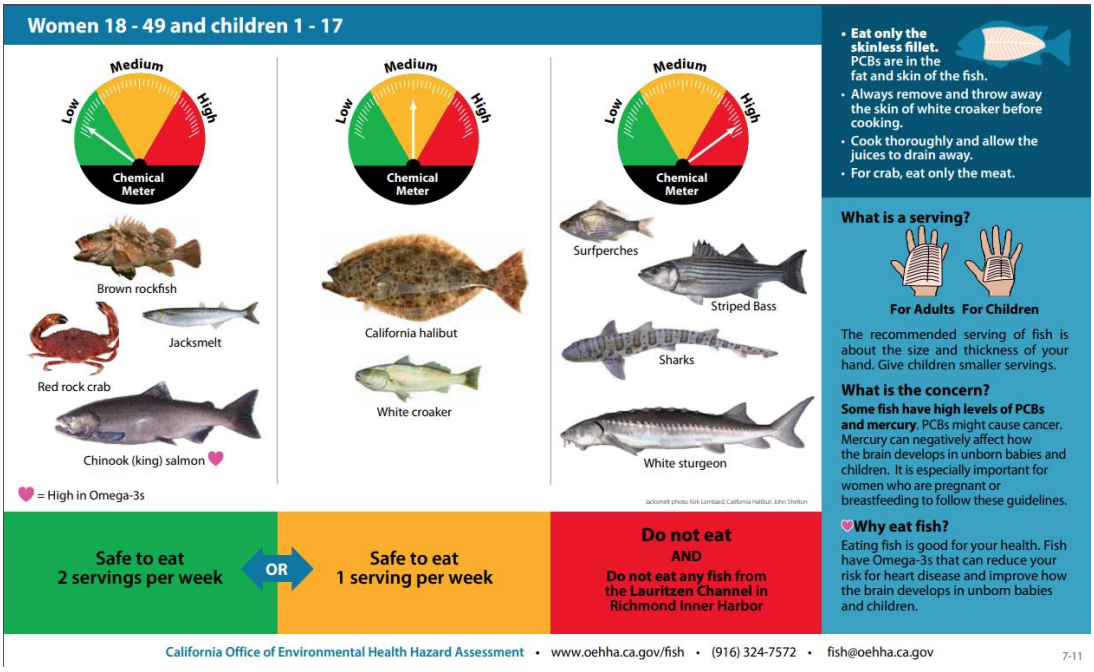
101. The San Francisco Bay Regional Water Quality Control Board ("Regional Board") has identified certain parts of the Bay as "hot spots" where PCB concentrations in sediment are multiple orders of magnitude higher than elsewhere in the Bay. Some of these hot spots, like Redwood City Harbor, are located in the County.

102. PCB contamination in the Bay has been so severe that the California Office of Environmental Health Hazard Assessment ("OEHHA") has advised some people not to eat certain types of fish caught in the Bay.

a. For example, children and women aged 18 to 49 are advised against eating striped bass, sharks, and white sturgeon caught in the Bay *at all*. These persons also are advised to limit their consumption of California halibut and white croaker caught in the Bay to a single serving a week.

b. All persons are advised against eating the skin and fatty tissue of fish caught in the Bay.

103. The following image depicts a poster distributed by the OEHHA.



104. Over the decades, numerous studies have found that PCBs are adversely affecting Bay birds. Studies of herons, terns (including the endangered California least tern), and other birds in the Bay have identified high PCB concentrations in eggs and linked this contamination to reduced embryo weight and increased embryo mortality.

H. The County and Municipalities' Need to Limit PCB Discharges into the Bay

105. The Regional Board regulates water quality in the Bay.

106. Under the National Pollution Discharge Elimination System ("NPDES") authorized by the Clean Water Act, the Regional Board has issued a Municipal Regional Stormwater Permit ("MRP Permit") that regulates PCB discharges in stormwater and dry-weather runoff from the County and all the municipalities in it, including the Municipalities that are Plaintiffs in this action.

107. The current version of the MRP Permit requires the County and Municipalities to sharply limit PCB discharges in stormwater and dry weather runoff to the Bay.

108. To comply with the MRP Permit, Plaintiffs have taken a wide range of actions, and will have to take a wide range of actions, to limit PCB-laden stormwater and dry-weather runoff from flowing into the Bay. These actions include, and/or may in the future include—among other things:

a. Testing and monitoring;
b. The installation of "green infrastructure" to capture PCBs in runoff;
c. Measures to control PCB discharges when structures with PCBs are demolished;
d. Identification of PCB-contaminated sites and abatement of contamination at those sites;
e. More frequent street sweeping;
f. Trash capture devices that capture particles and sediment carried in runoff;
g. Costs associated with coordinating MRP compliance among jurisdictions in the County, including Plaintiffs;
h. Costs associated with coordinating with the California State Water Resources Control Board and Regional Board; and
i. Ongoing operating and maintenance for green infrastructure, capture devices, and/or other abatement devices/infrastructure/mechanisms.

109. Monsanto foresaw, or could have foreseen, that PCB contamination would require government bodies like the Regional Board to adopt regulations to curb PCB discharges through

stormwater and dry-weather runoff into waterways like the Bay. Monsanto foresaw, or could have foreseen, that regulations curbing such discharges would require local governments like the County and the Municipalities to take a wide range of actions and bear associated costs.

110. Plaintiffs already have incurred substantial costs to limit PCB discharges into the Bay through stormwater and dry weather runoff. Plaintiffs will continue incurring such costs for decades into the future.

V. CAUSES OF ACTION

FIRST CAUSE OF ACTION

(Continuing Public Nuisance on Behalf of the People of the State of California)

(Against All Defendants)

111. The People, by and through the County and Municipalities, incorporate by reference each allegation contained above.

112. Buildings, roadways, infrastructure, inland waters, flora, and fauna in the County including the Municipalities are contaminated with PCBs.

113. The Bay's sediments, waters, flora, and fauna also are contaminated with PCBs. This contamination includes sediments, waters, flora, and fauna within the County's geographic boundaries.

114. PCB contamination of the County, the Municipalities, and the Bay is a public nuisance that substantially and unreasonably interferes with rights common to the public, including a substantial number of the County and Municipalities' residents:

a. This PCB contamination threatens the health of people who eat fish and shellfish harvested from the Bay.

b. This PCB contamination interferes with the public's right to use waterways for a range of beneficial uses including, but not limited to, recreational and commercial fishing.

c. Monsanto has unlawfully obstructed people from using the Bay, a navigable waterway, in the customary matter by limiting their ability to extract and consume fish and shellfish from the Bay.

d. This PCB contamination has harmed a range of living organisms.

115. PCB contamination of the County, the Municipalities, and the Bay has simultaneously affected many thousands of persons.

116. PCB contamination of the County, the Municipalities, and the Bay is severe, pervasive, and costly. Especially because the County, the Municipalities, and the Bay have immense cultural, economic, environmental, and social value, any ordinary person would be reasonably annoyed and disturbed by this contamination.

117. Monsanto, by acting or failing to act, created this public nuisance or permitted it to exist. Monsanto's conduct amounted to affirmative, knowing action to create the nuisance:

a. Monsanto made about 99% of the PCBs ever used in the United States.

b. Monsanto made virtually all the PCBs that contaminate the County, the Municipalities, and the Bay today.

c. Despite knowing about their dangers, Monsanto wrongfully promoted and marketed PCBs and PCB-containing products for an extremely wide range of commercial, household, and industrial uses and applications. This promotion and marketing caused PCBs to be used or misused in a wide range of unsuitable commercial, household, and industrial uses and applications, from which PCBs would inevitably be discharged into the environment in large quantities.

d. Monsanto made false or misleading statements about the dangers of PCBs and PCB-containing products, the prevalence of PCBs in products, the likelihood of PCB releases, and the prevalence of PCBs in the environment. Monsanto also concealed the dangers of PCBs and PCB-containing products, the likelihood of PCB releases, and the prevalence of PCBs in the environment. Monsanto's concealment and false or misleading statements increased PCB sales, generating profits for the company at the expense of creating this nuisance.

e. Monsanto manufactured, promoted, marketed, distributed, and sold PCBs and PCB-containing products without providing adequate warnings and instructions about how they should be properly used, handled, and disposed. Monsanto also directed PCB customers and users to use, handle, and dispose PCBs in improper ways that caused PCBs to be released into the environment.

f. Despite knowing that more heavily chlorinated PCBs were more problematic pollutants, Monsanto nevertheless promoted, marketed, distributed, and sold them aggressively. To facilitate this conduct, Monsanto continued to invest heavily in expanding its manufacturing capacity for heavily chlorinated PCBs, long after the company learned about heavily chlorinated PCBs' particular risks.

g. Even after learning about PCB risks, Monsanto chose not to thoroughly investigate them.

h. Monsanto consciously decided not to recall or take back PCBs and PCB-containing products.

i. Monsanto's actions and failures to act caused PCBs to contaminate the County, the Municipalities, and the Bay at levels that pose unacceptable risks to human health and the environment.

118. The seriousness of the harm caused by Monsanto outweighs the social utility of Monsanto's conduct.

119. The County, the Municipalities, and the People did not consent to Monsanto's creation of this public nuisance.

120. The harms associated with this public nuisance are reasonably abatable.

121. Monsanto and the Defendants have failed to abate the public nuisance of PCB contamination of the County, the Municipalities, and the Bay.

122. Each of the Defendants has succeeded to, and/or has agreed to bear, the liabilities of Original Monsanto relating to PCBs.

123. For these reasons, the People pray for relief as set forth below.

SECOND CAUSE OF ACTION

(Continuing Public Nuisance, By the County and the Municipalities)

(Against All Defendants)

124. The County and the Municipalities incorporate by reference each allegation contained above.

125. Buildings, roadways, infrastructure, inland waters, flora, and fauna in the County including the Municipalities are contaminated with PCBs.

126. The Bay's sediments, waters, flora, and fauna also are contaminated with PCBs. This contamination includes sediments, waters, flora, and fauna within the County's geographic boundaries.

127. PCB contamination of the County, the Municipalities, and the Bay is a public nuisance that substantially and unreasonably interferes with rights common to the public, including a substantial number of the County and Municipalities' residents:

a. This PCB contamination threatens the health of people who eat fish and shellfish harvested from the Bay.

b. This PCB contamination interferes with the public's right to use waterways for a range of beneficial uses including, but not limited to, recreational and commercial fishing.

c. Monsanto has unlawfully obstructed people from using the Bay, a navigable waterway, in the customary matter by limiting their ability to extract and consume fish and shellfish from the Bay.

d. This PCB contamination has harmed a range of living organisms.

128. PCB contamination of the County, the Municipalities, and the Bay has simultaneously affected many thousands of persons.

129. PCB contamination of the County, the Municipalities, and the Bay is severe, pervasive, and costly. Especially because the County, the Municipalities, and the Bay have

immense cultural, economic, environmental, and social value, any ordinary person would be reasonably annoyed and disturbed by such contamination.

130. Monsanto, by acting or failing to act, created this public nuisance or permitted it to exist. Monsanto's conduct amounted to affirmative, knowing action to create the nuisance:

a. Monsanto made about 99% of the PCBs ever used in the United States.

b. Monsanto made virtually all the PCBs that contaminate the County, the Municipalities, and the Bay today.

c. Despite knowing about their dangers, Monsanto wrongfully promoted and marketed PCBs and PCB-containing products for an extremely wide range of commercial, household, and industrial uses and applications. This promotion and marketing caused PCBs to be used or misused in a wide range of unsuitable commercial, household, and industrial uses and applications, from which PCBs would inevitably be discharged into the environment in large quantities.

d. Monsanto made false or misleading statements about the dangers of PCBs and PCB-containing products, the prevalence of PCBs in products, the likelihood of PCB releases, and the prevalence of PCBs in the environment. Monsanto also concealed the dangers of PCBs and PCB-containing products, the likelihood of PCB releases, and the prevalence of PCBs in the environment. Monsanto's concealment and false or misleading statements increased PCB sales, generating profits for the company at the expense of creating this nuisance.

e. Monsanto manufactured, promoted, marketed, distributed, and sold PCBs and PCB-containing products without providing adequate warnings and instructions about how they should be properly used, handled, and disposed. Monsanto also directed PCB customers and users to use, handle, and dispose PCBs in improper ways that caused PCBs to be released into the environment.

f. Despite knowing that more heavily chlorinated PCBs were more problematic pollutants, Monsanto nevertheless promoted, marketed, distributed, and sold them aggressively. To facilitate this conduct, Monsanto continued to invest heavily in expanding its manufacturing capacity for heavily chlorinated PCBs, long after the company learned about heavily chlorinated PCBs' particular risks.

g. Even after learning about PCB risks, Monsanto chose not to thoroughly investigate them.

h. Monsanto consciously decided not to recall or take back PCBs and PCB-containing products.

i. Monsanto's actions and failures to act caused PCBs to contaminate the County, the Municipalities, and the Bay at levels that pose unacceptable risks to human health and the environment.

131. The seriousness of the harm caused by Monsanto outweighs the social utility of Monsanto's conduct.

132. The County and the Municipalities did not consent to Monsanto's creation of this public nuisance.

133. The harms associated with this public nuisance are reasonably abatable.

134. Monsanto and the Defendants have failed to abate the public nuisance of PCB contamination of the County, the Municipalities, and the Bay.

135. The County and the Municipalities have suffered harm different from the type of harm suffered by the general public:

a. The County and the Municipalities have particular duties to safeguard the health of its residents and visitors.

b. The County and the Municipalities have particular duties to comply with PCB discharge limitations into the Bay.

c. The County and the Municipalities have suffered damages because of the public nuisance. The County and the Municipalities already have borne

monitoring, investigation, planning, compliance, and/or other costs and losses.

d. The County and the Municipalities will suffer damages because of the public nuisance. The County and the Municipalities will continue to bear substantial monitoring, investigation, planning, compliance, and/or other costs and losses because of PCB pollution in the County and the Bay.

e. The County and the Municipalities own, control, or otherwise are responsible for large swaths of property affected by PCB contamination.

f. Large portions of the Bay, which is contaminated with PCBs, lie within County boundaries.

g. Certain of the Plaintiffs own tidally affected parcels of land contaminated with PCBs.

h. The state of California has conveyed submerged land to the County, the City of Redwood City, and the City of San Mateo. Under state law, the County is obliged to serve as a steward and trustee of those public trust resources. Those resources have been contaminated with PCBs.

136. The Plaintiffs have suffered damages because Monsanto created this public nuisance.

a. The public nuisance has caused the County and the Municipalities to incur damages in the form of monitoring, investigation, planning, compliance, and/or other costs and losses.

b. The public nuisance has damaged the County's and the Municipalities' natural resources.

137. Monsanto's wrongful conduct was a substantial factor in causing harm to the Plaintiffs.

138. Monsanto acted with malice, oppression, or fraud as required for an award of punitive damages. As alleged elsewhere, Monsanto deliberately misled buyers of PCBs and PCB-containing products, users of PCBs and PCB-containing products, governments, and the public.

Monsanto also concealed the dangers of PCBs. Monsanto knowingly caused injury to the public welfare to safeguard its own profits.

139. Each of the Defendants has succeeded to, and/or has agreed to bear, the liabilities of Original Monsanto relating to PCBs.

140. For these reasons, the County and the Municipalities pray for relief as set forth below.

THIRD CAUSE OF ACTION

(Continuing Private Nuisance, By the County and the Municipalities)

(Against All Defendants)

141. The County and the Municipalities incorporate by reference each allegation contained above.

142. PCB contamination caused by Monsanto has obstructed the County and the Municipalities from owning and freely using their property, so as to interfere with their comfortable enjoyment of life or property:

a. The County, the City of Redwood City, and the City of San Mateo own, lease, occupy, or control submerged land in the Bay that is contaminated with PCBs. This submerged land continues to become contaminated because of PCB-laden discharges into the Bay.

b. Certain of the Plaintiffs own tidally affected parcels of land contaminated with PCBs.

c. The County and the Municipalities own, lease, occupy, or control buildings, roadways, infrastructure, inland waters, and land that are contaminated with PCBs. PCB contamination has required the County and the Municipalities to respond with measures to curtail PCB discharges from this property.

d. The Municipalities own, lease, occupy, or control municipal stormwater systems that receive PCB-laden water and solid materials (such as sediments).

e. PCB-laden sediment and other solid materials deposit and/or accumulate in the Municipalities' stormwater systems.

f. PCB contamination of municipal stormwater systems has prevented the Municipalities from freely using these municipal stormwater systems as designed without taking expensive remedial measures such as upgrades, retrofits, and upstream source controls.

g. The County and the Municipalities own, lease, occupy, or control land that they have had to, or will have to, use to construct remedial infrastructure to comply with regulatory requirements pertaining to PCB contamination.

143. This PCB contamination that interferes with the County's and the Municipalities' property interests constitutes a nuisance:

a. PCB contamination of property owned, leased, occupied, or controlled by the County and the Municipalities causes PCBs to be discharged into the Bay, threatening the health of people who eat fish and shellfish captured in the Bay.

b. PCB contamination of property owned, leased, occupied, or controlled by the County and the Municipalities interferes with the public's right to use waterways for a range of beneficial uses including, but not limited to, recreational and commercial fishing.

c. Through PCB contamination of property owned, leased, occupied, or controlled by the County and the Municipalities, Monsanto has unlawfully obstructed people from using the Bay, a navigable waterway, in the customary matter by limiting their ability to extract and consume fish and shellfish from the Bay.

d. PCB contamination of property owned, leased, occupied, or controlled by the County and the Municipalities causes contamination of the Bay that has harmed a range of living organisms.

144. Each of these interferences is substantial and unreasonable, so as to be annoying, disturbing, offensive, or inconvenient to the ordinary person.

145. Monsanto, by acting or failing to act, created this private nuisance or permitted it to exist. Monsanto's conduct was intentional and unreasonable, or – at minimum – unintentional but negligent or reckless:

a. Monsanto made about 99% of the PCBs ever used in the United States.

b. Monsanto made virtually all the PCBs that contaminate the County, the Municipalities, and the Bay today.

c. Despite knowing about their dangers, Monsanto wrongfully promoted and marketed PCBs and PCB-containing products for an extremely wide range of commercial, household, and industrial uses and applications. This promotion and marketing caused PCBs to be used or misused in a wide range of unsuitable commercial, household, and industrial uses and applications, from which PCBs would inevitably be discharged into the environment in large quantities.

d. Monsanto made false or misleading statements about the dangers of PCBs and PCB-containing products, the prevalence of PCBs in products, the likelihood of PCB releases, and the prevalence of PCBs in the environment. Monsanto also concealed the dangers of PCBs and PCB-containing products, the likelihood of PCB releases, and the prevalence of PCBs in the environment. Monsanto's concealment and false or misleading statements increased PCB sales, generating profits for the company at the expense of creating this nuisance.

e. Monsanto manufactured, promoted, marketed, distributed, and sold PCBs and PCB-containing products without providing adequate warnings and instructions about how they should be properly used, handled, and disposed. Monsanto also directed PCB customers and users to use, handle, and dispose PCBs in improper ways that caused PCBs to be released into the environment.

f. Despite knowing that more heavily chlorinated PCBs were more problematic pollutants, Monsanto nevertheless promoted, marketed, distributed, and sold them aggressively. To facilitate this conduct, Monsanto continued to invest heavily in expanding its manufacturing capacity for heavily chlorinated PCBs, long after the company learned about heavily chlorinated PCBs' particular risks.

g. Even after learning about PCB risks, Monsanto chose not to, or otherwise failed to, thoroughly investigate them.

h. Monsanto consciously decided not to, or recklessly or negligently failed to, recall or take back PCBs and PCB-containing products.

i. Monsanto's actions and failures to act caused PCBs to contaminate the County, the Municipalities, and the Bay at levels that pose unacceptable risks to human health and the environment.

146. The seriousness of the harm caused by Monsanto outweighs the social utility of Monsanto's conduct.

147. The County and the Municipalities did not consent to Monsanto's creating this private nuisance.

148. The harms associated with this private nuisance are reasonably abatable.

149. Monsanto and the Defendants have has failed to abate this private nuisance.

150. The Plaintiffs have suffered damages because Monsanto created this private nuisance.

a. The private nuisance has caused the County and the Municipalities to incur damages in the form of monitoring, investigation, planning, compliance, and/or other costs and losses.

b. The private nuisance has damaged Plaintiffs' natural resources.

151. Monsanto's wrongful conduct was a substantial factor in causing harm to the Plaintiffs.

152. Monsanto acted with malice, oppression, or fraud as required for an award of punitive damages. As alleged elsewhere, Monsanto deliberately misled buyers of PCBs and PCB-

containing products, users of PCBs and PCB-containing products, governments, and the public. Monsanto also concealed the dangers of PCBs. Monsanto knowingly caused injury to the public welfare to safeguard its own profits.

153. Each of the Defendants has succeeded to, and/or has agreed to bear, the liabilities of Original Monsanto relating to PCBs.

154. For these reasons, the County and the Municipalities pray for relief as set forth below.

FOURTH CAUSE OF ACTION

(Continuing Trespass, By the County and the Municipalities)

(Against All Defendants)

155. The County and the Municipalities incorporate by reference each allegation contained above.

156. The County and the Municipalities own, lease, occupy, and/or control buildings, roadways, infrastructure, inland waters, and land contaminated with PCBs. As previously alleged, the County, the City of Redwood City, and the City of San Mateo own, lease, occupy, and/or control submerged bottomlands in the Bay. As previously alleged, certain of the Plaintiffs own tidally affected parcels of land contaminated with PCBs.

157. The County and the Municipalities have a right to exclusively possess certain buildings, roadways, infrastructure, inland waters, and land contaminated with PCBs. The County, the City of Redwood City, and the City of San Mateo have a right to exclusively possess their submerged bottomlands in the Bay.

158. Monsanto caused PCBs to enter and contaminate the County's and the Municipalities' property. Monsanto's conduct that caused this entry was intentional and unreasonable, or unintentional but negligent or reckless:

a. Monsanto made about 99% of the PCBs ever used in the United States.

b. Monsanto made virtually all the PCBs that contaminate the County, the Municipalities, and the Bay today.

c. Despite knowing about their dangers, Monsanto wrongfully promoted and marketed PCBs and PCB-containing products for an extremely wide range

of commercial, household, and industrial uses and applications. This promotion and marketing caused PCBs to be used or misused in a wide range of unsuitable commercial, household, and industrial uses and applications, from which PCBs would inevitably be discharged into the environment in large quantities.

d. Monsanto made false or misleading statements about the dangers of PCBs and PCB-containing products, the prevalence of PCBs in products, the likelihood of PCB releases, and the prevalence of PCBs in the environment. Monsanto also concealed the dangers of PCBs and PCB-containing products, the likelihood of PCB releases, and the prevalence of PCBs in the environment. Monsanto's concealment and false or misleading statements increased PCB sales, generating profits for the company at the expense of creating this nuisance.

e. Monsanto manufactured, promoted, marketed, distributed, and sold PCBs and PCB-containing products without providing adequate warnings and instructions about how they should be properly used, handled, and disposed. Monsanto also directed PCB customers and users to use, handle, and dispose PCBs in improper ways that caused PCBs to be released into the environment.

f. Despite knowing that more heavily chlorinated PCBs were more problematic pollutants, Monsanto nevertheless promoted, marketed, distributed, and sold them aggressively. To facilitate this conduct, Monsanto continued to invest heavily in expanding its manufacturing capacity for heavily chlorinated PCBs, long after the company learned about heavily chlorinated PCBs' particular risks.

g. Even after learning about PCB risks, Monsanto chose not to, or otherwise failed to, thoroughly investigate them.

h. Monsanto consciously decided not to, or recklessly or negligently failed to, recall or take back PCBs and PCB-containing products.

i. Monsanto's actions and failures to act caused PCBs to contaminate the County, the Municipalities, and the Bay at levels that pose unacceptable risks to human health and the environment.

159. The County and the Municipalities did not authorize the entry of PCBs onto their property.

160. The entry of PCBs onto the County's and the Municipalities' property, which Monsanto caused, was a substantial factor in causing actual harm to the Plaintiffs.

a. The entry has caused the County and the Municipalities to incur damages in the form of monitoring, investigation, planning, compliance, and/or other costs and losses.

b. The entry of PCBs onto the County's and the Municipalities' property has damaged their natural resources.

161. The harms associated with this trespass are reasonably abatable.

162. Monsanto acted with malice, oppression, or fraud as required for an award of punitive damages. As alleged elsewhere, Monsanto deliberately misled buyers of PCBs and PCB-containing products, users of PCBs and PCB-containing products, governments, and the public. Monsanto also concealed the dangers of PCBs. Monsanto knowingly caused injury to the public welfare to safeguard its own profits.

163. Each of the Defendants has succeeded to, and/or has agreed to bear, the liabilities of Original Monsanto relating to PCBs.

164. For these reasons, the County and the Municipalities pray for relief as set forth below.

VI. PRAYER FOR RELIEF

For these reasons, the Plaintiffs seek the following relief against the Defendants:

1. Compensatory damages, in an amount to be proved at trial;

2. Natural resource damages;

3. Punitive damages;

4. A court order requiring Defendants to establish and deposit monies in an abatement fund to cover all future costs reasonably necessary for the County and the Municipalities to prevent PCBs from being discharged into the Bay, and to comply with municipal stormwater permits issued to the County and the Municipalities;

5. A court order restraining Defendants from their ongoing trespass on County and Municipalities' property;

6. Attorney's fees and expenses;

7. Costs of suit; and

8. Any other and further relief that the Court deems just, proper, and appropriate.

VII. JURY DEMAND

The Plaintiffs demand a jury trial on all causes of action for which a jury is available under the law.

Dated: April 20, 2022

Respectfully submitted,

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EXHIBIT 1

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 2

From MONSANTO CHEMICAL COMPANY

Buchanan-Davis

At St. Louis Roberts Building

Date May 29, 1956

To J. T. Garrett

Reference

At Main Office

Subject PYDRAUL 150

This afternoon Bob Sido called and stated that the Navy is not satisfied with the toxicity of Pydraul 150 for use in submarines. It is particularly concerned since as in the case of the atomic powered submarines, these vessels will remain submerged for periods up to six weeks. Therefore, any possible toxicological effects cannot be tolerated.

There will be a meeting on June 6 in Washington to discuss this matter and Sido would like very much to have you or someone else in the Medical Department, sit in to discuss our fluids. Others attending the meeting will be a Mr. Curran, Commander Seigel, BuMed, Mickey Elbert, BuShips, and Captain Alvis, who has recently replaced Dr. Holler. The subject of the meeting will be the demise of Pydraul 150 in the antenna retracting mechanisms of submarines unless we can present a convincing story as to its safety of use. If Pydraul 150 is ruled unsatisfactory, we would then suggest that the Navy consider the use of OS-16. This fluid is merely Santicizer 141 dyed blue, and was developed as an extremely non-toxic fluid for use in underground mining equipment. The physical properties are such that it could be substituted for the Pydraul 150 and I am sure that you have ample evidence of its non-toxicity. We would prefer at this stage of the game to have the Navy continue to use Pydraul 150; however, we have OS-16 as an ace in the hole.

HSL

H. S. Litzsinger

HSL:sj

MONS 095631

EXHIBIT 3

Messrs.:
O. R. Buchanan - Robts.
R. E. Hatton - M.C.
F. H. Langenfeld-Robts.
H. S. Litzsinger-Robts.
O. R. Sido-Washington,D.

St. Louis, Missouri

January 21, 1957

Mr. H. I. Armstrong

Roberts Building

PYDRAUL 150

Dr. Treon and I spent an afternoon with the Navy people to discuss Pydraul 150. Those present were Captain Shone, Captain Alvis, Captain Sessions, Commander Siegel and Mr. Mickey Albert. They discussed their information concerning Pydraul 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 Pydraul 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 Pydraul 150 per cubic meter or approximately 2 tenths of a part of the Aroclor component per million for 24 hours a day for 50 days caused, statistically, definite liver damage. 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. 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 Pydraul 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:SMB

EXHIBIT 4

April 8, 1957

Mr. James O. Lofstrom
Standard Oil Company
30 Rockefeller Plaza
New York 20, New York

Dear Mr. Lofstrom:

I have been asked to forward to you toxicity data on our fluids, Pydraul F-9, Pydraul 150, Pydraul 600, and Pydraul AC.

Pydraul F-9

There has been considerable toxicity research on Pydraul F-9. Attached is a discussion and interpretation of the toxicity studies. The results are also summarized in a briefer fashion on page 18 of the attached Pydraul F-9 Technical Bulletin.

Pydraul 150

The toxicity report on Pydraul 150 indicates that it is practically innocuous when fed orally to rats since the animals survived single doses of 28.5 grams per kilogram with loss of appetite and severe diarrhea as the only toxic effects. The fluid apparently is not absorbed through the unbroken skin of rabbits since this species survived doses up to 9.5 grams per kilogram of body weight. In rabbit skin and eye irritation studies, Pydraul 150 was no more irritating than a 10% soap solution tested similarly. As indicated with Pydraul [illegible] above, however, Pydraul 150 will cause severe pain if there is accidental splashing in the eyes of humans. Rats survived a 6-hour exposure to an atmosphere saturated with Pydraul 150 vapors.

Pydraul 600

The oral lethal dose for rats is approximately 30.5 grams per kilogram. When applied undiluted to the unbroken skin of rabbits the lethal dose was from 3.9 to 5.2 grams per kilogram. Animal skin and eye irritation studies indicated that Pydraul 600 is not a skin irritant. We know from experience with humans that accidental splashing in the eyes does cause severe pain but no permanent injury. Rats survived a 6-hour exposure to an atmosphere saturated with the vapors of Pydraul 600.

Pydraul AC

The oral lethal dose in rats is approximately 40 grams per kilogram and the minimum lethal dose by skin absorption (in rabbits) is 4.0 to 5.0 grams per kilogram. Rabbit skin and eye irritation studies indicate that Pydraul AC is not a serious irritant. Accidental contact with the eyes in the case of humans will result in irritation but no permanent damage. Rats survived a 6-hour exposure to an atmosphere saturated with vapors of Pydraul AC.

If I can be of any further assistance, please let me know.

Sincerely yours,

Elmer P. Wheeler
Assistant Director
Medical Department

EPW:dh
Enclosures
cc Mr. M. C. Plummer

EXHIBIT 5

AROCLOR

Resins and Plasticizers for Chlorinated Rubber

Technical Bulletin O-124 **May, 1957**
Monsanto Chemical Company, Organic Chemicals Division, St. Louis 1, Mo.

Introduction

Monsanto produces a series of chlorinated biphenyls and polyphenyls identified by the trademark *Aroclor** for use as plasticizers and resins for chlorinated rubber base lacquers, varnishes and paints. These protective coatings are fire resistant, corrosion resistant, chemical resistant (to acids, alkalies and water), and have good electrical insulating properties.

When properly pigmented, these coatings have good weatherability. Chlorinated rubber films plasticized with an *Aroclor* grip common structural materials in strong adhesive bonds. Addition of an *Aroclor* improves the flexibility and life of chlorinated rubber and plastic coatings.

The formulations suggested in this bulletin are common in commercial practice. They are given as a starting point or guide in developing formulations that expand the outstanding qualities of these compounds.

*Aroclor: Monsanto Trademark, Reg. U.S. Pat. Off.

Some important applications for protective and decorative coatings plasticized with **Aroclor** compounds - -

Wood and metal used in yachts, barges and other marine craft.

Structural steel for bridges, buildings, roofs and power-lines.

Structural materials at chemical plants, pulp and paper mills, textile mills, petroleum refineries and gas works for protection against acid fumes, alkalies and gas.

Tank cars and other rolling stock and construction machinery for protection against corrosive materials and weathering.

Equipment and stop-off lacquers used in electroplating.

Masonry floors and walls. Concrete swimming pools. Highway markings.

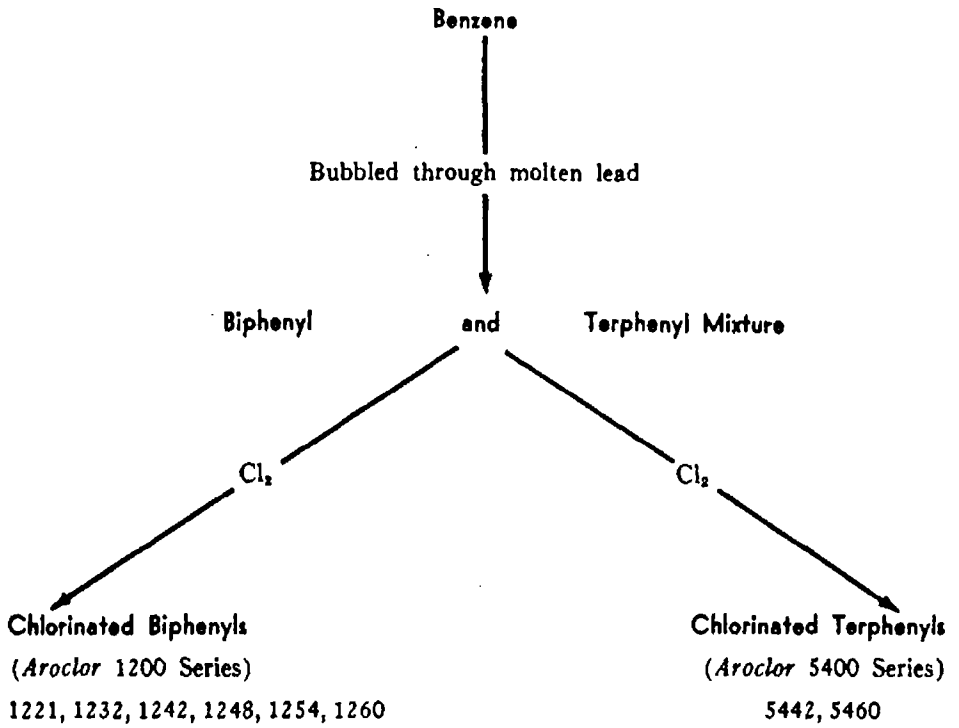
Cable coatings requiring fire resistance, chemical resistance, and excellent electrical properties.

Textile coatings resistant to chemicals, fire and water.

TABLE OF CONTENTS

This bulletin replaces technical bulletin P-124.

Naming and Preparation of Aroclor Compounds



Note: The last two digits in a numbered series refer to the degree of chlorination. *Aroclor* 1248 is a biphenyl with 48 per cent chlorination. *Aroclor* 5460 is a terphenyl with 60 per cent chlorination. Two special mixtures are:

Aroclor 4465—a 60:40 mixture (biphenyl to terphenyl) with 65 per cent chlorination.

Aroclor 2565—a 75:25 mixture (biphenyl to terphenyl) with 65 per cent chlorination.

The physical properties of the *Aroclor* plasticizers vary gradually with the degree of chlorination. At low percentages of chlorine, such as *Aroclor* 1221 and 1232, the compounds are clear and very fluid. At 42 per cent they resemble vegetable oil; at 48 per cent they thicken slightly and look more like a medium-grade mineral oil. At 54 per cent chlorine, the compounds are quite viscous; if a bottle containing them is turned upside down, the bubble rises slowly to the top. At higher percentages, the biphenyls become gumlike, and a fingerprint on the surface lasts several days. Then at 68 per cent chlorine, the range is complete; *Aroclor* 1268 is a white powder. The terphenyls (*Aroclor* 5442 and 5460) are both yellowish solids.

The gradual change in physical properties often allows a processor to select a plasticizer particularly suited for his operation. For example, if he wants to dry mix the plasticizer, *Aroclor* 1268 could be used. It melts at higher processing temperature and can act as a solvent-plasticizer.

Properties of Chlorinated Rubber

"Parlon" is a mixture of two polymers with an average chlorine content of 67 per cent made by chlorinating natural rubber. The typical properties of "Parlon" as given by the manufacturer, Hercules Powder Company, Wilmington, Delaware, are listed in Table I.

Table I. Typical Properties of "Parlon"

General	
Form as shipped	White, granular powder
Color of film	Water white
Odor	None
Clarity of film	Good
Taste	None
Moisture, per cent as shipped	0.5 maximum
Physical	
Specific gravity	1.64
Specific volume, as shipped, in cubic inches per pound	16.9
Bulking value, gallons per pound	0.0735
Index of refraction	1.554
Chemical resistance to:	
Acids, weak	excellent
Acids, strong	excellent
Alkalies, weak	excellent
Alkalies, strong	excellent
Salt spray	good
Alcohols	excellent
Ketones	soluble
Esters	soluble
Hydrocarbons, aromatic	soluble
Hydrocarbons, aliphatic	good
Oils, mineral	good
Oils, animal	poor
Oils, vegetable	poor
Electrical (clear unplasticized film*)	
Specific surface resistance, ohms $\times 10^{10}$	2,000
Dielectric strength, volts per mil (ASTM method)	2,300
Dielectric constant at 25°C. and 1,000 cycles	3.1
Power factor at 25°C. and 1,000 cycles	0.0015 to 0.0030
Power factor at 25°C. and 1,000 cycles, after immersion in water for 140 hours and surface wiped dry	0.0027

*Films used in tests were laid down from a toluene solution.

Properties, cont'd.

Mechanical (clear unplasticized film*)	20-cp. type	1,000-cp.type
Tensile strength, pounds per square inch, dry	4,270	4,850
Tensile strength, pounds per square inch, wet	4,100	4,360
Elongation, per cent, dry	3.6	3.3
Elongation, per cent, wet	3.8	3.4
Modulus of elasticity, pounds per square inch	1.4×10^5	—
Hardness, Sward index, per cent of glass	90	—

Note: Flexibility of "Parlon" film increases with viscosity of "Parlon" used.

Thermal (clear unplasticized film*)	
Burning rate	nonflammable
Effect of dry heat on film	stable up to and at 125°C.
Softening point	decomposes at 135° to 150°C.

Physical-Chemical (clear unplasticized film*)	
Effect of sunlight	Discolors and embrittles
Effect of aging	Very slight
Effect of hot water	Blushes
Effect of cold water	None
Moisture absorption (80% relative humidity for 24 hours), per cent	0.27
Moisture vapor permeability of 0.003-inch film (grams water/square centimeter/0.01 centimeter/hour at 21°C.)	0.2×10^4

Viscosity Types

Table II. "Parlon" Viscosity Types

Viscosity Type	Viscosity Range (centipoises)
5 cp.	5 to 7
10 cp.	8 to 12
20 cp.	16 to 25
125 cp.	110 to 190
1,000 cp.	800 to 2,000

Examples of actual or suggested applications of the several viscosity types are given below:

Type	Example of Use
5 cp.	In printing inks and as a fortifier for alkyd resin enamels.
10 cp.	In high-solids finishes and as a fortifier for alkyd resin and oleoresinous varnishes and enamels.
20 cp.	As a film-former in protective coatings and as a fortifier in enamels and varnishes.
125 cp.	As a film-former in protective coatings, in paper lacquers, adhesives, and textile finishes.
1,000 cp.	As a film-former in adhesives, textile finishes and other finishes where flexibility is important.

*Films used in tests were laid down from a toluene solution.

Solvent Compatibility

Solvents and solvent mixtures suggested for use in preparing formulations with *Aroclor* and "Parlon" are given in Table III:

Table III. Suggested Solvents for Compositions with Aroclor and "Parlon"

"Amsco Solv," B and E	Methyl ethyl ketone
Amyl acetate	Methyl isobutyl ketone
Butyl acetate	Methyl salicylate
Carbon tetrachloride	Notol
"Cellosolve"	Octyl acetate
Diacetone alcohol	"Sovasol" Nos. 74, 75
Diethyl carbonate	"Solvesso 100"
Ethyl acetate	"Tollac"
Ethylene dichloride	Toluene
Hi-Flash naphtha	"Union Aromatic Solvent" 3553-10
Methyl acetate	"Union Solvent No. 30"
Xylene	

Formulations and Properties of Chlorinated Rubber

Chlorinated Rubber Films

Aroclor 1262 and 5460, resinous types, show good compatibility in chlorinated rubber films laid down from toluene solution containing 20 per cent of the plastic in ratios of 2:1 and 1:1 ("Parlon" to *Aroclor*). The plasticizer types, *Aroclor* 1242, 1254 and 1260, also show good compatibility. Formulations and properties of films derived from both resin- and plasticizer-type *Aroclor* are listed below.

Table IV. Formulations for Aroclor Resin

Ingredient	Parts by Weight					
"Parlon," 20-cp.	16	16	16	12	12	12
Aroclor 5460	8	8	8	12	12	12
Dibutyl phthalate	—	4	—	—	3	—
Tung oil, Thermolyzed, 976	—	—	5	—	—	3.75
Xylene or butyl acetate	76	72	71	76	73	72.25

Table V. Formulations for Aroclor Plasticizer

Ingredient	Parts by Weight		
"Parlon," 20-cp.	20	20	20
Aroclor 1254 or 1260	4	7	20
Xylene	76	73	70

Films cast from these lacquers show improved characteristics due to *Aroclor*. Some of their advantages are listed below:

Adhesion

Unplasticized chlorinated rubber films have very poor adhesion. The lacquer film containing *Aroclor* 5460 gave good adhesion to aluminum, bare steel, primed steel, galvanized iron and "Transite" surfaces. Other commercial resins, particularly oil-modified alkyd resins, gave better adhesion to glass, tin, copper, sealed wood and cellophane.

The lacquer films plasticized with *Aroclor* 1254 or 1260 gave good adhesion to "Transite," cellophane, galvanized iron and primed steel surfaces. Some of the other commercial plasticizers tested in similar films gave better adhesion to aluminum, tin, bare steel, copper and sealed wood surfaces.

Though compounds with an *Aroclor* alone possess pronounced adhesive qualities, better adhesion to all of the surfaces results if mixtures of *Aroclor* or varied contents are used.

Resistance to Aqueous Solutions

Chlorinated rubber films with *Aroclor* 1254 or 1260 (plasticizers) and *Aroclor* 5460 (resin) show satisfactory resistance to solutions of 10 per cent hydrochloric acid, 5 per cent sodium hydroxide, 5 per cent sodium chloride and water spot tests.

Film Hardness

Softer films were produced with *Aroclor* 5460 in ratios of 5:10 and 10:10 (*Aroclor*:"Parlon") than with other commercial resins in similar mixtures. Likewise, softer films result from *Aroclor* 1254 or 1260 in ratios of 2:10 and 5:10 (*Aroclor*:"Parlon") than with other commercial plasticizers at these concentrations. From these tests compounds with *Aroclor* are shown to have strong plasticizing action on chlorinated rubber.

Cold-Check Resistance

Aroclor 5460 is superior to phenol formaldehyde resins in cold-check resistance imparted to chlorinated rubber films, but not as good as alkyds modified with long oil. *Aroclor* 1260 used as a plasticizer proved somewhat better than *Aroclor* 1254.

Weather Resistance

Pigmented chlorinated rubber finishes containing *Aroclor* have consistently withstood outdoor weather tests, but unpigmented finishes do not stand up well regardless of the resin or plasticizer used.

Poor resistance to ultraviolet light is also a weakness of chlorinated rubber. Most pigments (except ultramarine blue) are usable with "Parlon" and are recommended if the coating is to be subjected to outdoor weather or ultraviolet light. However, pigment protection varies considerably. Inspection of alkyd enamels fortified with "Parlon" showed weatherability varied from 63 months with chrome green to 4 months for titanium dioxide—iron blue combinations.

Sanding and Polishing Properties

Plastic films compounded with "Parlon" and containing *Aroclor* 5460, 1254 and 1260 have shown satisfactory sanding and polishing characteristics.

Applications

Alkaline-Resistant Coatings

Products containing *Aroclor* and chlorinated rubber are highly resistant to alkalies and moisture. Paints with combinations of *Aroclor* and chlorinated rubber are used in large quantities for concrete floors, walls, swimming pools and other surfaces. A paint formulation is given in Table VI.

Table VI. Paint Formulation for Alkaline Surface
(Parts by Weight)

Ingredient	Formulation		
	Formula 1 (basement floors)	Formula 2 (Fed. Spec. TT-P-91)	Formula 3 (swimming pools)
"Parlon," 20-cp. type	18	18	14.6
Aroclor 1254	10	10	4.4
"Rezyl 869"	8	—	—
Aroclor 5460 or "Cumar P10"	—	6	—
"Beckosol 31"	—	—	2.9
Tung oil, Thermolyzed, 976	—	—	4.4
Titanium dioxide	16	16	19.7
Zinc oxide	2	2	6.5
Silica flour	3	—	—
Carbon black	0.2	0.5	—
Xylene	42.8	47.5	—
Hi-Flash naptha	—	—	47.5
Totals	100	100	100

Chemical-Resistant Finishes

Particular care is necessary in choosing resins and plasticizers for chemical-resistant paints. Chlorinated rubber formulations with an *Aroclor* have proved outstanding for acid and alkali resistance. Five formulations are shown in Table VII.

Table VII. Formulations for Chemical-Resistant Paints
(Parts by Weight)

Ingredient	Formulation				
	1 Interior use, acids and alkalies	2 Exterior use, acids	3 Exterior use, alkalies	4 Maximum resistance, acids and alkalies	5 Soap resistant
"Parlon," 20-cp. type	16	16	16	18	12
Aroclor 5460	6.4	—	—	—	6
"Bakelite XJ-12895"	—	—	6.4	—	—
"Rezyl 807" (solids)	—	6.4	—	—	—
Aroclor 1254	8	4.8	4.8	8	—
Aroclor 1260	—	—	—	6	—
Tung oil, Thermolyzed, 976	—	4.8	4.8	—	7.7
Iron oxide	16	16	16	18	—
Titanium dioxide	—	—	—	—	18
Zinc oxide	—	—	—	—	6
Zylene	53.6	52	52	39	28
Hi-Flash naphtha	—	—	—	11	10.3
Toluene	—	—	—	—	12
Totals	100	100	100	100	100

These formulations were applied to metal bars or panels and tested for resistance.

Formula 1 showed good resistance to 10 per cent hydrochloric acid and 5 per cent sodium hydroxide solutions.

Formula 2 gave excellent outdoor protection to metal surfaces on plants manufacturing acids.

Formula 3 performed well on exteriors of plants producing alkali.

Formula 4 had excellent resistance to acids, alkalis and salt solutions. It also showed good adhesion to glass and other surfaces.

Formula 5 proved good for resistance to warm, soapy water.

Note: No finishes with *Aroclor* or chlorinated rubber are recommended for continuous exposure at temperatures above 140° F.

Marine Finishes

The marine industry makes great use of chlorinated rubber coatings plasticized with *Aroclor* to protect wood and metal on boats, barges and other marine equipment. They possess good resistance to salt water and their hard finish deters algae and other marine growth.

A suggested formula for a white marine paint is given in Table VIII.

Table VIII. Formulation for a Chlorinated Rubber Marine Paint

Ingredient	Parts by Weight
"Parlon," 20-cp. type	20
Aroclor 1254	6
"Rezyl 869"	6
Titanium dioxide	25
Xylene	23
Hi-Flash naphtha	20
Total	100

Emulsion Paints

If chemical resistance is required on porous surfaces, *Aroclor* 1254 is often added to chlorinated rubber emulsion paints. The Hercules Powder Company reports that preferred water phases for such paints are either a 1 per cent distilled water solution of "Aerosol OT" or a 4 per cent distilled-water solution of sodium oleate. A lacquer-to-water ratio of 2.5 to 1 (by weight) is suggested for the complete emulsion. "Parlon" of any viscosity may be used. A typical paint phase for such an emulsion paint is given in Table IX.

Table IX. Formulation for Paint Phase of Emulsion Paint

Ingredient	Parts by Weight
"Parlon"	28
Aroclor 1254	14
"Cumar P10"	10
Xylene	24
Hi-Flash naphtha	24
Total	100

Adhesives

Chlorinated rubber adhesives with an *Aroclor* were developed originally for adhering labels to acid bottles because of their general resistance to chemicals. These adhesives are also of unusual interest because they are fire resistant. A typical formulation is given in Table X.

Table X. Formulation for Chlorinated Rubber Adhesive

Ingredient	Parts by Weight
"Parlon," 125-cp. type	20
Aroclor 1254	6
Aroclor 1260	6
Toluene	68
Total	100

Paper and Textile Coatings

Chlorinated rubber coatings with *Aroclor* are worthy of consideration for specific end uses in the paper and textile coating fields. In general, this type of coating is restricted by odor and taste. Unpigmented finishes seem suitable for certain fabrics used indoors, but not for exposure to high temperatures or direct sunlight.

Electrical Coatings

Because of their desirable electrical properties, these compositions are useful for insulating and protecting electrical wire and apparatus from moisture. With selected fungistats and waxes, coatings of this type are used to protect electronic equipment in the tropics against moisture and fungi. The fire resistance of these plastics is an added dividend in the electrical field.

Printing Inks

Printing inks requiring a fast drying time and chemical resistance are often based on chlorinated rubber compositions plasticized with an *Aroclor*. These inks are especially useful on soap wrappers and boxes, bottle labels and many other commodities because of their alkali resistance.

Other Resins and Plasticizers Compatible With Chlorinated Rubber

The resins and Monsanto plasticizers given in Tables XI and XII are compatible with chlorinated rubber, but none gives the over-all desired qualities attained by using an *Aroclor*. The strong points and limitations of each are known. If their use is necessary for specific applications in chlorinated rubber, more detailed information on them may readily be found.

Table XI. Resins Compatible with "Parlon"

"Amberol 801, 806P, ST-137, F7"
Aroclor 1262, 5460
"Aroplaz 920, 930, 935, 940"
"Bakelite" XR-3180, XR-4503, XR-4006, BR-2963, XJ-9868, BR-1329, BR-3360"
"Beckacite 1112"
"Beckamine P-138, P-254"
"Super-Beckamine 3501"
"Beckapol 1400"
"Beckosol 1 (solid), 18, 31, 34, 40, 1329"
"Beetle" Resin 227-8
"Clorafin 70"
Copal
"Cumar P10"
Dammar
"Duraplex C-45-LV, C-48, C-49, C-50-LV, C-51, C-62, D-61, D-62, E-71, E-71-A, E-73"
East India gum
Ester gum
Ethyl methacrylate
"Esterol 750"
"Formvar"
"Gelva 2.5"
"Glyptal 1247, 2450, 2454, 2458, 2464, 2466, 2500"
"Lewisol 2L, 28, 33"
Methyl methacrylate polymers
"Neville R-3, R-10"
"Pentalyn A, G, M, X"
"Petrex 1, 130H"
"Phenac 633-M"
"Rezyl 116, X315, 412, 775, 803, 807, 829, 869, 880, 1103"
Rosin
*Santolite** MPH (sulfonamide-aldehyde resin)
"Stabelite Ester 1, 2, 10"
"Stabelite" resin
"Super-Beckacite 1001"
"Syntex H1, H3, H12, 17, 213, 22, 28, 29, 32, 36"
"Teglac 15, Z-152"
"Velsicol AD6-3"
"Vinsol"

Table XII. Monsanto Plasticizers Compatible with "Parlon"

Aroclor 1242
Aroclor 1254
Aroclor 1260
Dibutyl phthalate
Diethyl phthalate
Dimethyl phthalate
Santicizer B-16 (butyl phthalyl butyl glycolate)
Santicizer M-17 (methyl phthalyl ethyl glycolate)
Tricresyl phosphate
Triphenyl phosphate

**Santolite, Santicizer*: Monsanto Trademarks. Reg. U.S. Pat Off.

Toxicity

Animal toxicity studies and 20 years of manufacturing and use experience indicate that *Aroclor* compounds are not serious industrial health hazards. If the materials are heated to volatilization, ventilation should be provided to prevent inhalation of vapors. This is true of other major components of the formulation as well as the *Aroclor* compounds.

Repeated or prolonged skin contact should be avoided although there are few instances of skin irritation. Human patch tests with finished products containing *Aroclor* compounds have shown no irritation. Monsanto will furnish information on specific *Aroclor* compounds upon request.

Shipping Information

Regulations	— None
Standard Containers	— Steel and Fiber (*Aroclor* 1268, 5460) drums.
Rail Classification	
Chlorinated diphenyl (synthetic resin, liquid, NOIBN)	— *Aroclor* 1142, 1148, 1154, 1160, 1162, 1168, 1221, 1232, 1242, 1248, 1254, 1260, 1268
Synthetic resin, liquid, NOIBN	— *Aroclor* 1260 mix, 1262 mix
Snythetic resin, other than liquid, NOIBN	— *Aroclor* 2565, 4065, 4465, 5042, 5060, 5442, 5460
Truck Classification	
Synthetic resin powder, NOI	— *Aroclor* 2565
Synthetic resin, lumps or solid mass, NOI	— *Aroclor* 4065, 4465, 5042, 5060, 5442, 5460

Trademark Index

Trademark	Company
"Aerosol OT"	American Cyanamid Company
"Amberol"	Rohm & Haas Company
"Amsco Solv"	American Mineral Spirits Co.
"Aroplaz"	U. S. Industrial Chemicals Co.
"Bakelite"	Bakelite Company
"Beckacite"	Reichhold Chemicals, Inc.
"Beckamine"	Reichhold Chemicals, Inc.
"Beckopol"	Reichhold Chemicals, Inc.
"Beckosol"	Reichhold Chemicals, Inc.
"Beetle" Resin	American Cyanamid Company
"Cellosolve"	Carbide & Carbon Chem. Co.
"Clorafin"	Hercules Powder Company
"Cumar"	Barrett Division, Allied Chem. & Dye
"Duraplex"	Rohm & Haas Company
"Esterol"	L. Sonneborn Sons, Inc.
"Formvar"	Shawinigan Resins Corp.
"Gelva"	Shawinigan Resins Corp.
"Glyptal"	General Electric Company
"Hercolyn"	Hercules Powder Company
"Lewisol"	Hercules Powder Company
"Neville"	Neville Chemical Company
"Pentalyn"	Hercules Powder Company
"Petrex"	Hercules Powder Company
"Phenac"	American Cyanamid Company
"Rezyl"	American Cyanamid Company
"Solvasol"	Socony-Mobil Oil Company
"Solvesso"	Esso Standard Oil
"Stabelite" Ester	Hercules Powder Company
"Stabelite" Resin	Hercules Powder Company
"Super-Beckacite"	Reichhold Chemicals, Inc.
"Syntex"	Flintkote Company
"Teglac"	American Cyanamid Company
"Tollac"	Neville Chemical Company
"Troluoil"	Anderson-Pritchard Oil Corp.
"Transite"	Johns-Manville Sales Corp.
"Velsicol"	Velsicol Corp.
"Vinsol"	Hercules Powder Company

AROCLOR
Resins and Plasticizers for Chlorinated Rubber

Monsanto Technical Bulletin O-124
May, 1957

For further information on the products described in this bulletin
contact the nearest Monsanto office.

MONSANTO CHEMICAL COMPANY

ST. LOUIS, MISSOURI

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MONSANTO CHEMICALS (AUSTRALIA) LTD.
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DSW 007407

EXHIBIT 6

From MONSANTO CHEMICAL COMPANY

At St. Louis - Roberts 2

cc C.E. Caspari - M.O. 2
H.C. Koehler - Robts. 3
J.M. Magner - Robts. 2
K.E. Maxwell - S. Clara
J.W. Starrett - Robts.
M.C. Throdahl - Robts.

Date August 30, 1957

To Mr. P. G. Benignus

At Roberts 3

Reference PCB Sales Information Bulletin 8-27-57
OD 1149 - "Aroclors As Agricultural Chemicals", 4-1-57 by JMM

Subject

AROCLOR USE TO INCREASE THE INSECTICIDAL LIFE OF LINDANE

It is most surprising to see that you are recommending without restriction a use for Aroclor which has not been approved by U.S.D.A.-F.D.A. For the protection of the company it appears that salesmen who may try to promote this use of Aroclor in agriculture should be fully apprised of limitations and of risks involved if promoted for use on feed and food crops. In turn they should apprise customers of the true status of the development and advise them that if they use Aroclor in insecticide formulations on food or feed crops they should first obtain government approval.

You may already know that since Aroclors are toxic and, according to your attached reference, may extend the residual life of the pesticide, the Federal Government would require the following before selling for use on food and feed crops:

(1) Proof of benefits from the application.

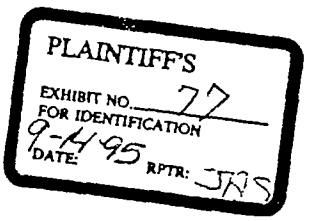
(2) Data to show whether or not residual Aroclor is present and whether it modifies the residual amount of Lindane or other active ingredient at harvest.

(3) If Aroclor is present or if the residual quantity of Lindane or other active ingredient has been significantly changed, tolerances for the Aroclor and for the pesticide in question must be developed.

(4) If a toxic quantity of Aroclor is present at harvest in food or feed crops a tolerance cannot be established until after two year chronic toxicity feeding tests have been completed for the Aroclor.

Obviously, much of the above is obviated if the Aroclor-insecticide formulation is not used on food or feed crops. Even then the label must show safe handling procedures, since Aroclor is toxic.

Incidentally, the findings published by Duda, as per your attached reference, are not in accord with research findings reported in reference report OD 1149. In this report you will note that Aroclor



TRAN 053674

contributes to longevity of insecticidal action only when combined with highly volatile compounds, and then only when applied to hard, smooth surfaces such as glass...not on agricultural plants. This is called to your attention because government label approval for use in agriculture also calls for proof of performance.

Admittedly, your August 27 bulletin does not specify using Aroclor in insecticides for use on food or feed crops but neither does it specify such a combination should not be used on food or feed crops. Perhaps this is an over-sight which you will wish to call to the attention of recipients of the bulletin.

L. V. Sherwood

LVS/eb

p.s. We repeatedly find that users of formulations prepared for a specific use will apply the material for other uses. In other words, even though Monsanto may encourage the use of Aroclor in pesticide formulations for non-agricultural use you can rest assured that some of it will be used on agricultural commodities. For these reasons alone it is strongly recommended that we state very specifically in any Monsanto literature, including correspondence, that Aroclors not be used on agricultural commodities. I believe our Legal Department will confirm that there is an important legal aspect involved.

TRAN 053675

EXHIBIT 7

3/60
5,000 reprinted
3/62

obsolete

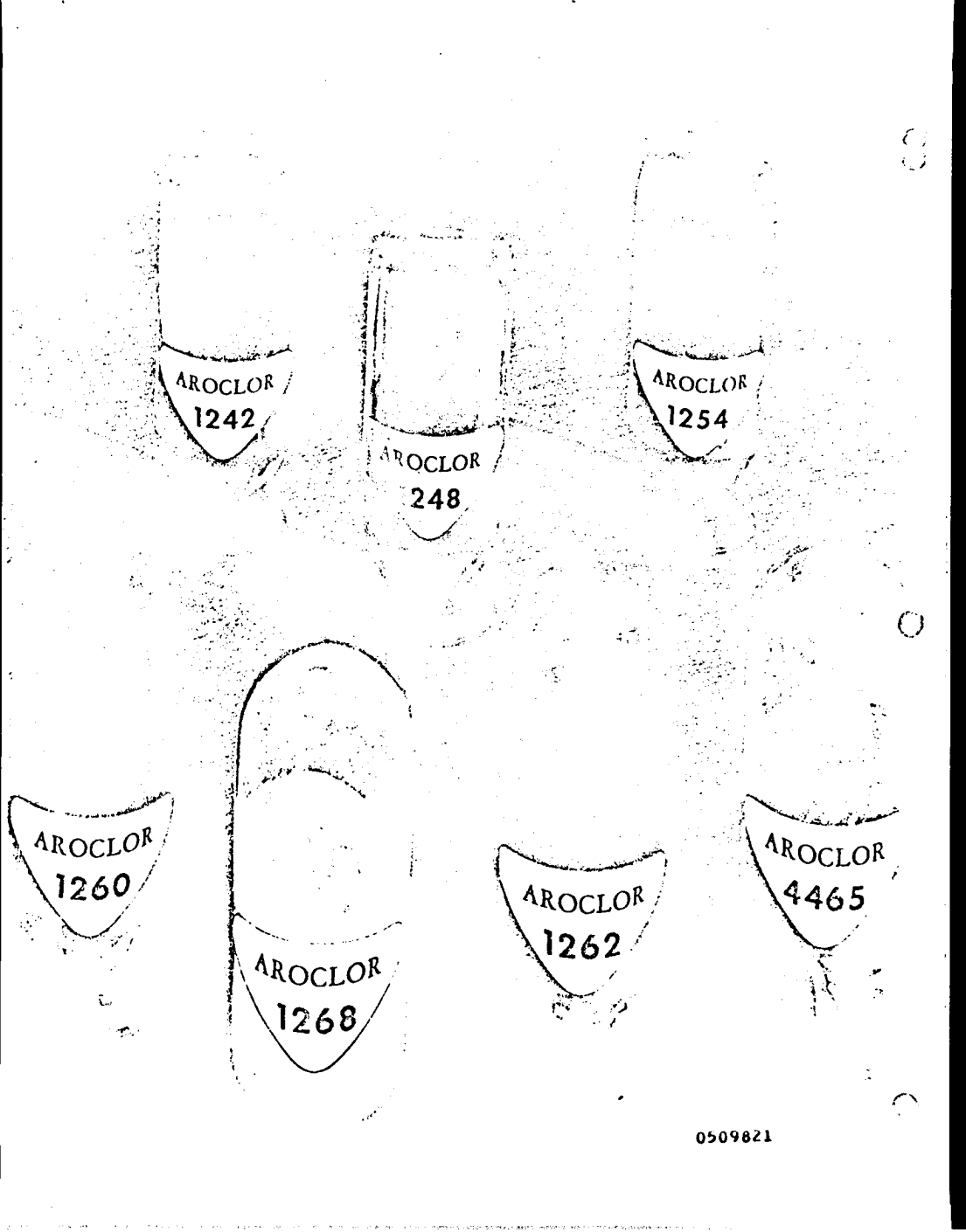
THE

aroclor

COMPOUNDS

Monsanto

0509820



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. Otc. 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.

0509822

Page No.

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 bard 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.

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"

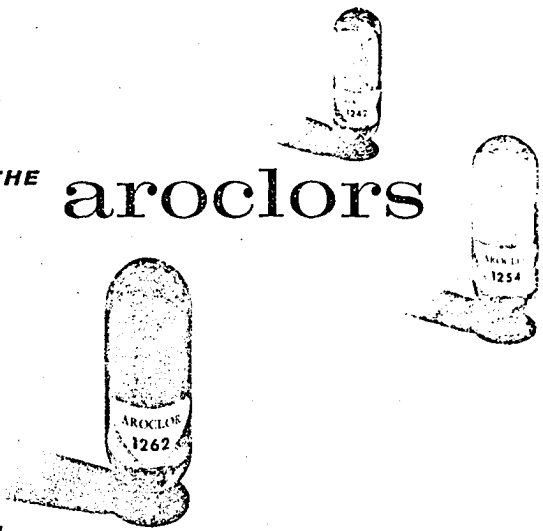
0509825

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 (266°F or 130°C) — —	300 400 — —	— — —	— — —

0509826

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.

0509827

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.

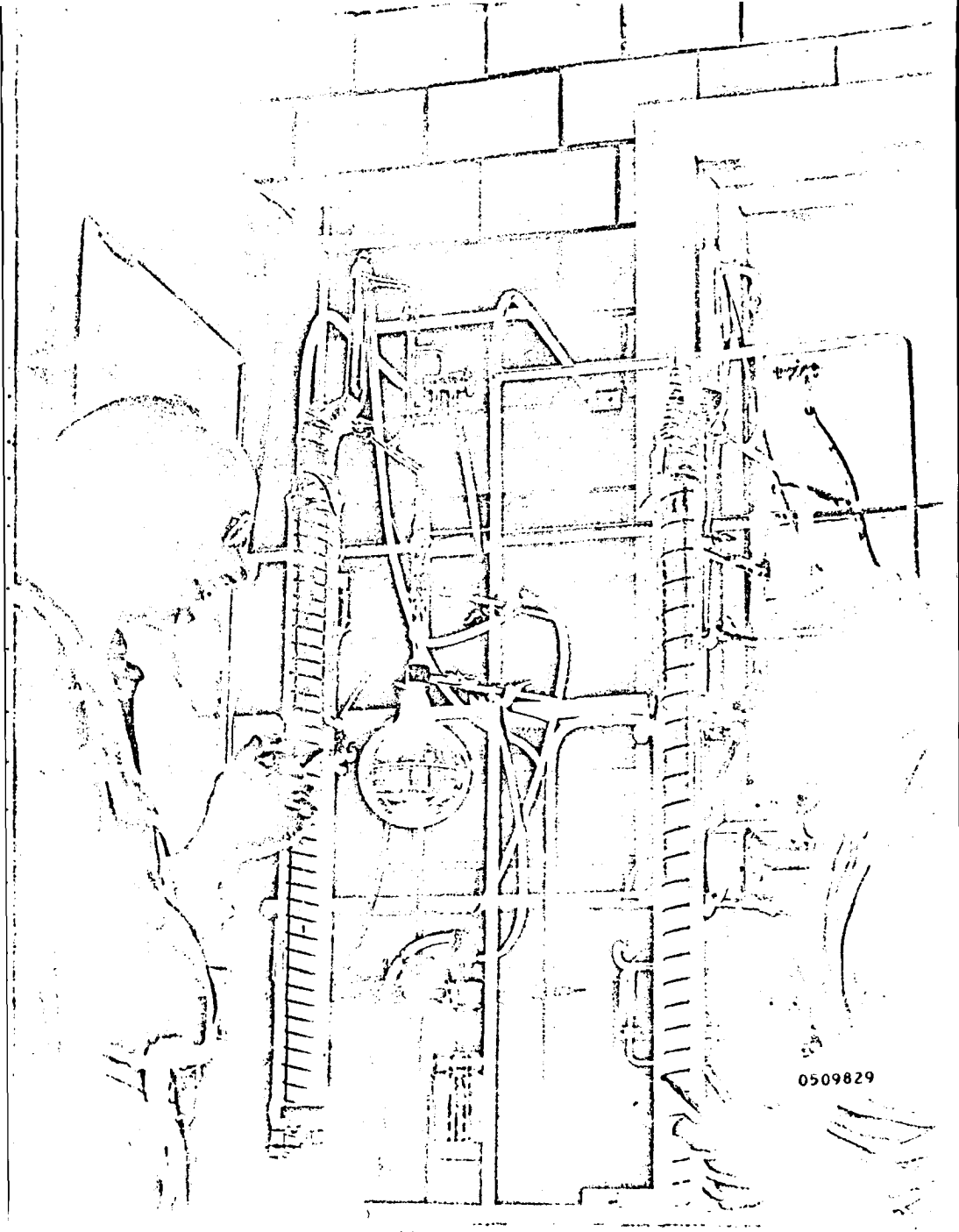
ELECTRICAL RESISTIVITY

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.

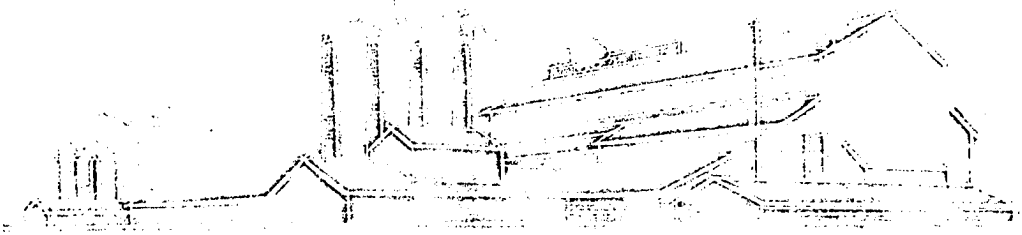
SOLUBILITY

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.


0509829

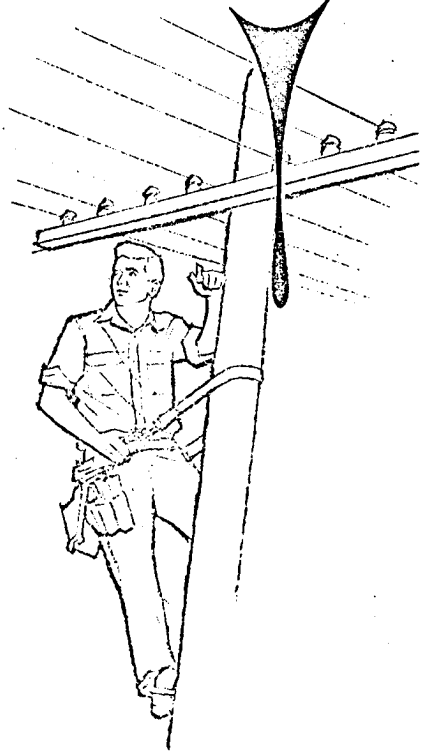
industrial applications of the aroclors



0509830

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-

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 500×10^9	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 500×10^9	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

0509832

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 10^9 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.

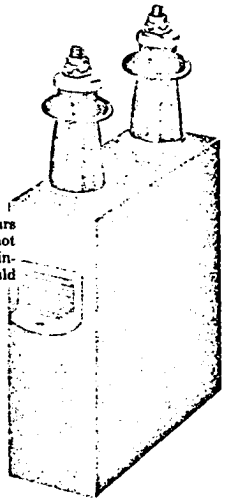
*Determined by special request.

0509833

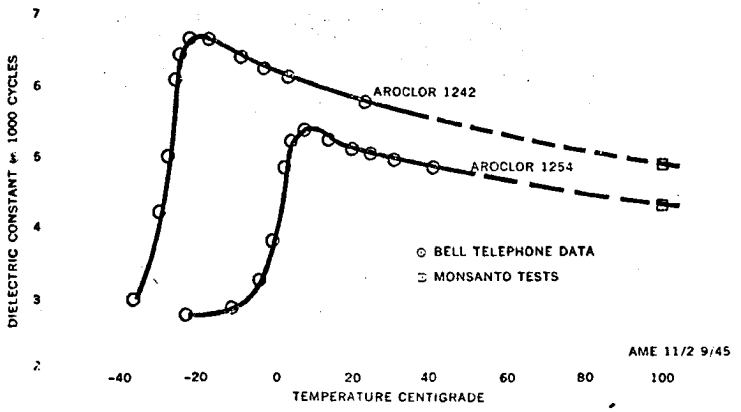
Typical Capacitor Aroclor (continued)

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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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.

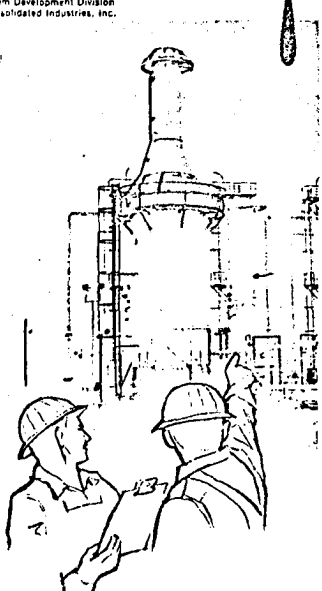
mechanical applications of aroclors

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]solidated 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.

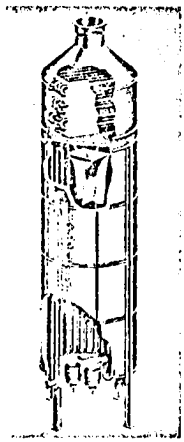

Photo courtesy of Western Precipitation Corp.

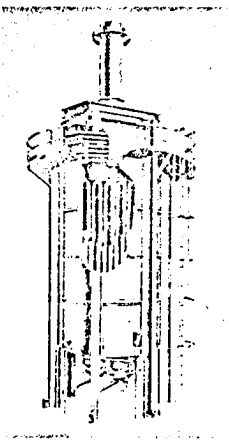

Photo courtesy of Struthers Wells Corp.

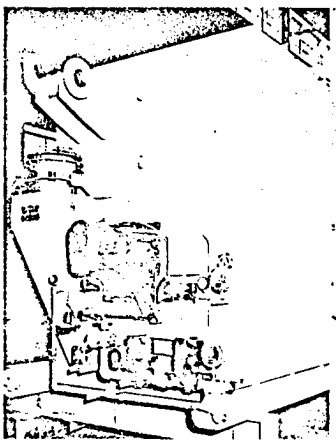

Photo courtesy of Union Iron Works

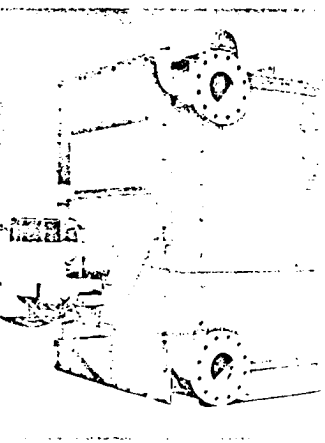

Photo courtesy of The International Boiler Works Co.

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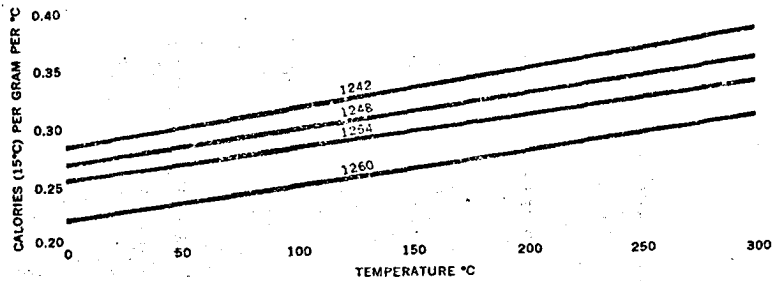
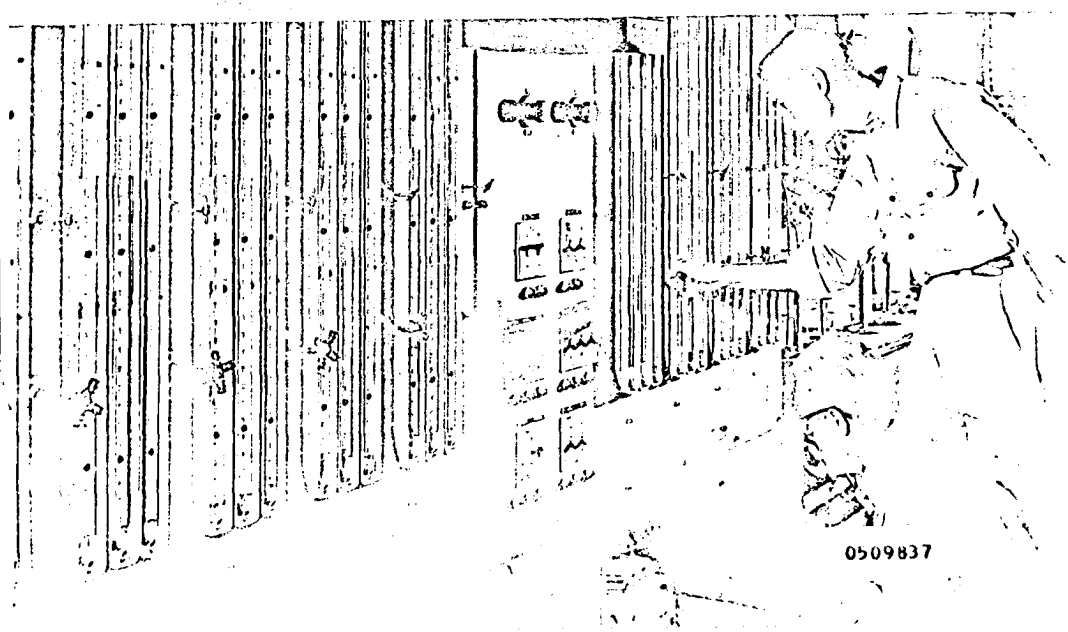
HEAT CAPACITY OF AROCLORS
AT VARIOUS TEMPERATURES



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^{-4}
60	140	0.0564	233×10^{-4}
100	212	0.0555	229×10^{-4}



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 $Vt = Vt^1 [1 + a (t - t_1)]$. 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

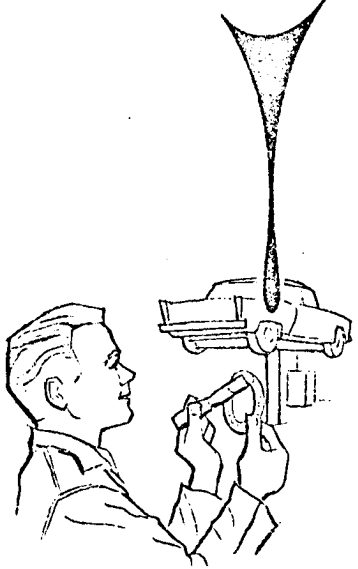
The fluid Aroclors 1248 and 1254 are highly stable to air; they make good oils for vacuum pumps at a much lower cost than high priced silicone type oils. These Aroclors operate efficiently in vacuum diffusion pumps used to pull high vacuum for metalizing plastics; dehydrating foods, medicinals; and for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

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

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:

	% by weight			Gravity at	Approx.
Mix No.	Oil*	Aroclor 1248	Pour Pt.	15.5°C.	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.

0509842

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

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.

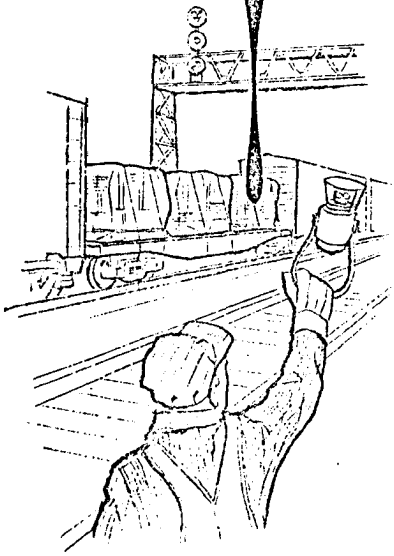
Excellent mastics, too, can be prepared by blending selected Aroclor resins with Indopol polybutenes. The mastics have good adhesive qualitites for specialized uses such as sealing of automobile body construction.

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.

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.

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

Aroclor 1254 in yellow traffic paint.

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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.

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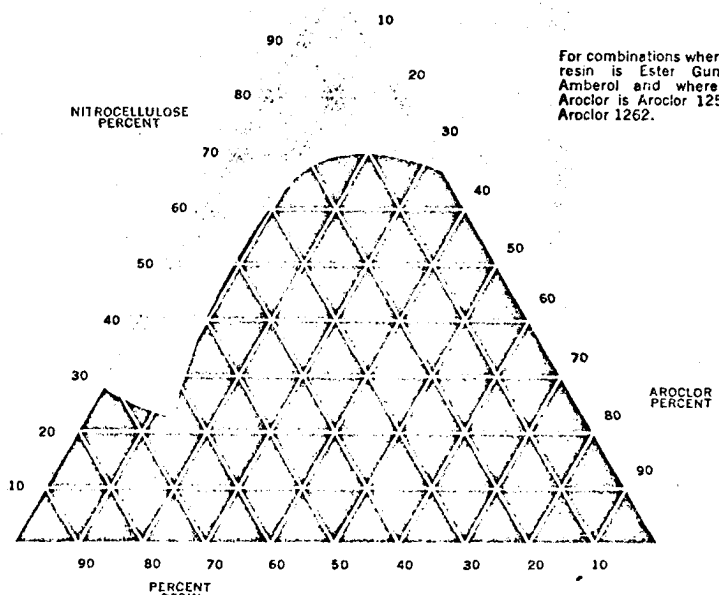
In the trilinear diagrams, the compositions, represented by any point in the unshaded areas, are those which produce homogeneous lacquer films. On the other hand compositions represented by points in the shaded areas produce impractical, segregated, brittle or soft films. For detailed information as 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).



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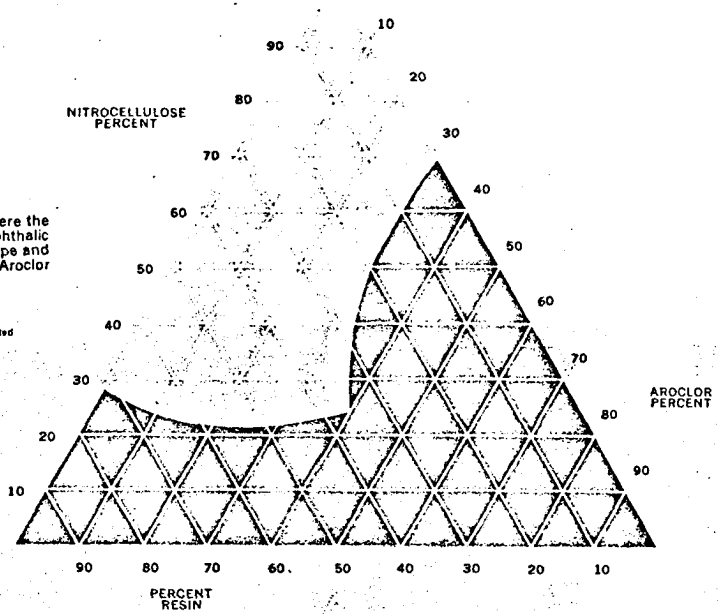
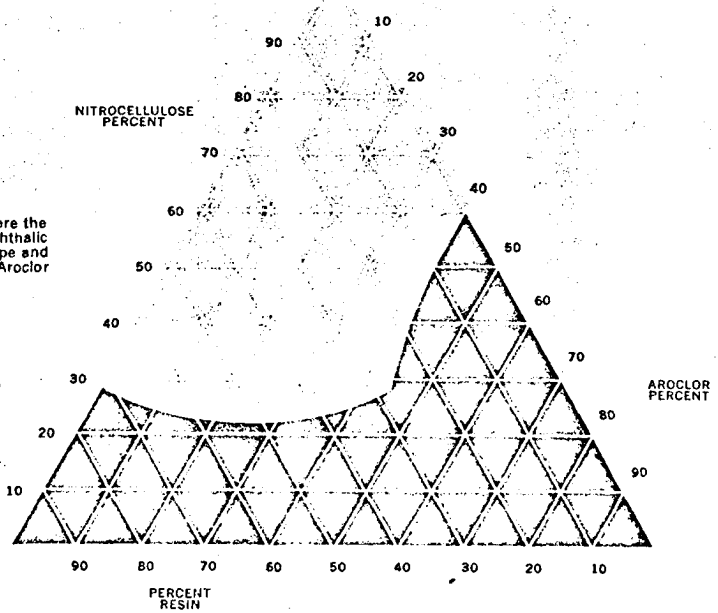
For combinations where the resin is of the phthalic anhydride-glucerol type and where the Aroclor is Aroclor 1262.*

*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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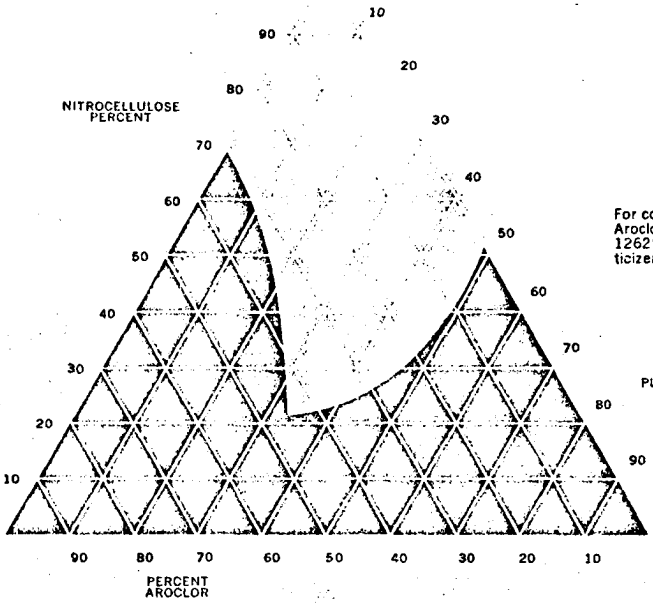
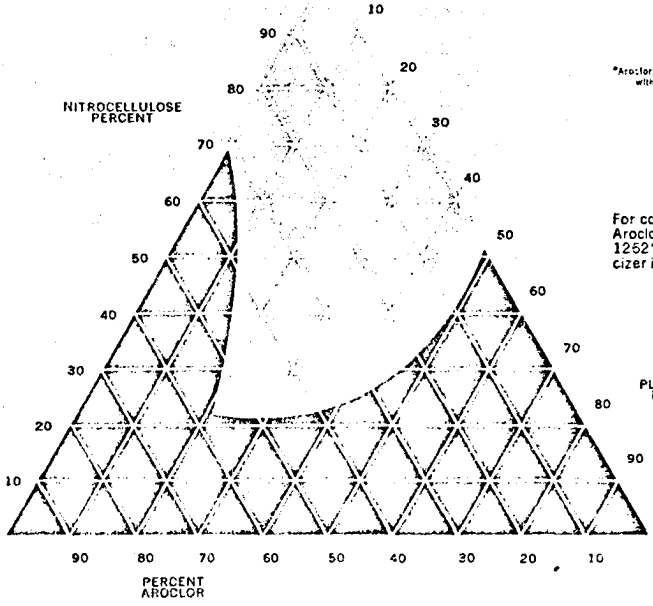


For combinations where the Aroclor resin is Aroclor 1262* and where the plasticizer is Dibutyl Phthalate.



*Aroclor 1260 may be substituted without material change.

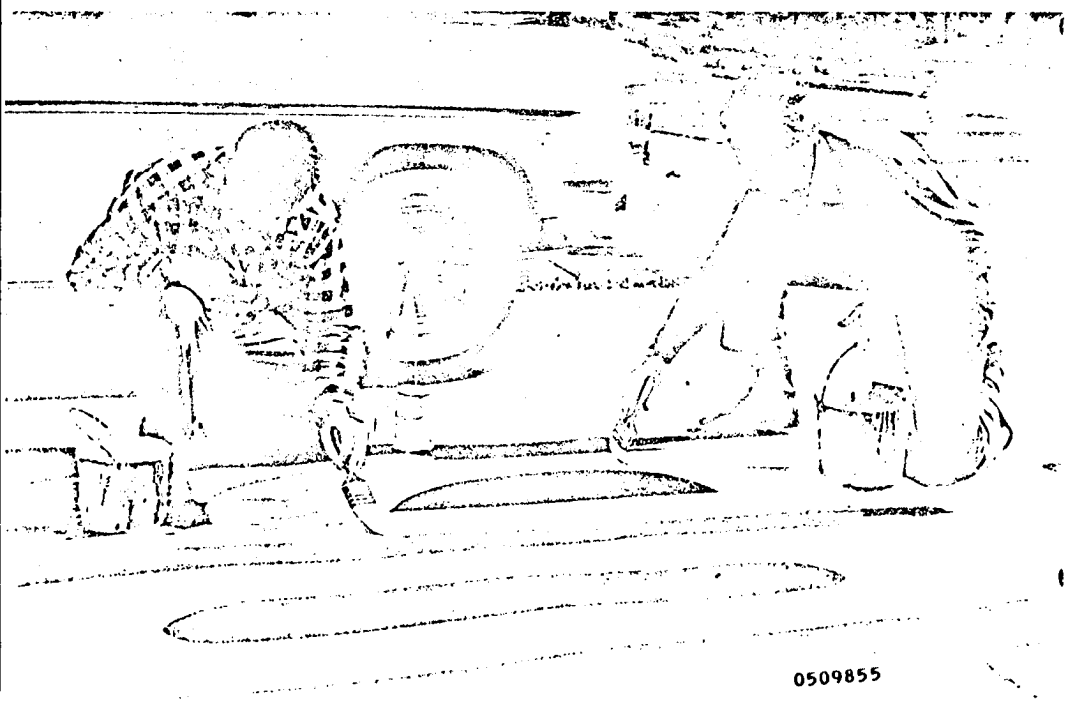
For combinations where the Aroclor resin is Aroclor 1252* and where the plasticizer is Tricresyl Phosphate.

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.



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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.

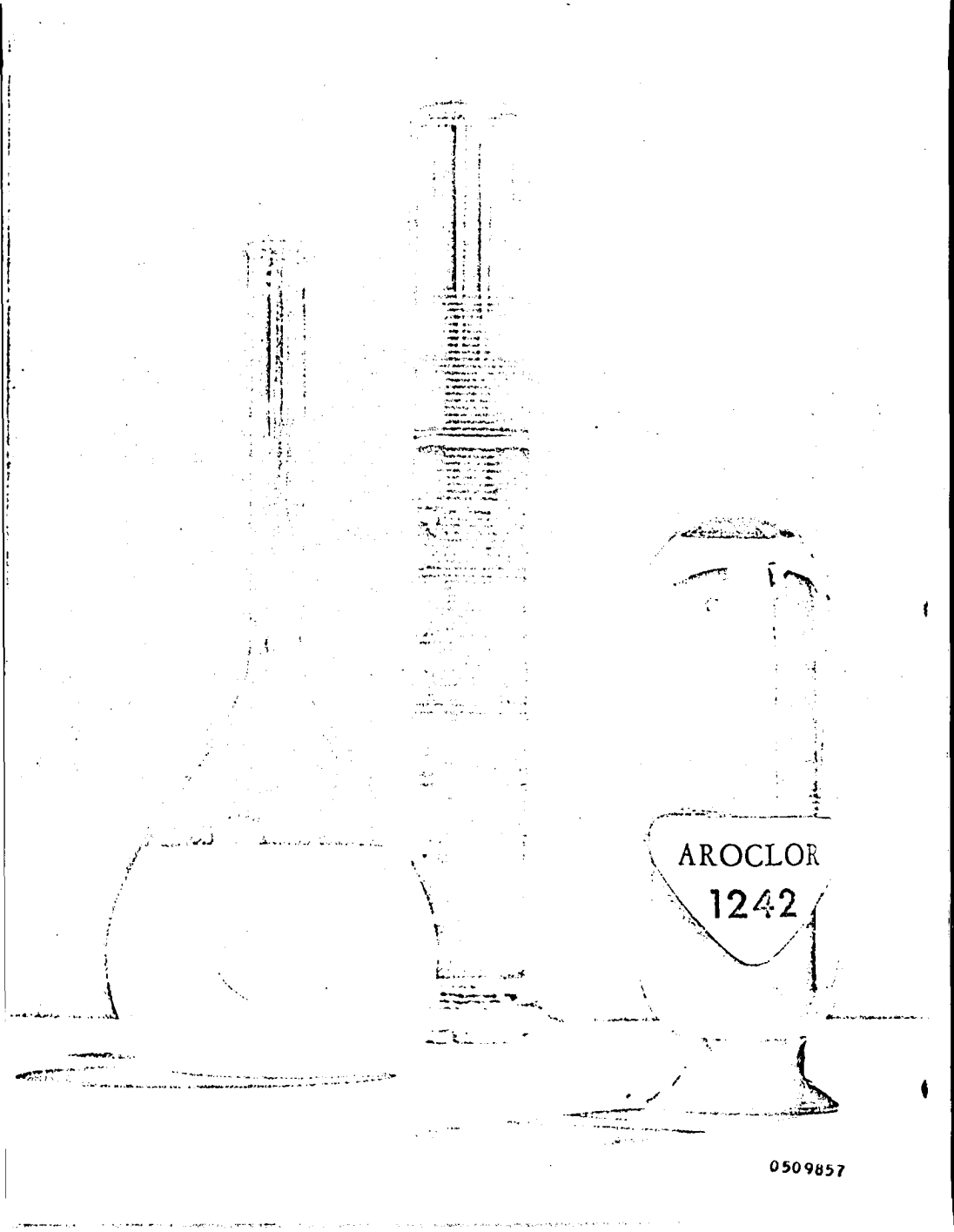
Ethyl cellulose formulations plasticized with Aroclors find end use applications as protective lacquers, adhesives, and as strippable coatings.

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. Gearheart and F. M. Ball, OFFICIAL DIGEST, Vol. 343, 1953.



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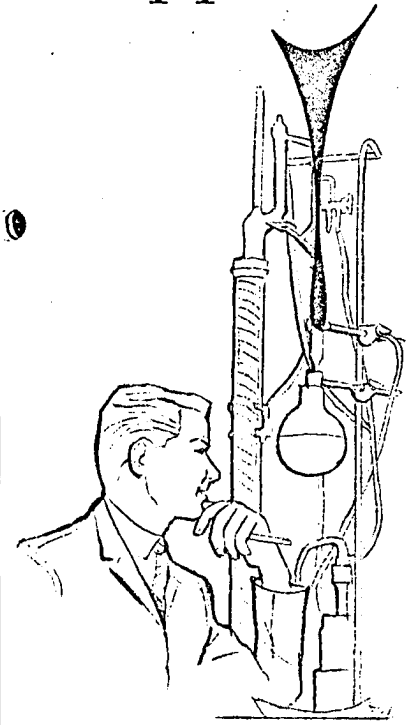

METHODS FOR EMULSIFYING AND MAKING STOCK SOLUTIONS OF AROCLORS

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 28°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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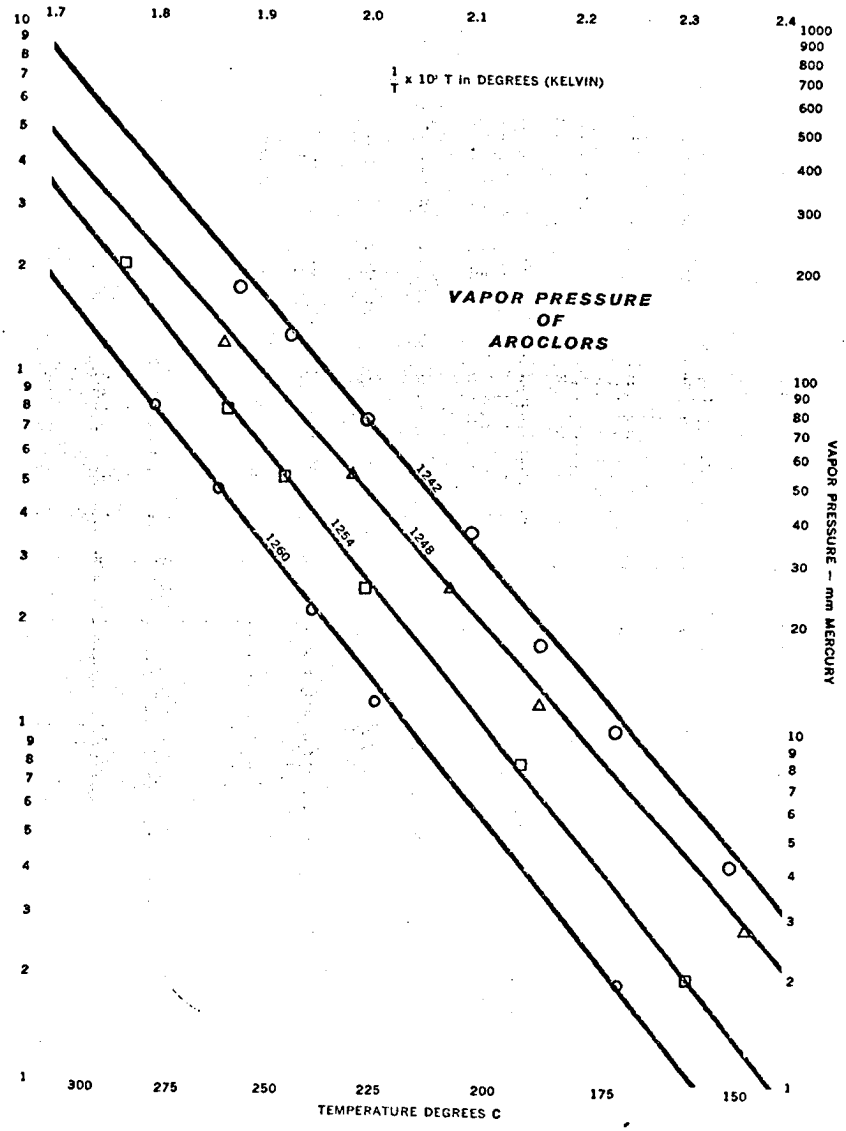

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VAPORIZATION RATES

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.

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RESISTANCE OF STRUCTURAL MATERIALS TO AROCLORS

Metals	Aroclor 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.

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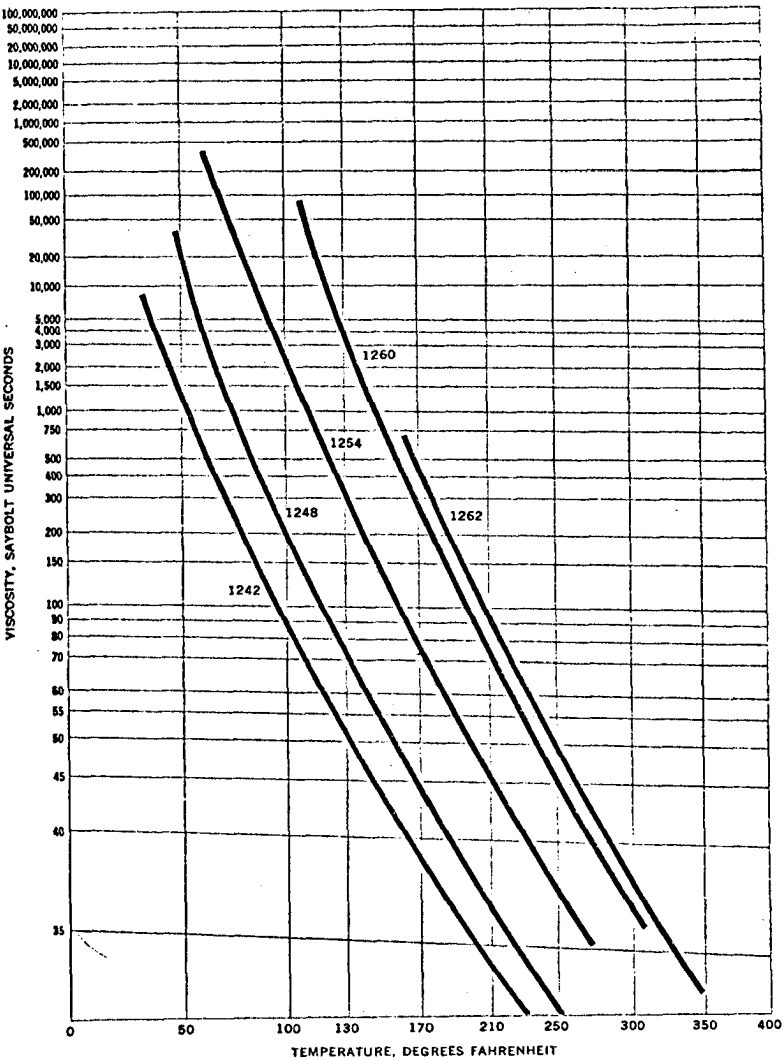
VISCOSITY RANGES OF SOME OF THE AROCLORS



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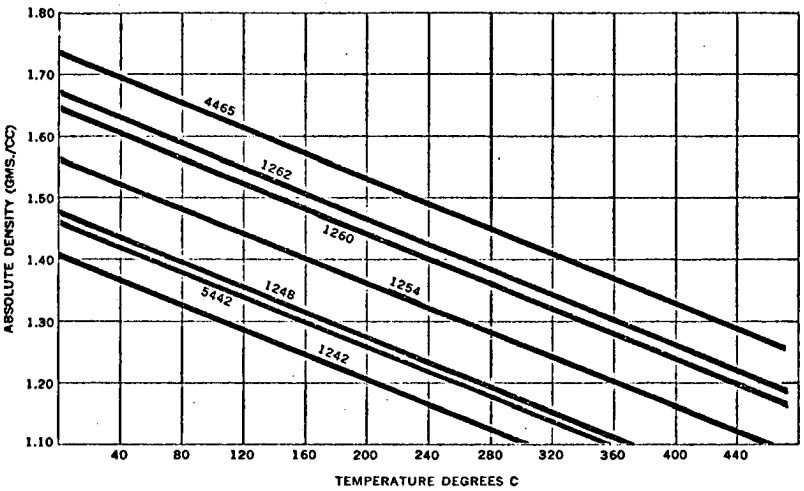
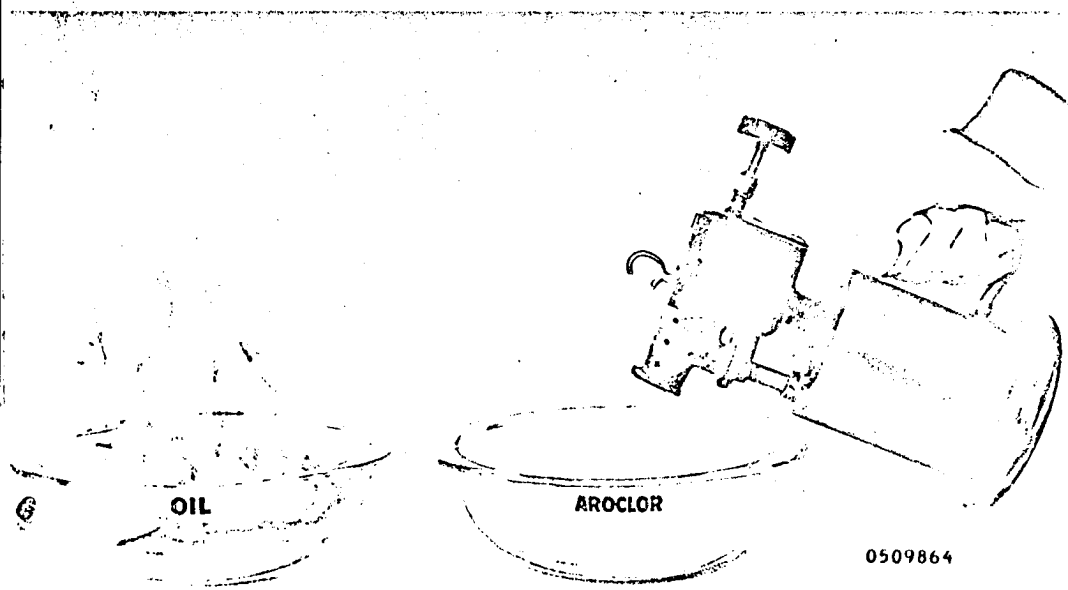
DENSITIES OF AROCLORS AT VARIOUS TEMPERATURES





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

2-800-05/62-53

EXHIBIT 8

March 15, 1962

Dr. Marcus Key
U. S. Public Health Service
Division of Occupational Health
1010 Broadway
Cincinnati 2, Ohio

Dear Dr. Key:

Confirming our telephone conversation, I am forwarding a copy of our Technical Bulletin No. PL-306 entitled "Aroclor Plasticizers." On pages 48 and 49, we have summarized our available data relating to possible skin effects if the Aroclors are misused.

You will note that in the first paragraph under "Dermatology and Toxicology" on page 48, we state, "When Aroclor compounds are used at elevated temperatures, engineering controls must be applied, either by the use of closed systems or by effective local-exhaust ventilation together with general workroom exhaust."

Again, in the last paragraph on page 48, we make reference to avoiding skin contact. In the section on "Safe Handling" at the top of page 49, we again point out the necessity for avoiding exposures, particularly when the Aroclors may be used in applications where elevated temperatures are involved.

As I told you on the telephone, our experience and the experience of our customers over a period of nearly 25 years, has been singularly free of difficulties. To our knowledge, there have been only three instances where chloracne has occurred. In view of the millions of pounds which have been produced and used in many and varied applications, the low

DSW 018247

frequency of any difficulties has been gratifying. I am sure that the earlier problems with mixtures of the Aroclor and chlorinated napthalenes were in part, responsible for the subsequent trouble-free experience. Certainly we have attempted to provide sufficient information to insure safe handling and usage. We have not in any case attempted to minimize potential hazards.

We have carried out screening toxicological tests on many of the lower Aroclors. We have, likewise, carried out extensive inhalation tests on Aroclor 1248 and 1254. Because of the physical nature of 4465 and the fact that we had no reports of any exposures or difficulties, we have not carried out any toxicological experiments on this compound. I would, however, assume that it has the same toxic character as the lower Aroclors. Therefore, if sufficient material were inhaled, liver problems would develop.

If you have any further questions, please let me know.

Very truly yours,

R. Emmet Kelly, M. D.
Medical Director
Medical Department

REK:sg
Enclosure

CC: Mr. Jerry Molos
U. S. Public Health Service
Division of Occupational Health
1014 Broadway
Cincinnati 2, Ohio

DSW 018248

EXHIBIT 9

E. P. Wheeler

April 8, 1969

Aroclor Degradation in Soil

W. R. Richard

M. J. Magner
H. S. Bergen
R. E. Keller
Scott Tucker

Marsh Magner has told me that several Aroclors were applied to soil in test plots at the University of Florida, Gainesboro on the 28th of June, 1939. The application was to determine possible termite proofing value of the Aroclors. Marsh believes that the test plots are still undisturbed and that he can locate them from plot maps which he has in his files.

Aroclors 1242, 1248 and 1254 were mixed in test soil (1 cubic foot per plot) at two rates of application and in replicate spots. In addition there were additional plots with these Aroclors mixed with penta.

Additionally Aroclor 5442 was applied at one rate of application.

Marsh had reasons to look at some of these sample plots in June of 1963 and recalls that in some instances there was still visual evidence of the presence of Aroclor.

I believe we should consider asking Marsh to look into the possibility of obtaining samples of these plots for measurement of loss or "degradation".

I never would have suspected that we might come across such a situation where we may be able to obtain data on actual aging of Aroclors in soil. Thirty years of exposure might be much more valuable than any accelerated test that could be devised.

Elmer P. Wheeler

cs

DSW 201039

STLCOPCB4059103

EXHIBIT 10

MEETING OF THE BOARD OF DIRECTORS

November 22, 1967

The regular monthly meeting of the Board of Directors of Monsanto Company was held on November 22, 1967, at 1:30 P.M. at the St. Louis County, Missouri, offices of the Company.

Present: Edward A. O'Neal, Dillon Anderson, Edward J. Bock, David R. Calhoun, John L. Christian, Fredrick M. Eaton, John L. Gillis, Herbert Hoover, Jr., Robert K. Mueller, Edgar M. Queeny, James S. Rockefeller, Charles H. Sommer, Charles Allen Thomas and Monte C. Throdahl.

Memorandum of Mr. T. K. Smith, Jr., dated October 27, 1967 requesting the appropriation of $2,900,000 for expanding Aroclor® facilities at the Anniston, Alabama and W. G. Krummrich plants, was submitted to the members in advance of the meeting. This project will improve quality and will increase manufacturing flexibility, manufacturing and blending capacity, and raw materials and finished goods storage capacity. Upon motion made and seconded, the following resolution was unanimously adopted:

> RESOLVED, that the expenditure of $2,900,000 for expansion of Aroclor® facilities at the Anniston, Alabama and W. G. Krummrich plants, is hereby approved.

DSW 013007

EXHIBIT 11

DATE February 14, 1969

cc. J. R. Fallon
R. A. Garcia - AKRON
S. Shaw

SUBJECT INQUIRY FROM VAPOR CORPORATION ON TOXIC EFFECT OF CHLORINATED DIPHENYL

TO : J. J. Roder - CHICAGO

Stan forwarded to me the note you received from Ed Gustaf and the accompanying letter from T. Fujiwara, Managing Director, Nipon Vapor Generator Company, and to H. J. Schickedanz, General Manager, Vapor International. We have been advised by our Japanese representatives of the bran oil poisoning of quite a number of Japanese citizens that was attributed to Kaneclor 400 (chlorinated biphenyl comparable to FR-2).

We assembled both medical and application data and sent it to our Japanese counter-parts as arguments for the safe use of chlorinated biphenyl heat transfer fluid. Essentially, we said that there are certain toxic and systemic effects that can be brought about by the vapors of chlorinated biphenyls. We did not rule specifically on the injestion limits of this chemical. We also directed attention to the large number of applications in food processing that utilize Therminol FR heat transfer fluid. We brought out very strongly the fact that these systems have been designed to minimize accidental contamination of food products with chlorinated biphenyls.

I think we have a good track record here in the States using Therminol FR in these applications. However, it only seems a matter of time until the regulatory agencies will be looking down our throats regarding the use of this material. Possibly, by the time this comes about, we will have completed feeding studies with chlorinated biphenyls that will allow us more exact data than has been available in the past. As a matter of fact, they're feeding this stuff to chickens now, but I have no specific results of these tests. I can only suggest that you attempt to put Gustaf's mind at ease regarding the "toxic" aspects of these chlorinated biphenyls by playing down the medical reports and playing up proper system design.

Look at the bright side for us in the heat transfer fluid end of our business -- if the government closes us down on the use of chlorinated biphenyls, we have two excellent fluids in Therminol 55 and Therminol 66, as well as, a proprietary fluid in Therminol 77 to exploit. Therminol 66 will certainly be available in Japan according to recent information from our Engineering Department.

MONS 096865

A final caution Jim, please use the attached information with some discretion. I certainly would not pass completed sets of this data to those asking the questions, but rather extract the essential points from this data, namely, the ruling on vapor limits as handed down by the Industrial Hygienist Association, and a strong play on proper system design to prevent accidental contamination of food products and processing material by chlorinated biphenyls.

Don Roush

Don Roush

MONS 096866

EXHIBIT 12

Monsanto

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

DATE : March 6, 1969

SUBJECT : AROCLOR WILDLIFE ACCUSATIONS

REFERENCE :

TO : E. Wheeler - EWHEE

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 chromic (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.

(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 13

April 2, 1969

REPORT AND COMMENTS ON MEETING ON CHLORINATED BIPHENYLS IN THE ENVIRONMENT AT INDUSTRIAL BIOTEST LABORATORIES, CHICAGO, MARCH 21, 1969

Robert L. Metcalf

From the background data presented it appears that something of the order of 80 million pounds of polychlor biphenyls (PCB) are produced annually. These products contain from 3 to 9 chlorine atoms per molecule and become increasingly inert and stable to environmental oxidation with higher degree of chlorination. However, about half the production is in the 3-chlorine atom variety (Aroclor 1242).

At first thought it seems unlikely because of the major uses of PCB in capacitors, transformer oils, heat transfer fluids in closed systems, that these materials could be the source of the substantial degree of environmental contamination reported. However, about 40 million pounds annually is stated to be used as plasticizers, hydraulic fluid, adhesives, and in carbon paper. From this amount a very substantial percentage must escape into the environment as waste. Because of the apparent high stability of PCB, amounts entering the environment would be degraded very slowly and it seems possible that at least 10million pounds annually may become environmental contaminants. Since the PCB's were introduced commercially in 1929 there have been 40 years of production. If this has averaged 50 million pounds per year, then about 2×10^9 pounds have been made and perhaps 2×10^8 pounds have entered the environment. Because of the apparent stability of these compounds most of this amount may still be circulating in the global ecosystem and this is suggested by the levels reported by Holmes et al. (1967) and Risebrough et al. (1968) in animal tissues which are quite comparable to those found for DDT. Both PCB

and DDT are extremely stable and water insoluble and have been produced in roughly the same total amounts over the past 30 years.

Thus it seems quite reasonable to conclude that the environmental contamination described for PCB is due to waste amounts of these compounds. This, coupled with the thorough evidence from mass spectometry strongly suggests that there is an important environmental quality problem involved in wastes of PCB.

Experimental Work Planned at Industrial Biotest.--

This laboratory is highly experienced and seems quite competent to provide standard data required by FDA for evaluating the safety (or hazard) of agricultural or industrial chemicals. The long term feeding studies on rats and dogs will doubtless serve to indicate the chronic toxicity hazards of chronic ingestion of the PCB at ppm levels and this will almost certainly result in severe liver damage at some reasonable level. The chicken reproduction investigations at 0.01, 1, 10, and 100 ppm should be considerably more meaningful particularly in regard to studies of egg hatchability, shell thickness, etc.

While the fish toxicity investigations will be interesting, I cannot see that they are particularly relevant or necessary at this time and I would think this data could be obtained from Fish and Wildlife investigations, etc., and will undoubtedly be forthcoming, unsolicited.

Conclusions and Suggestions.--

It seems to the writer that the evidence regarding PCB effects on environmental quality is sufficiently substantial, widespread, and alarming to require immediate corrective action on the part of Monsanto. The defensive measures presently underway will do little if anything to

refute the evidence already presented. I would suggest the following:

1. A substantial analytical program to monitor air and water effluents from Monsanto plants producing PCB and also those of major customers.

2. Prompt correction of effluent conditions where PCB can be demonstrated.

3. Serious consideration of curtailing sales of PCB for uses such as plasticizers, adhesives, and carbon paper where waste is certain to enter environment.

4. Review of dispoaal and recovery methods for PCB in capacitors, transformers, heat transfer fluids, and hydraulic fluids. Emphasize to customers importance of preventing environmental contamination.

5. Thorough investigation of environmental fates of various PCB's including photochemical oxidations, chlorination in water systems, etc.

6. Biochemical and electron microscopic study of levels of PCB ingestion which cause proliferation of endoplasmic reticulum and induction of multifunction oxidases in chickens and rats (perhaps these are partially included in present Industrial Biotest experiments).

7. Begin investigations of possible biodegradable substitutes for PCB's as plasticizers, adhesives, fire resistant hydraulic fluids, etc., anticipating loss of these markets as a necessary corollary of environmental problems. Are, for example, chlorinated diphenyl oxides or diphenyl sulfides suitable for these uses. They should be considerably more biodegradable.

EXHIBIT 14

PCB committee
aug 25 - 69

State Health dept - analysis done by Ag. Dept.
Georgia - Found PCB in milk
- asked govt for Toxicity data
- we told FDA to give Toxicity data
W. Virginia - also found in milk -

Hartford Times

Sales call report - Great Lakes Steel Corp.

Japan - Aroclor 1248

- Thermal use in process heating -

- research in food product & cooling oil
- research seemed to be impossible -
- contact all customers - assure them there is no way to contaminate without detection.

P 583A

Scott analysis -
- Electrosol - 5 ppm - detergent

Grant Foo in Ann Arbor, Mich - originally found PCBs in soap
Talking to water commission lab
at Duluth now

- Ward Study - Lake Michigan - 9 of 80 samples had PCB - (1254)
- Water samples -
- Trying to find source of DDT
- Tested samples at all streams dumping in Lake Michigan -
PP Trillium DDT, DDE, endrine,

Pensacola -

- Visit to plant by State Officials
- Lawyer not in
- Sr people left - no real meeting
Pres. - Satisfied -
- Did probably on for the moment.

- mud samples - 4 PPM
½ mile below outfall. -

- Monsanto (with sattlely) to monitor
own outfall. -

- only used Aroclor A.C. since 1969

- Plant feels need be in for
law suit by shrimp fishermen
in Pensacola Bay.

Oregon State -
"Biological Impact of Pesticide
in the Environment"
400 - 25 state
Industry POT

Risebrough - presentation Slides
- Pelican meat - no shell
- 1000 eggs - only 3 with shells

- material Monsanto PCB & our statement
- M. won't release production figures guessed 22M #/yr. -

- could find levels 1 ppm on very long string

- Pres did not mention PCB's nor Monsanto - discussion industrial chemicals. -

Overall impression:
"They'll put us out of business"
- Can show safety factor - close tie to pesticides - could get tight restrictions

Gov. of Oregon - Set up commission to advise him on synthetic chemicals.

Subject is Snowballing

Where do we go from here → 1254, 1260 } identified
Possibly 1248, 1242 }

Alternatives:

1.) Go out of Business

2.) Sell the Hell out of them as long as we can and do nothing else

The Big Question!

What do we tell our customers?

Cronic data – 90 day studies - "no effect in rat & dog"
– "100 ppm – some decrease in egg thickness in hens"

3.) Try to stay in business in Controlled Applications - Control Contamination levels

1.) Have alternate products.

2.) or Help customers clean up their use

What we should Know

1.) Greater effort to coordinate all + researchers working throughout World.

2.) Water Pollution - single, most important area

3.) Positive approach toward Toxicity - clean up the use.

1.) Is it PCB? yes

2.) How did it get there? – air, water, etc.
Yes

3.) Toxicity – Safe limits

4.) What do we do in interim until Safe limits are established/listed

- Biological Testing
- Control of use
- Alternate Products

(Program by 15th of September)

PCB Committee — ✓ Bergen
✓ ~~Wheeler~~
✓ ~~Seibold~~
✓ Springgate

Task Force
Farrar
Wheeler
Richards
Hodges
John ~~Ford~~

cc ✓ Scott
cc ~~Fowler~~
Paul Hodges
cc: Emmett Kelly
cc: Stratmeyer
cc: TC Ford

EXHIBIT 15

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.

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 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 REPLIES
TO CHARGE THAT PCB
THREATENS ENVIRONMENT

ST. LOUIS, April 10 -- Monsanto Company said today it was well aware of the concern over possible environmental contamination by polychlorinated biphenyl (PCB), an industrial chemical made by the company. The company began a six-point program in 1968 to properly identify and measure PCB in the environment. Steps have been taken to strictly control use of the chemical and replace those grades of PCB which linger in nature.

Monsanto's statement came in response to charges by Congressman William F. Ryan (Dem.) of New York that the discovery of PCB in the ecology represented a major threat.

Howard L. Minckler, Monsanto vice president and general manager of its Organic Chemicals Division, said, "We have and will continue to cooperate fully with governmental agencies investigating this problem. We also have been in close contact with our customers. Monsanto has spent over $1 million to verify or correct scientific reports, monitor the use of PCB and search for substitute products where needed. This program will be successfully concluded this year.

DSW 019461

-more-

--2 MONSANTO: REPLY TO PCB CHARGE xxx year.

"It is unfortunate that Congressman Ryan evidently did not have all this information at his disposal. Just last month we participated in a U.S. Department of the Interior meeting where we exchanged ideas with some 40 scientists and told them of our findings and actions," Minckler said.

The Monsanto executive also noted that the use of PCB is misunderstood by some investigators. "For example, we do not know of any current use of PCB in insecticides. Even so, we are asking the U.S. Department of Agriculture to reject any insecticide which has PCB as an inert carrier," Minckler said.

"PCB is not a household product, as some have suggested," Minckler continued. "To our knowledge, it is not used in plastic food wraps, house paints, cellophane, asphalt or tires. The principal market is electrical applications where the chemical performs a vital function as an insulating fluid. In this use, PCB is completely sealed in a metal container. Other major markets employ similar closed systems."

Monsanto's PCB program was initially directed at proper identification of chlorinated hydrocarbons appearing in the environment. This research, confirmed by others, found only the higher chlorinated materials. At the same time, Monsanto undertook animal feeding studies which show PCB is not a highly toxic material.

DSW 019462

-more-

The second part of Monsanto's investigation was coordination with all customers and a rigid critique of its PCB manufacturing units. Although loss of PCB during manufacturing was negligible, production techniques were further modernized and new pollution abatement devices are continually being upgraded.

Monsanto has concentrated its further research on those few PCB compounds which degrade slowly. Alternate products for these grades, which retain the functional properties of PCB and present no potential threat, will be introduced later this year.

Minckler concluded, "Monsanto is seeking the best solution to this potential environmental problem. Action not based on reason and scientific facts can only result in greater problems. For example, we have been advised by one electrical equipment manufacturer that an immediate ban on PCB would result in major power failures throughout the world. This is not the answer. Proper use of this vital chemical and substitution, where appropriate, is the answer."

-oOo-

EXHIBIT 17

Monsanto

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

DATE February 16, 1970

SUBJECT

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

POLLUTION LETTER

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

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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 18

July 30, 1971

MEMORANDUM FOR THE RECORD

SUBJECT: Updated review of toxicity studies in progress with polychlorinated biphenyls (Aroclor 1242, 1245 and 1260).

TO: Dr. Leo Friedman
Director,
Division of Toxicology (BF-150)

This memo is meant to update our review of extensive toxicological studies being carried out at Industrial BioTest Laboratories under the sponsorship of the Monsanto Company.

Prior to formation of the EPA progress reports related to these studies were being transmitted directly to Dr. O. G. Fitzhugh. When Dr. Fitzhugh transferred to EPA he left behind what data he had on hand, however, we had no way of knowing if any of the reports had been updated and at the same time lost in transit. For this reason I called Drs. Kelley and Wheeler of Monsanto Company to request that they provide us with an up-to-date set of progress reports. They agreed to both provide me with the requested reports and in addition to authorize the Industrial BioTest Laboratories to answer any direct questions I might have.

The following is a summary of the submitted reports. In essence they do not differ significantly from that incorporated into the toxicity section of Supplement 1 of the PCB Status Report.

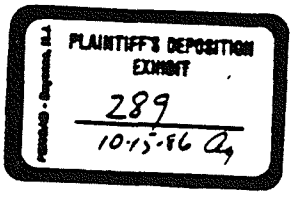
Dog fed Aroclor at levels of 0, 1, 10, 100 ppm.

The study has progressed for 18 months. Parameters studied are: body weight, food consumption, behavioral reactions, hematology, blood (bio-) chemistry studies and urine analysis.

Aroclor 1242 - No compound related effects noted.

Aroclor 1254 - There has been decreased weight gains for males and females at 100 ppm and for females at 10 ppm.

Aroclor 1260 - There has been decreased weight gains for males and females at 100 ppm and for females at 10 and 1 ppm. At 12 and 18 months male and female at 100 ppm have shown moderate increases in serum alkaline phosphatase.



Rats fed Aroclor at levels of 0, 1, 10 and 100 ppm.

The study has progressed for 15 months. Parameters studied are those described for the dog with the addition of a 1 year sacrifice which includes gross and microscopic examinations along with organ and organ to body weight data.

Aroclor 1242 - No compound related effects noted.

Aroclor 1254 - At the 1-year sacrifice, males at 100 ppm had elevated liver weights, however, histopathology was negative.

Aroclor 1260 - At the 1-year sacrifice, males at 100 ppm had elevated liver and kidney weights, however, histopathology was negative.

Rats fed Aroclor at levels of 0, 1, 10 and 100 ppm through three successive a and b generations. The study has progress through the $F_{1a,b}$. In addition the F_0 parents have been examined.

Aroclor 1242 - There appeared to be a drop in lactation index (number of viable weaned pups/number of pups at day 5) for both F_{1a} and F_{1b} litters at the 100 ppm level.

Aroclor 1254 - There was a sharp drop in the number of pups delivered of parents in the 100 ppm group for the F_{1b} litters. A further F_{1c} litter confirmed this finding.

For the parents, the females at 100 ppm gained less weight then controls. For both male and female at 100 ppm liver to body wt. ratios were increased although absolute liver weights were not. Also for males and females at 100 ppm there were elevated thyroid weights. Histologic examination revealed thyroiditis in 3 of 5 males.

Aroclor 1260 - There was an increase in stillborn pups in the F_{1b} group at 100 ppm. There appears to be a trend toward decreased litter size for both F_1 litters at 100 ppm.

The parents males at 100 ppm had increased liver weights and liver to body weight ratios.

Chickens fed Aroclor at levels of 0, 1, 10, and 100 ppm and observations made of egg production and hatchability.

Aroclor 1242 - For parents, body weights of males at 10 and 100 ppm were decreased. Food consumption at 100 ppm was decreased.

Egg production at 100 ppm was decreased, and hatchability at 10 ppm was decreased. None hatched at 100 ppm. Unhatched eggs contained embryos 1-3 cm in size. Shell thickness was reduced in 100 and 10 ppm groups.

Aroclor 1254 - For parents body weight of males and females fed 100 ppm were slightly reduced. Food consumption at 100 ppm was reduced. There were some scattered pathological changes the significance of which is difficult to access at this time.

Egg production in the 100 ppm group was reduced. None of the eggs at 100 ppm hatched. Shell thickness was decreased at 100 ppm.

Aroclor 1260 - There were no untoward effects noted in either parents or eggs derived from them.

Chickens were fed at levels of 2, 4 and 8 ppm aroclor 1242 in an effort to establish where between the levels of 1 and 10 ppm a no effect level lies. Parameters studied were as for this previous chicken study. In addition a 30 day recovery period on normal diets was included.

Aroclor 1242 - The only effect noted was a decrease in the percent hatch for the 4 and 8 ppm diets.

CONCLUSION:

The summary of data to date indicates several areas of concern. Primary is the apparent effects on reproductive processes of the PCBs. Although the chicken is known to be sensitive to this class of compounds, reacting in a manner similar to its reaction to the chick edema factor, none the less a real effect has been recorded. While results vary for the three aroclors studied, for the 1242 effects on hatchability were noted at levels as low as 4 ppm in the diets of parents.

For the rat decreases of litter size or increases in stillborns are seen at levels of 100 ppm in parents fed 1254 and 1260. Since for 1254 these effects were magnified from the $F_{1a,b}$ to $_{c}$, it is possible that successive generations may show an increased severity in effect.

For the dogs it is conjectural what histology is reflected by the increased serum alkaline phosphatase.

Our conclusions at this time are that pending completion of studies in progress we are in a poor position to recommend guideline levels for contamination. This lack of complete toxicologic data when coupled with

our essential lack of information about background levels of contamination in foodstuffs in general, makes it all the more imperative that we resist setting guidelines on anything more then a case by case basis at this time.

H. Blumenthal, Ph.D.
Acting Deputy Director
Division of Toxicology (BF-151)

cc:
BF-152
BF-2 (Dr. Kolbye)

HBlumenthal:mmt 7/30/71

EXHIBIT 19

[redacted]

July 18, 1975

Dr. J.C. Calandra
Industrial BIO-TEST Laboratories
1810 Frontage Rd.
Northbrook, Ill. 60062

re: AROCLOR 2-year Rat Feeding Studies

Dear Joe:

The attached table summarizes a comparison of the 3 revised AROCLOR reports (1242, 1254, 1260).

In 2 instances, the previous conclusion of "slightly tumorigenic" was changed to "does not appear to be carcinogenic". The latter phrase is preferable. May we request that the AROCLOR 1254 report be amended to say "does not appear to be carcinogenic".

The number of hepatomas reported for AROCLORS 1260 and 1242 have been interchanged. This appears to have arisen from confusion regarding the numbering of the animals. The original reports show tumors in animals with numbers in the 100-300 range for AROCLOR 1260 and in the 500 to 800 range for AROCLOR 1242. This leads me to conclude that the numbering scheme shown in the second set of reports is correct. With AROCLOR 1254 confusion is compounded. The original report showed tumors in animals with numbers in the units to teens, but the revised report shows animal numbers ranging from 40 to 1000. Can this be straightened out?

I was unable to reconcile the differences in the animal numbers between the first supplemental report and the original reports, I had inquired as to the changes in the numbers. As I recall, I was told that the sections had been renumbered when the new slides were made and that a key relating to the sets of numbers

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would be supplied. This has not been done. It may not be necessary for AROCLORS 1260 and 1242, but AROCLOR 1254 remains unresolved.

Insofar as I can see, the remainder of the reports appear acceptable.

Kindest personal regards,

Sincerely,

George J. Levinskas, PhD
Mgr., Environmental Assessment
and Toxicology

/bkp

att.

cc: Dr. George Roush, Jr., M.D.

Product	Supplemental Report #1 (mailed)	Supplemental Report #2 (JCC delivered)
AROCLOR 1260		
conclusion	slightly tumorigenic	does not appear carcinogenic
hepatomas	3	7
range of test animal nos:		
p. 9	600 to 800	100 to 300
p. 10	1000 series	800 to 900
p. 11	70 to 100	10 to 40
p. 12	500 to 600	80 to 200
p. 13	600 to 700	200 to 300
p. 14	700 series	200 to 300
AROCLOR 1254		
conclusion	slightly tumorigenic	slightly tumorigenic
hepatomas	6	6
AROCLOR 1242		
conclusion	slightly tumorigenic	does not appear carcinogenic
hepatomas	7	3
range of test animal nos.	as in report #2 for AROCLOR 1260	as in report #1 AROCLOR 1260

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EXHIBIT 20

ARCCCON 1754

Industrial **BIO-TEST** *Laboratories, Inc.*
1810 FRONTAGE ROAD
NORTHBROOK, ILLINOIS 60062

TOXICOLOGY
ENVIRONMENTAL SCIENCES
CHEMISTRY
PLANT SCIENCES
MEDICAL SCIENCES

AREA CODE 312
TELEPHONE 272-3030

August 4, 1975

Dr. George J. Levinskas, Manager
Environmental Assessment and Toxicology
Monsanto Company
800 North Lindbergh Boulevard
St. Louis, Missouri 63166

Dear George:

Re: Aroclor - 2 Year Rat Studies

In regard to the comments and questions covered in your letter dated July 18, 1975, pertaining to the above, please note the following:

1. We will amend our statement in the last paragraph on page 2 of the Aroclor 1254 report to read, "does not appear to be carcinogenic" in place of "slightly tumorigenic" as requested.

2. In regard to the animal numbers in the Aroclor 1242 and 1260 reports, they are correct in our final revised report. In the original reports, the Aroclor titles for these two materials were reversed.

3. The animal identification numbers appearing in the reports on evaluation of additional liver sections are the same as those in our original report. The animals were not renumbered.

4. We cannot find any discrepancy in animal identification numbers in the reports (original, re-evaluation, final revision) on Aroclor 1254. However, in the report on re-evaluation of additional liver sections dated March 24, 1975, there was a typographical error on page 1 which referred to Aroclor 1260 instead of 1254. Perhaps this is the basis of your confusion.

I hope that this will serve to further clarify the situation. Thank you for your assistance and cooperation.

Sincerely yours,

Joe

J. C. Calandra
President

DSW 035053

JCC:AR

EXHIBIT 21

Monsanto

File Dieldrin PR

FROM (NAME & LOCATION) Pierre R. Wilkins - New York

DATE : December 10, 1975

cc: PCB Study Group

SUBJECT : REPORT BY PCB STUDY GROUP

REFERENCE :

TO : Mr. Earle H. Harbison

CONFIDENTIAL

The following is a response by the PCB study group to the specific questions asked concerning the past, current and future impact upon Monsanto's image of PCB manufacture.

1. How much has Monsanto's image suffered by remaining in the PCB business?

   The group considered this question in terms of these key audiences:

   a. the general public
   b. local and national media
   c. government
   d. customers
   e. environmentalists

   We found that the negative impact to date has been minimal measured against the highly visible environmental and political controversies which have occupied so much national attention in recent years.

   Specifically, the group concluded that:

   - With the exception of localized instances, public perception of Monsanto's role in the PCB problem is low and/or the company is not viewed as having acted irresponsibly.
   - Key government agencies such as the EPA have publicly acknowledged Monsanto's voluntary restriction to closed system uses as being a responsible corporate act.
   - The voluntary program as well as the openness of Monsanto's disclosure policy has defused organized environmental action.
   - Most media acknowledge the restricted use policy and few news outlets charge the company with irresponsible practices.
   - Customers who at the beginning of the restrictive-use policy were irritated by such action now acknowledge the soundness of the policy.
   - Nonetheless, negative environmental effects and/or potential health hazards always leave a residue of ill will with most audiences and publics and this negative reaction must be fully recognized.

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2. Is the adverse impact now, or in the future, likely to be greater than the benefits derived from staying in the business?

In responding to this question, the group took into consideration the decision already made by MICC to phase out the PCB business within a given time frame. It therefore appeared appropriate to state what the group believed to be conditions and likely events which would take place in the months ahead so that MICC management could weigh both the manner and the time frame of an orderly withdrawal from the business.

With that in mind, the group assumes the following conditions in the months ahead:

- The Toxic Substances Act will become law in 1976 and by year-end mechanisms will be in place to ban or restrict PCB use to closed systems; levels of discharge into the environment will be firmly established and policed.

- Additional lawsuits may well occur, seeking redress directly or indirectly from Monsanto. With the passage of the Toxic Substances Act, the company will have an additional legal defense against such litigation. Yet, the fact of the litigation will help keep the controversy alive.

- The EPA will not call for a total ban of the product with or without a Toxic Substances Act. Nor will the FDA follow the Canadian government in lowering the acceptable levels in fish to two parts per million. Should such levels be lowered, however, there would be a devastating effect upon commercial and recreational fishing, and a consequent detrimental impact upon Monsanto and its customers.

- Serious questions will continue to be raised in regard to the potential human health hazard and such medical and research data will build.

- Media attention, which has fluctuated in the past five years, will remain high and constant. Monsanto's customers will bear the brunt of the criticism; media pressure will build for strict control if not a total ban. Monsanto will receive an increasing share of the criticism in the absence of a publicly stated intention to withdraw from PCB manufacture.

- Alternative products by Monsanto's competitors will receive increased attention and this will escalate the public debate. Public perception may well be that viable alternatives already are available which offer most if not all of the necessary performance benefits of PCB without the negative environmental effects.

- The attitude of customers will continue to shift, as it has in recent months, from a firm defense of PCB's performance benefits to consideration of Monsanto or competitor alternatives.

- Other problem or crisis areas, such as now being experienced in the Great Lakes Region and the Hudson River Valley, will flare up in other parts of the U.S., further exacerbating the issue.

These conditions suggest, in answer to the question at hand, the negative impact on Monsanto's image will, indeed, exceed the benefits derived from staying in the business.

The group further considered a number of broad principles and courses of action during the period ahead to minimize the negative impact on Monsanto's image. Those were:

1. A precipitous withdrawal from the market would create a negative impact among key audiences, diminishing the positive impact gained by Monsanto's past and present policy of responsible corporate action. A rational, orderly process is required.

2. Efforts should be undertaken to counteract any perception that our competitors have achieved alternative product "breakthroughs" and have "stolen the march" from Monsanto by aggressively publicizing Monsanto's work on alternate products, environmental testing, etc.

3. Consideration should be given to a public announcement of Monsanto's intention to withdraw from PCB manufacture. The same degree of openness which has characterized the successful policy of the past should be the mark of the future.

4. Monsanto must retain the initiative achieved with its voluntary program of restricted uses. A similar strategic move or gesture should be considered to protect Monsanto's image during the period ahead. Such a gesture could be a call for a national conference of insurance underwriters, industry and government representatives to evaluate the effect of alternative products which lack the same fire-resistant qualities of PCB.

5. Principally, Monsanto must not be viewed as being forced into a decision to withdraw from PCB manufacture by either government action or public pressure. Rather, key audiences must perceive Monsanto as having initiated responsible action in a manner consistent with its past reputation and practices.

Pierre R. Wilkins

/eb

D. R. Bishop, W. R. Corey, K. W. Easley, J. E. McKee, W. B. Papageorge, C. Paton, R. G. Potter, W. W. Withers

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