In a telephone conversation with Mr. Larry Marion, Washington Bureau of Business Week Magazine at 11 a.m. today, he reported that there will only be one short reference to Monsanto in the article on PCBs because of space and time limitations which resulted from the 11th hour interview, last Tuesday -- the publication's deadline.

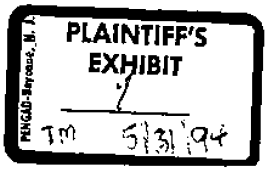
Based on the last draft of the article Marion has seen, it will say only the following:

> "Meanwhile in an unpublished study, Monsanto Company, the sole U.S. producer of the chemical, reports an abnormally high number of its deceased workers have died of lung cancer."

Note: It is believed that this sentence will immediately follow a paragraph devoted to the Mobil Oil report which suggests the first link between PCBs and cancer in humans.

Marion added that he had filed a report covering the entire interview with Dr. Reush and Mr. Harbison with his editors in New York and that "some copy editor may well add more information but he doesn't know that this will happen. The magazine will be on the street tomorrow, September 3. He also confirmed that Chemical Week (a sister publication) is doing a similar story for publication next Tuesday and has all the information derived from the Monsanto interview.(including the seven lung cancers versus an expected 2.7).

MONS 060108



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Talked with Myer Lurie, Managing Editor, Chemical Week Magazine, and Joe Dunphy, Chemical Week reporter at 2 p.m. today. The following is a verbatim transcript of the Monsanto references that will be included in an article of PCBs that will appear in the September 8 issue (on the street on Sept. 7):

INVESTIGATIONS INTO POSSIBLE OR ACTUAL CONTAMINATION FROM PCBS CONTINUES ON SEVERAL FRONTS.

"Monsanto says/company has undertaken an in-house health study of workers exposed to PCBs. Monsanto epidemiologist report preliminary evidence of seven cases of lung cancer among 50 cases of deceased workers uncovered by a study of about 300 workers exposed to PCBs. In constrast, a nationwide sample indicates that 2 (I corrected this to 2.7) deaths out of 50 are normally caused by lung cancer.
But the company cautioned that the evidence is preliminary and further research is underway to determine whether the lung cancer was related to non-workplace exposure's such as tobacco.
(Then a wrapup of the Mobil findings is described).

"Monsanto's William G. Krummrich plant at Sauget, Ill., is the sole U.S. PCB manufacturing facility. Estimated '76 production is 24 million pounds, well below previous annual average of about 40 million pounds."

MONS 060109

WATER_PCB-SD0000009322

CONFIDENTIAL

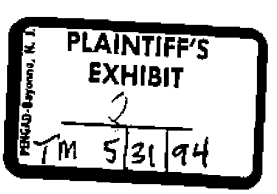
Date: October 2, 1969

Subject: REPORT OF AROCLOR "AD HOC" COMMITTEE

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

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

MONS 036720



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1. Objectives Page 1
2. Probability of Success Page 2
3. Recommendations Page 3-4
4. Basis for Recommendations Page 5-11
5. General Background Page

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on August 25,

OBJECTIVES

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

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

1. Protect continued sales and profits of Aroclors;

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

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

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PROBABILITY OF SUCCESS -

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

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

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

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

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

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RECOMMENDATIONS

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

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

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

2. Reduce losses of Aroclors in liquid wastes from Monsanto plants to ~~absolute~~ minimum. Goal--0 to 5 ppb For 1254 & 1260 ~~10 parts per million~~.

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

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

   a. Environment of Anniston and WGK Plants.

   b. Monsanto products where contamination is possible.

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

   d. Customer plants' environments.

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

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

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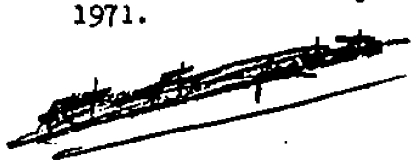
RECOMMENDATIONS (Continued)

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

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



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BASIS FOR RECOMMENDATIONS

1. Notification of All Customers

Feb.

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

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

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

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

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

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BASIS FOR RECOMMENDATIONS (Continued)

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

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

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

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

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

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BASIS FOR RECOMMENDATIONS (Continued)

2. Consultation with Federal Agencies

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

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

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

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

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

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

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BASIS FOR RECOMMENDATIONS (Continued)

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

3. Contact with other Governmental and University Laboratories

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

4. Losses from Monsanto Plants

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

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

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

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BASIS FOR RECOMMENDATIONS (Continued)

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

5. Atmospheric Losses at Anniston and WGK

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

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

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

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

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

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BASIS FOR RECOMMENDATIONS (Continued)

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

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

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

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

7. Expansion of Analytical Capabilities

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

8. Assignment of Full-Time Effort

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

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

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BASIS FOR RECOMMENDATION (Continued)

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

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

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

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

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

9. Budgetary Considerations

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

WATER_PCB-SD0000009335

ROUGH DRAFT - 11/10/69

OUTLINE

PCB ENVIRONMENTAL POLLUTION ABATEMENT PLAN



I. Introduction

II. Problem

III. Extensiveness

IV. Nature of the Problem

~~Research and medical input~~

V. Effect on Monsanto

VI. Effect on Customer

VII. Involvement with other producers

VIII. Sources of Contamination

~~A. Indirect Pollution~~

IX. Recent technical changes which have bearing on the contamination

X. Courses of Action

XI. Recommended Course of Action

XII. Implementation of the Recommended Course of Action

A. Immediate Action (12-1-69)

B. Interim 1-3 months

C. Short term - 3-6 months

D. Long term (1-3 years)

1. Research medical
2. Manufacturing
3. Engineering
4. Market
5. Patent
6. Environmental Control
7. Legal
8. Public Relations 9. Others

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XIII. Probability of Success

XIV. Cost of Program

$220,000 and bio with max. at $20-25M

XV. Future

MONS 035333

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PCB ENVIRONMENTAL POLLUTION ABATEMENT PLAN

Introduction

On 15 October the "AD HOC" Committee consisting of Messrs. M. Farrar, P. Hodges, E. John, W. Richard, and E. Wheeler issued a report summarizing the polychlorinated biphenyl (PCB) pollution problems from the known available information to date. Out of this report came considerable information, conclusions, and recommendations which we have attempted to tie together into a plan of action in this document. Our objective has been to take a reasonable and responsible approach to the entire problem. Before we get into the problem, we should clarify the meaning of PCB, the nature of the entire line, and how these tie into our product line of Aroclors.

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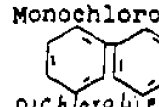
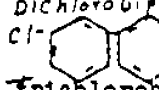
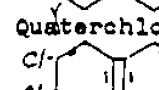
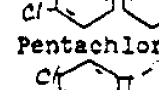
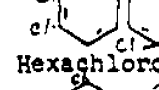
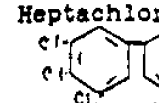
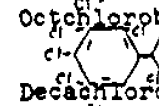
Monsanto entered the Aroclor market in 1930 by acquiring Swain Electrical Company or known today as our Anniston, Alabama plant. The first load of Aroclor which incidentally was Aroclor 1254 -- went out of Anniston, Alabama to GE in 1931: Since that time the market has grown to 170 to 200M worldwide.

Chemical	Monsanto Product Line	Nature of Material at Ambient
Biphenyl  ~~Solid at~~ ~~Sublimes at~~		Solid
Monochlorobiphenyl 	Aroclor 1221	thin liquid (oil)
Dichlorobiphenyl 	Aroclor 1232	thin flush water
Trichlorobiphenyl 	Aroclor 1242	oily type fluid material
Quaterchlorobiphenyl 	Aroclor 1248	Thicker - transmission oil
Pentachlorobiphenyl 	Aroclor 1254	Heavy-Molasses
Hexachlorobiphenyl 	Aroclor 1260	Thick - tar
Heptachlorobiphenyl 	Aroclor 1262	Very thick - liquid
Octchlorobiphenyl 	Aroclor 1268	Solid
Decachlorobiphenyl 	Aroclor 12715	Solid

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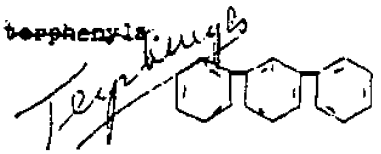
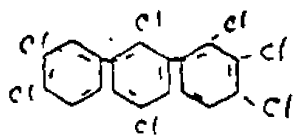
Total possibility are 210 theoretically possible chlorinated biphenyls

~~terphenyls~~ Terphenyls



Santowax or terphenyl

Solid



Aroclor 5460

Solid

II. Problem

Damage to the ecological system by contamination from polychlorinated biphenyl (PCB).

III. Extensiveness

The problem involves the entire United States, Canada, and sections of Europe especially the United Kingdom and Sweden. As the investigation broadens other areas of Europe, Asia and Latin America will surely become involved. Evidence of contamination have been shown in some of the very remote parts of the world. The involvement could and most likely will follow the DDT investigations.

IV. Nature of the Problem

Professors Widmark and Jensen of the Institute of Analytical Chemistry at Stockholm, Sweden, in November 1966, announced and confirmed findings PCB in fish, birds, and eggs. Subsequent findings were made in 1967 in Great Britain. In February 1969, Professor Risebrough of the University of California published an article in the San Francisco Chronicle relaying his findings of PCB in the environment of the United States. Monsanto confirmed the presence of PCB's in mid-1969 and confirmed the adequacy of work by Widmark and Jensen and others; truly, the PCB's are a worldwide ecological problem.

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Analysis indicates the environmental presence of the 5 and higher chlorinated biphenyls which take the appearance of Aroclor 1254 and Aroclor 1260. We have strong indications that Aroclor 1242 or at least part of it degrades biologically. Since the Aroclor 1242 contains around 7 percent of the 5 chlorine biphenyl or higher we cannot rule out the possibility that the observations may be a concentration affect of the higher chlorinated biphenyls of Aroclor 1242.

To date there have been no reports of finding Aroclor 1242 present in the environment (except outside the effluent of our plants where we know Aroclor 1242 is present).

The seriousness of the problem can best be spelled out as follows:

1. Fish - Marine or aquatic species concentrate PCB in the fatty tissue. Toxic is small quantities (down to 5 ppb) to sensitive marin life such as shrimp.
2. Birds - Predatory species feeding on the marine or aquatic life can further concentrate PCB to possible harmful effects. Specifically in birds PCB can affect the calcium metabolism leading to egg shell imperfections which prevents proper hatch of the young. In fact, Monsanto has confirmed the eggshell by feeding chickens, a high order of the species, PCB's in controlled tests.
3. Man - There is no harmful effect known to man or other mammals after 40 years of production. Investigations are underway by various sources.

MONS 035337

4. Political and Public Emotion - PCB's are falsely linked with DDT because PCB's show up in the analysis for DDT. PCB's are linked with other permanent type chlorinated hydrocarbon pesticides. This becomes particularly serious since about every article of food in the country is being examined for a trace of these materials.

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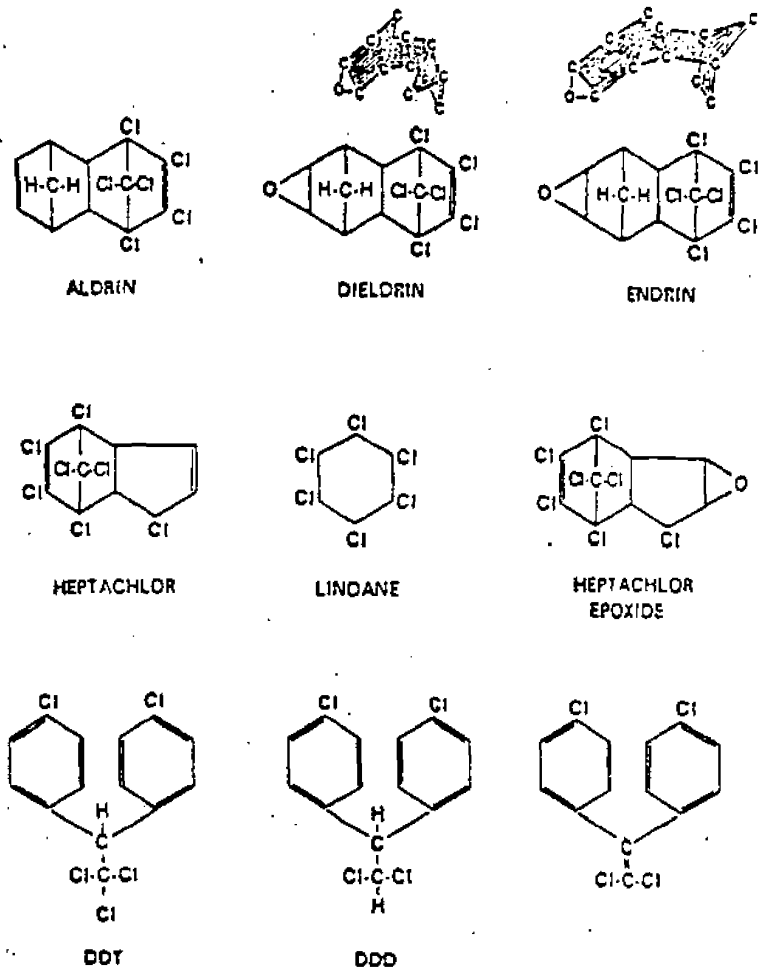

Fig 1 Structural Formulae of Nine Chlorinated Hydrocarbon P

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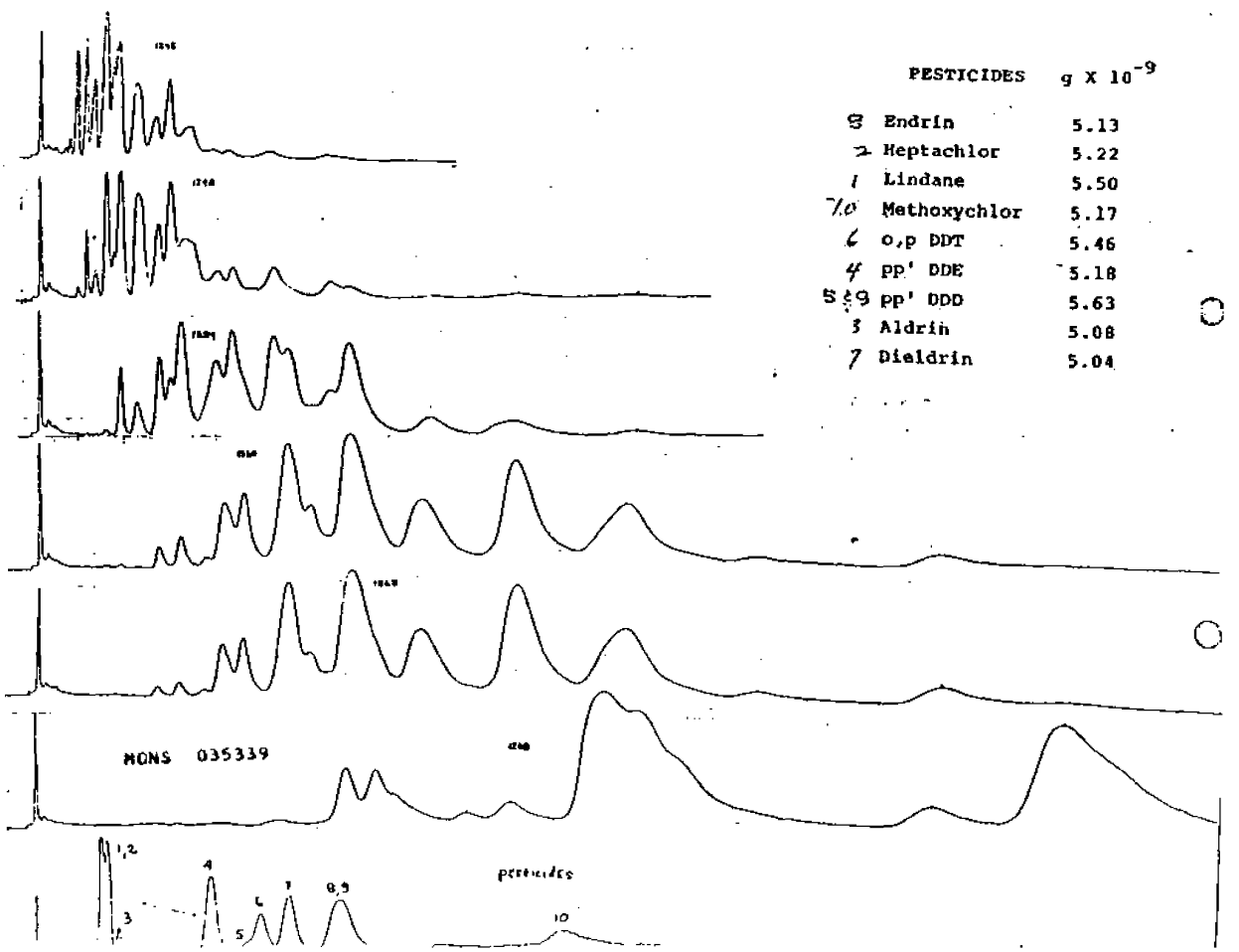

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V. Effect on Monsanto

Business potential at stake on a worldwide basis:

Fluids	Plasticizers	Total/Year
70M lbs.	34M lbs.	104M lbs.
$16M	$6M	$22M
$6-8M G.P.	$2-3M G.P.	$8-11M G.P.

Already competition is using certain data against us in competitive situations.

A. Legal Liability

Direct lawsuits are possible. The materials are already present in nature having done their "alleged damage". All customers using these products have not been officially notified about known effects nor do our labels carry this information. These are only a few of the possible legal implications which would best be covered by the legal department.

B. Public Image

The corporate image of Monsanto as a responsible member of the business world genuinely concerned with the welfare of our environment will be adversely affected with increased publicity.

The evidence proving the persistence of these compounds and their universal presence as residues in the environment is beyond questioning. This combined with certain scare publications is certain to give an adverse image. Guilty (by) association (with DDT) will prevail as the background while actual facts may be sparse.

C. Customer Relations

MONS 035340

Some customers who presently use these materials will be "scared off" to other competitive products. Products associated with the same name or "trademark" will be adversely affected ie., Therminol, Pydraul and Aroclor. Competitors will use the information for an

WATER_PCB-SD0000009344

influence on Monsanto products.

Customers will seek other "outs" rather than become involved.

VI. Effect on Customers and Ultimate Consumers

One of the unique features of PCB's is their fire resistance. Here the basic decision whether to risk lives due to fire or risk extinction of, some species of birds. In this case the PCB would probably be accepted as a necessary pollutant and tolerated under controlled conditions.

A. Electrical Industry - Capacitors and Transformers use Aroclor because it is the best inexpensive dielectric fluid available.

B. Food Processing - Bulk "deep frying" units for potato chips, fish, and doughnuts use the fire resistance fluid as an indirect heating medium.

C. Die Caster -- and other hot metal working industries fire resistance fluids to protect the worker.

Affects a wide range of plastics and adhesives because the PCB serves as the plasticizer.

A wide range of paints and coatings are affected. The "Carbonless" carbon paper used so widely would disappear.

VII. Involvement With Other Producers

Although Monsanto is most probably responsible for the U.S. contamination and jointly responsible with MCL for the United Kingdom problem, we cannot accept responsibility for the world. There are five known producers in the free world, several possible producers behind the iron curtain and couple of additional companies making overtures about entering the business. Monsanto representatives have on one occasion discussed this problem with a couple of these producers but they expressed no great concern. In fact, it is highly possible that one of

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these manufacturers is dumping his waste into the Rhine River. Certainly any action taken by one producer will most assuredly affect the other. It is entirely possible that a joint plan of action could be developed but will most probably have to be spearheaded by Monsanto. It is also likely that producers of other chlorinated products used with PCB's will be dragged into the investigation.

VIII. Sources of Contamination

Although there may be some soil and air contamination involved, by far the most critical problem at present is water contamination. To our knowledge to date the contamination can be broken down into two general categories, open and indirect pollution.

A. Open Pollution - Our manufacturing facilities sewered a sizeable quantity of PCB's in a years time.

1. Fluids

Fluids are probably the most open source of pollution because of their mobility. They also may be the least serious because they are generally the lower chlorinated materials.

2. Electrical

Electrical customers have in the past sewered their wastes.

3. Heat Transfer

Heat transfer customers have sewered their objectionable and their spilled material.

4. Industrial

These fluids have generally been sprayed into drains, washed down sewers and generally regarded as very harmless.

All of the fluids have had the "pink" constituent dumped on dirt roads as a "dedusting agent" which inadvertently found its way back to the stream.

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5. Plastics

The plastics are not as mobile as the fluids so therefore they have not found and cannot find their way back to streams in open pollution.

B. Indirect

Shipping containers and the cleaning thereof for subsequent use a source of contamination.

1. Fluids

a. Electrical - Disposal of "burned out" transformer and capacitors may find its way back to streams. Scrap units (new) are generally disposed of in land fills but could possibly get back to the stream.

b. Heat Transfer - Leaks could contaminate.

c. Industrial - Cross product contamination carried out of an air compressor. Residual material carried on parts.

2. Plasticizers

a. Process Contamination from Washing

(1.) Environment Contamination

Swimming pool paints

Incineration of wax coatings

Traffic paints

(2.) Product Contamination

Coating for tank lining

Painting inks and paper coatings

Certain adhesives

MONS 035343

IX. Recent Technical Changes Which Have Bearing on the Contamination

A. Fluids

The sources of pollution were pointed out as they have been in the past because we are dealing with that quantity of material in the

WATER_PCB-SD0000009347

environment today which was deposited over the past forty years. We must state that responsible people throughout the industry have taken corrective action to reduce contamination in the last two years. There have also been technical advances which have brought about the use of lower chlorinated biphenyls which may be an advantage because to date the low chlorinated ones have not been identified present in nature.

1. Electrical - The large customers have established collect systems and the waste is recovered. Incinerators are being investigated and built for the disposal of the materials. There has been a shift away from the higher chlorinated types products and could probably shift almost entirely away from those products.
2. Heat Transfer - System have been tightened up and redesigned to confine the contents. Here, too, the trend has been to shift away from the higher chlorinated materials.
3. Industrial - Selling ponds have been built by the large manufacturers to catch the material and decant off the PCB for reprocessing. The trend here as the other fluid areas has been towards the lower chlorinated materials.
4. Plants - The plants effluent has been passed through limestone which provides surface to catch some of the material. But high concentrations can be found in our effluent (that is relative to those findings in nature causing the problem).

B. Plasticizer

Quite opposite to fluids the trend in plasticizer Aroclor has been to the higher chlorinated biphenyls. In plasticizers the lower chlorinated biphenyl will not be an acceptable solution however, the lower chlorinate terphenyl could offer a possible solution.

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X. Courses of Action

A. Do Nothing

We cannot deny the findings and the acquisitions by the various agencies. If we took no action we would likely face numerous suits. We would let government tolerances be based on public and political pressure along with any experimental or developed data which they may generate. We would most likely be forced out of this business. Other product areas would be adversely affected. We would project an image as an irresponsible member of the business world. Project poor customer relations. The only advantage to this technique offers is it reduces the cost but this too must be weighed against potential loss of business.

B. Discontinue Manufacture of All Polychlorinated Biphenyls (PCB)

Although we all realize this could be an eventually unfortunately the solution is not this simple. Assuming we did stop manufacture immediately, the pollutants are present in the environment, the liability is present and possibly by the shifting to the lower chlorinated materials and the recovery techniques the contamination may already be reduced to an acceptable level. Obviously the entire business would be lost without any or very few substitutes to be offered. Other product areas would be affected. Financial loss could be considered due to raw material contracts, customer contracts, and royalty -- secrecy contracts. Competition would take advantage on all fronts. We would be admitting guilt by our actions. Loss of capitol investment in the plant, associated utilities, and associated processes. We would possibly gain a little public image on this action.

MONS 035345

C. Respond responsibly, admitting that there is growing evidence of environmental contamination by the higher chlorinated biphenyls and take action as new data is generated to correct the problem.

WATER_PCB-SD0000009349

This approach would enable us to phase out the higher chlorinated materials in many applications where they are no longer necessary or really desired. Wecould maximize the corporate image by publicizing this act. We would reduce a known pollutant. Additionally we could gain precious time needed to develop new products and investigate further the lower chlorinated materials. As new research data is generated our course may be altered considerably. Certain limited actions may reduce or limit the problem.

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XI. Recommended Course of Action

Based on the information available today the only recommendation we can honestly make is respond responsibly admitting that there is growing evidence of environmental contamination by the higher chlorinated biphenyls and take action as new data is generated to correct the problem.

XII. Implementation of the Recommended Course of Action

A. Immediate (By 12-1-69)

1. Set up a task force under a project manager or the equivalent responsible for initiating, directing and implementing all action that Monsanto decides to take. This includes sufficient budget necessary to cope with the immediate problems. This task force should include representatives from Medical, Legal, Research and the two involved Marketing Groups and Public Relations and must conduct liaison with MCL and other locations involved in the problem.
2. Decide on timing and content of any public and/or customer notification of PCB problem.

B. Interim (Within 3 months)

Fluids	Plasticizers
1. Confirm Aroclor 1254/Aroclor 1260 are found in the environment.	1. Announce differential between fluids/plasticizer uses.
2. Publicize the difficult anal. tasks.	2. Announce safety of other PCB's/ chlorinated terphenyl.
3. Protect other PCB/chl. terph.	3. Educate customers on control of effluent for all products.
4. Announce plans to reformulate certain Therminols and Pydraul where control of the product is difficult.	4. Initiate program to develop A/ 1254 & 1260 substitutes

WATER_PCB-SD0000009351

5. Emphasize better control over other Aroclor 1254 & 1260 uses.

5. Investigate with manufacturers the feasibility of alternate products.

6. Initiate customer education on need for effluent control of all products.

6. ~~Analyze 1242~~

7. Determine composition of all PCB's.

Develop a comprehensive Program

C. Short Term (within the next 12 months)

1. Research - Expand program for more meaningful biodegradation studies and confirming analytical results. Expand toxicity studies. Follow developments concerning publicity and those developments covering political implications of PCB contamination.

Medical

2. Marketing - Discontinue or substitute replacement products for those applications of Aroclors 1254 and 1260 where the Aroclor remains mobile.

Work with customers to clean up plants on other Aroclors. Report the habitual violators or "do nothings" to the product group.

Reclaim or safely dispose of fluids.

MONS 035348

Consider renaming products that do not contain PCB. Follow and report market developments such as customer disposal systems. Follow and report any political or public feedback which may affect the contamination problems and must be coordinated with Medical, Research and Legal.

3. Production - Clean up plants and stop gross contamination.

4. Legal - Define our present position, recommend reasonable action that will not unduely alarm the market but reduce the exposure in terms of liability. Coordinate recommendations with Marketing

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5. Public Relations - Publicize actions where believed advantageous. Certainly discussions should be held with other producers within same period to determine their planned course of action, if any.

D. Long Range Tentative Outline (From 1 year to 3 years)

Realizing that the comprehensive program must be outlined the "Long Range Tentative Outline" is meant to serve as a guide: All aspects of this program should be reviewed quarterly by Organic Management.

1. Research-Medical

   Continue biodegradation studies and analytical support

   Isomer distribution

   Toxicity and metabolism studies

   Water soluble removal

   Incineration analytical support

   Confirmation analytical

   Contract academic research for reference

   Develop new and improved formulations

2. Manufacturing

   a. Process Research and Development

      (1.) Identification of typical Aroclor isomers

      (2.) Develop control for effluent composition

      (3.) Test substitute formulations, etc.

      (4.) Develop new processes

   b. Clean Up Plants

   c. Modify processes to meet market needs

3. Engineering

   a. Develop and set up on plant locations incineration systems

   b. Design new processing equipment as necessary

4. Marketing

   a. Specify alternates or changes

   b. Customer liaison

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c. Set reclaim or disposal of fluids

d. Work on name association problems

5. Patent

Investigate trademarks registered

Cover with patents any work felt patentable

6. Environmental Control

Develop cheap disposal systems for customers

a. Incineration or pyrolysis

b. Biodegradation unit etc.

c. Consultants in pollution control

7. Legal

Investigate and define our position on Royalty secrecy agreements.

Contracts - Raw Material and Customer

8. Public Relations

Portray to public positive actions at correcting the contamination problem. Release periodical statements covering our position.

XIII. Probability of Success

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XIV. Cost of Program

Neither the program nor the costs have been clearly defined at this time. However, a cost estimate of $220,000 for toxicological work alone has been presented. Tentative figures indicated under the worst conditions the entire program could run as high as $2.0-2.5M. At this stage it is very difficult if not impossible to develop a reasonable cost figure but one point is clear it will be larger than the normal research budget can handle. For this reason, assuming the approach is acceptable, we shall be forced to ask for additional appropriations to fund the program.

XV. Future

Follow developments on the problem as they unfold.

Develop an aggressive research program to confirm or deny findings and better understand the problem.

Develop costs for the duplementation of the Recommended course of action.

Develop specific actions with each department involved

Submit the actions with costs for approval

Develop a timetable to solve the overall problem.

Prepare for "precipitious pullout" or drastic legislative action although we do not feel this is a likely possibility.

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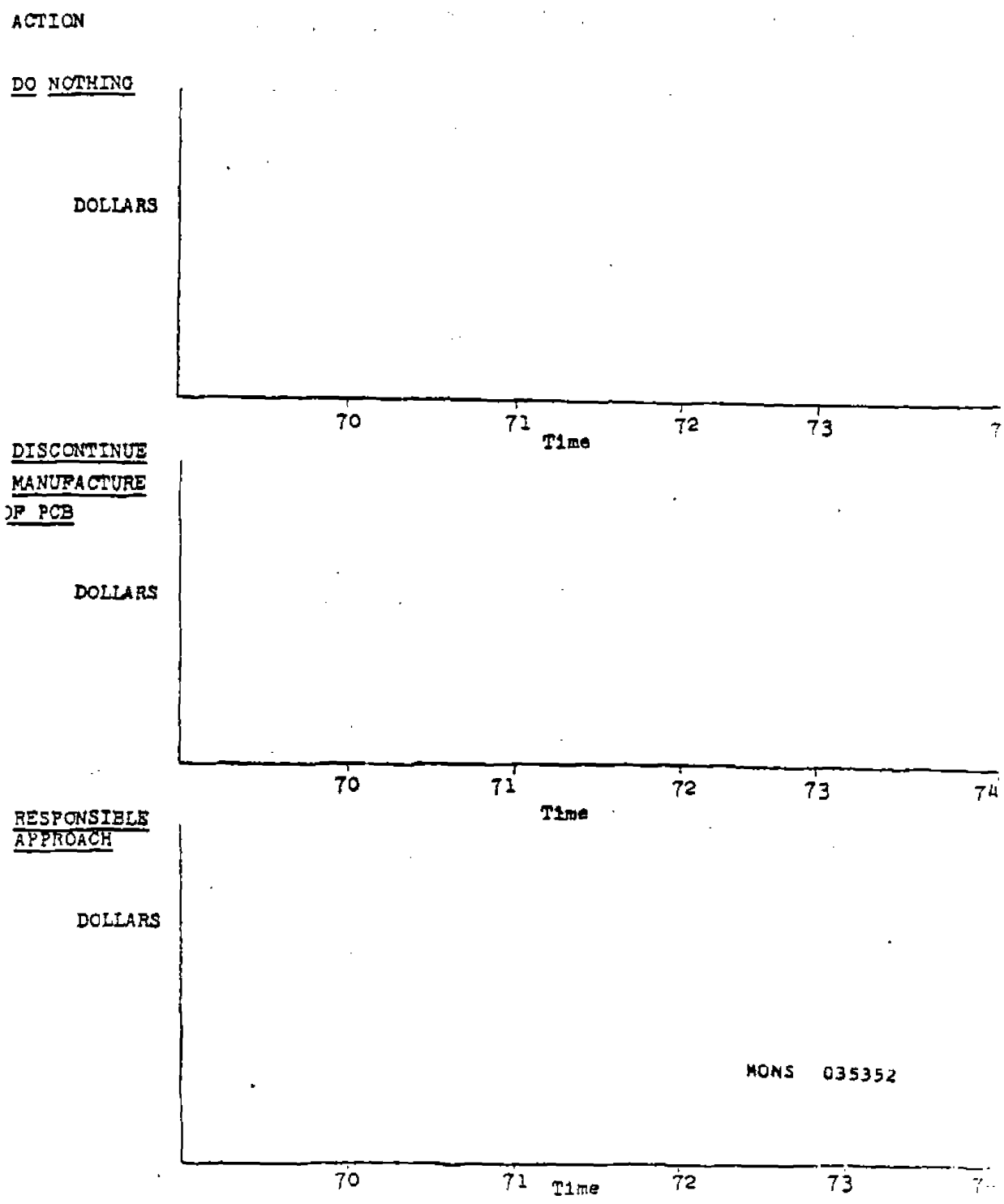
PROFIT AND LIABILITY VS. TIME



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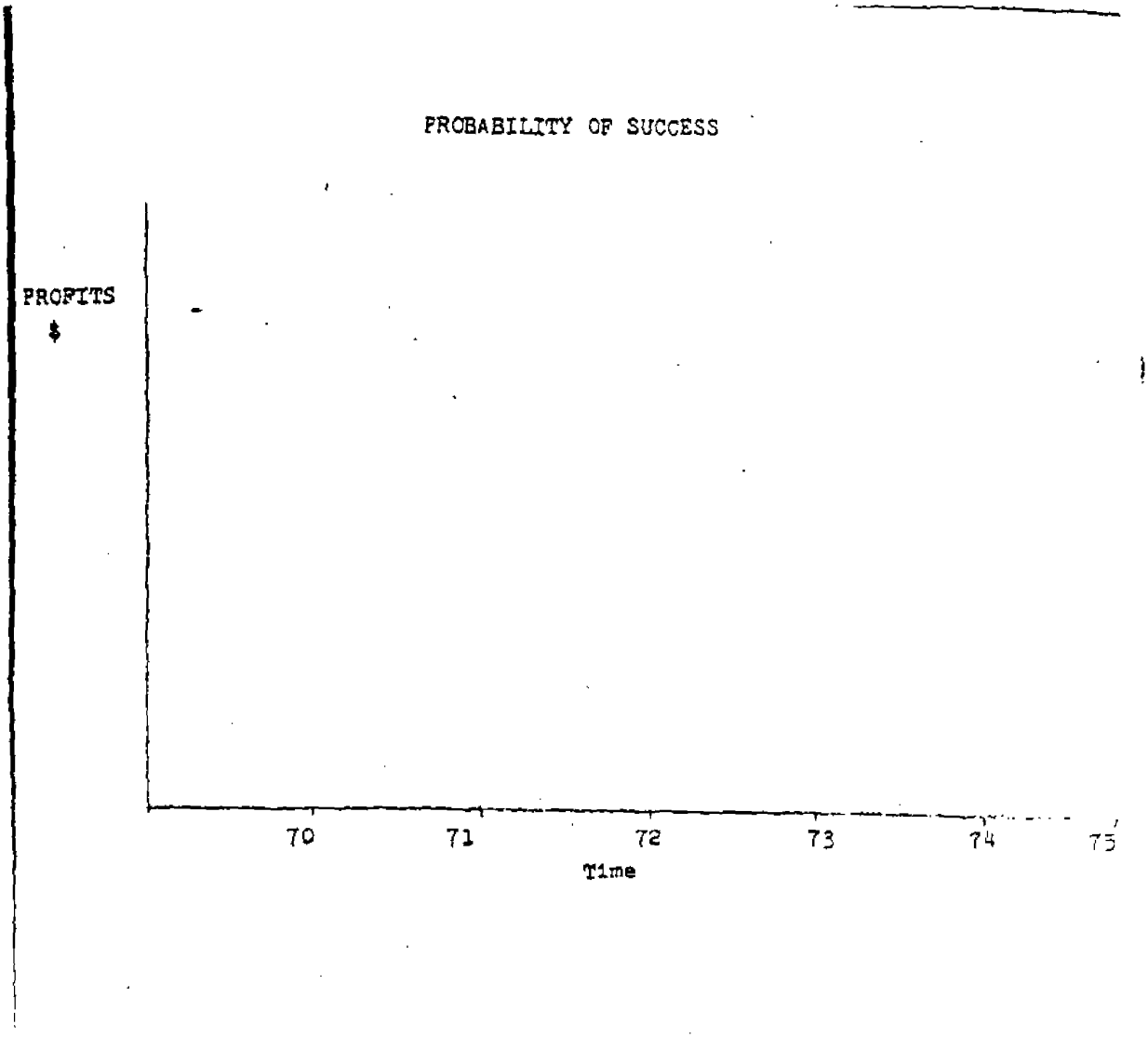

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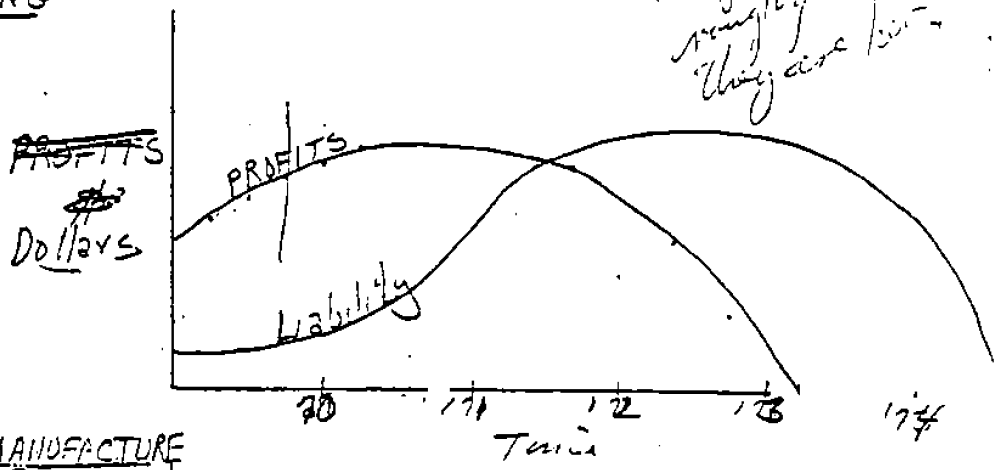
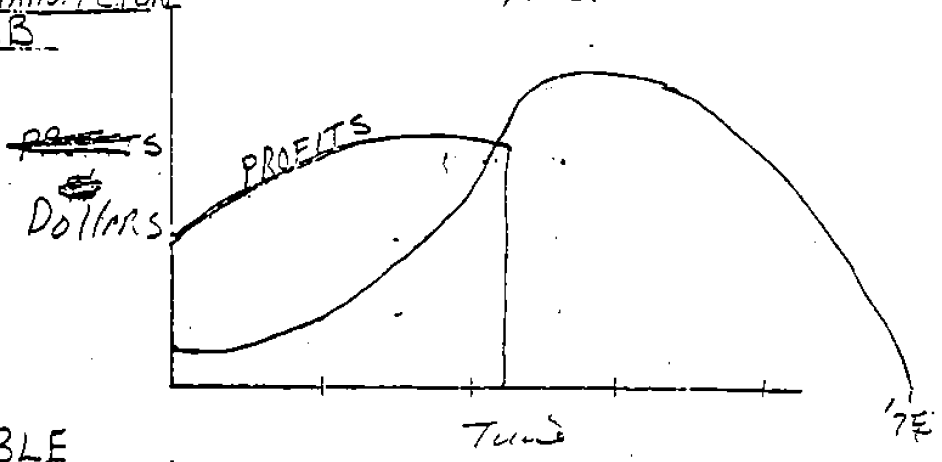
PROFIT AND LIABILITY VS TIME

ACTION

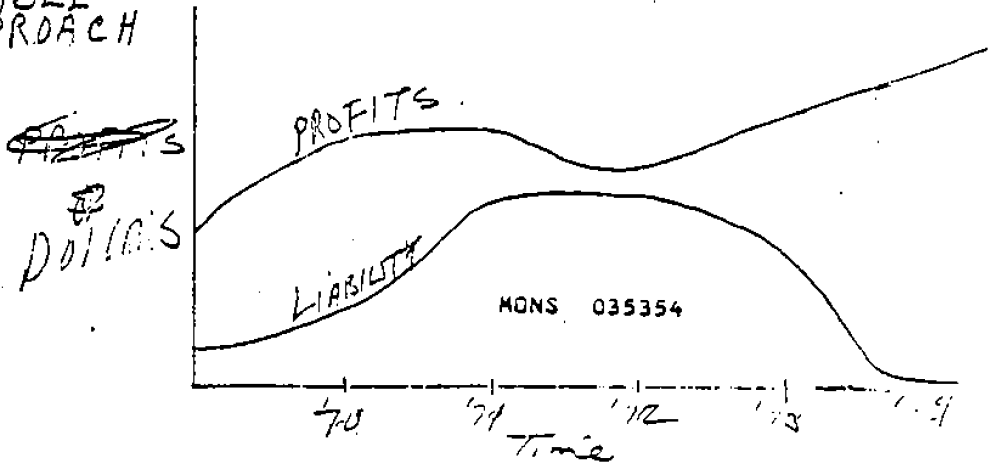
DO NOTHING



DISCONTINUE MANUFACTURE OF PCB



RESPONSIBLE APPROACH



MONS 035354

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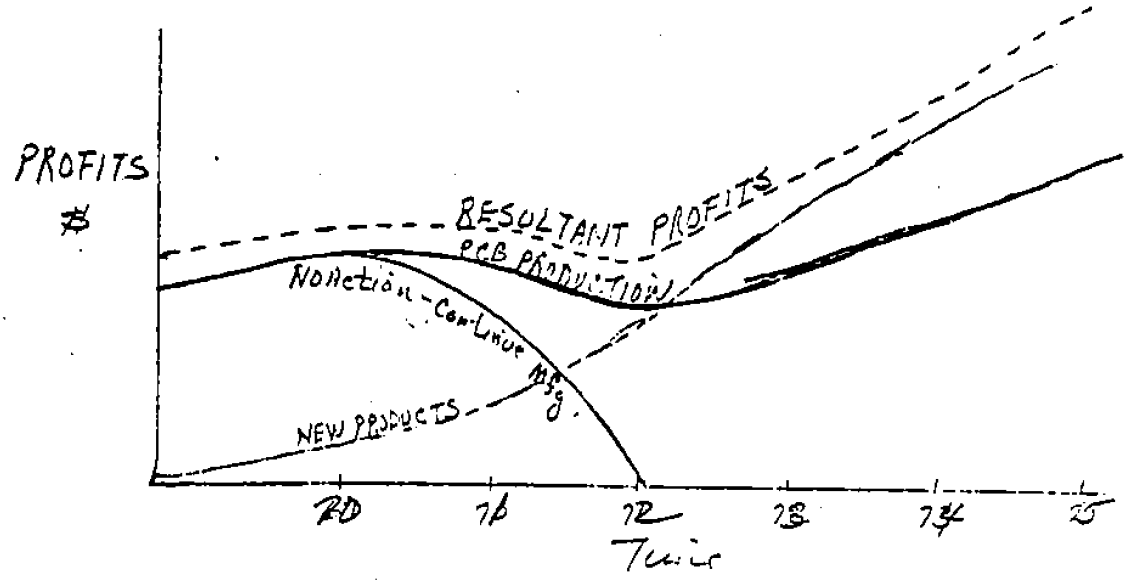
PROBABILITY OF SUCCESS



MONS 035355

WATER_PCB-SD0000009359

(I)

Plan

I Objective

I Problem

II Background page 1, 2, [illegible] zero

IV Monsanto confirmation 2, 5, 6

III Seriousness of the Problem to Monsanto 3, 4, 7, 8, 9

II Effect on Monsanto letter

Effect on Customers and Ultimate Consumers

VI Effect on Other Producers (letter)

Main Sources of Pollution

X Present Product Knowledge

Possible Action Necessary to Combat Pro

Alternate Courses of Action Available

[illegible]

Recommended Course of Action

MONS 035350

(II)

XIV Additional considerations within the Recom...

Course of Action

XV Implementation of Recommended Course of Action

A. Research

B Manufacturing

C Engineering

D Marketing

E Medical

F Enviromental Control

~~G Restoration and Reclamation contractors~~

G Legal

H Public Relations

I. Patent

MONS 035357

III

I Cost of Program

II Probability of Success

III Timetable for Completion

MONS 035358

WATER_PCB-SD0000009362

I. Objective

Develop a plan of action to

A. Protect continued sales and profits of chl[illegible] biphenyl products

B. Permit continued development of new uses [illegible]

C. Develop substitute products where necess[illegible]

D. Stop and/or control contamination of the global ecosystem with poly chlorinated biphenyl

E. Protect the Corporative Image as a responsible member of the Business Community in preventing controlling Pollution of Environment

F. Reduce legal exposure by phasing out [illegible] having questionable exposure to the en[illegible]

MONS 035359

II Problem

Polychlorinated biphenyl (PCB) or Aroclor product contaminates DAMAGE to THE ECOSYSTEM by of the environment and its association and airing with OC-FROM.

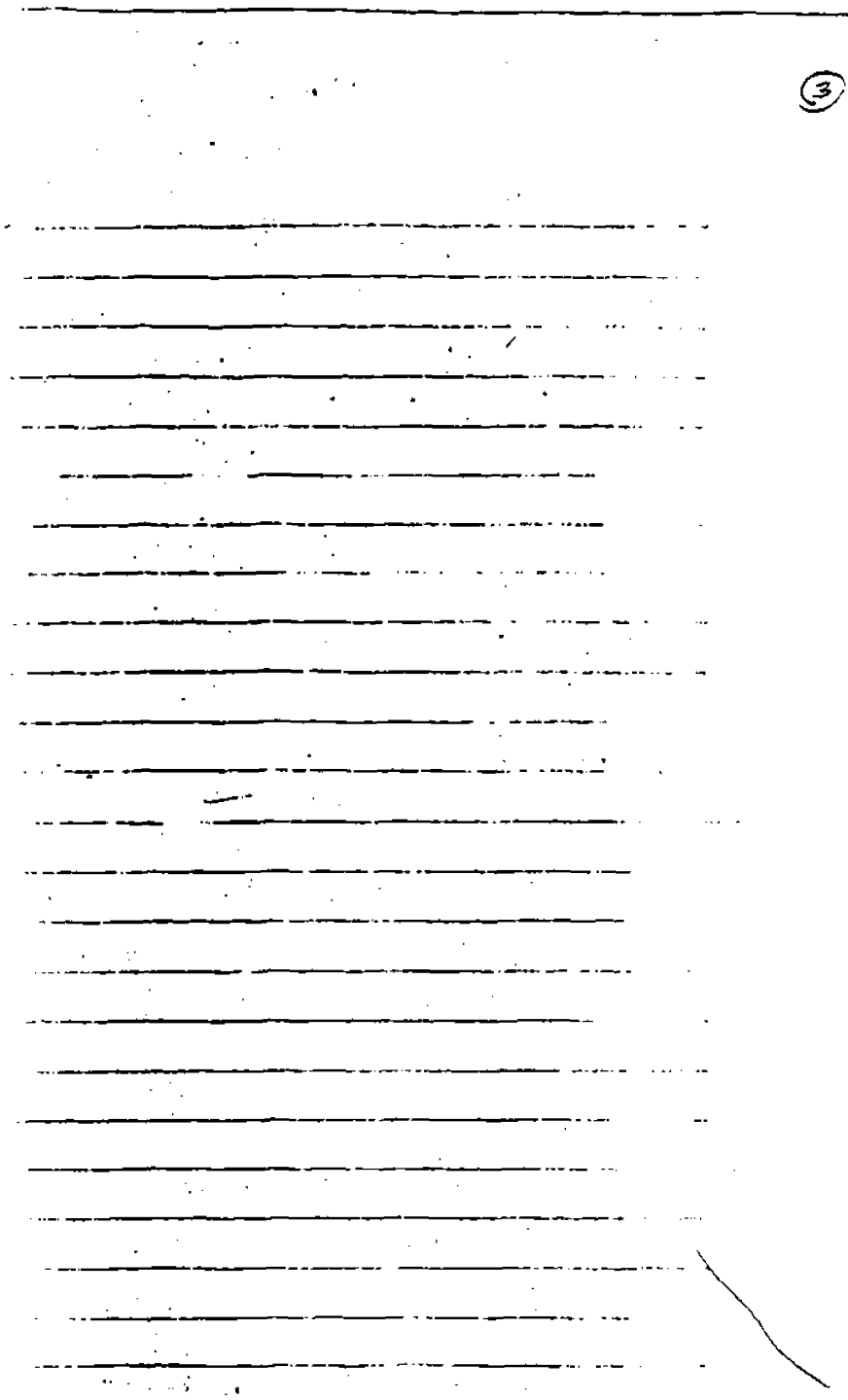
I other pesticides as members of a family of e

call "chlorinated hydrocarbons".

DAMAGE

MONS 035360

(3)



MONS 035361

PLAINTIFF'S EXHIBIT
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TM 5/31/94

October 11, 1937.

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

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

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

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

L.A. Watt

Attachment 3-2

WATER_PCB-SD0000009366

Dr R. E. Kelly - Mfg. Director.

Summary from John H. Schmidt Pat. Dept. 10/8/47

Ferric chloride reagent is compared with cupric potassium chloride as a gravimetric reagent for sulfur. The advantages of ferric chloride are noted in the case of bronze and metallic copper. Possible use in the determination of the composition of non-ferrous furnace metals is mentioned.

X-ray diffraction patterns of the ferric chloride and the cupric potassium chloride residues show that sulfur remains as cuprous sulfide and elementary sulfur.

The procedure described has been in use for approximately one year and has given satisfactory results.

LITERATURE CITED

(1) American Society for Testing Materials, "X-Ray Diffraction Data for Chemical Analysis, Supplement."
(2) Holler, A. C., and Yeager, J. P., *Ind. Eng. Chem., Anal. Ed.*, 16, 349 (1944).
(3) Lundell, G. E. F., and Hoffman, J. I., "Outlines of Methods of Chemical Analysis," p. 218, John Wiley & Sons, Inc., New York, 1938.
(4) Cumenge, E., and Wimmer, R., *Dinglers Polytech. J.*, 250, 85 (1883).
(5) Silverman, Louis, *Ind. Eng. Chem., Anal. Ed.*, 10, 433 (1938).
(6) Weiser, H. B., Milligan, W. O., and Marshall, J. M., *J. Phys. Chem.*, 47, 496 (1943).

On the Toxicity of the "Arochlors"

ROBERT M. BROWN, Chief,
Industrial Hygiene Section, Division of Health, Department of Public Welfare,
City of St. Louis, Missouri

A recently published article (*1*) has recommended the substitution of one of the "Arochlors" as the melting-point bath liquid in preference to the customary sulfuric acid. As stated in that article, the "Arochlors" are a group of chlorinated diphenyls produced by the Monsanto Chemical Company.

There is need, therefore, to give a warning. For the toxicity of these compounds has been repeatedly demonstrated, both from the standpoint of their absorption from the inspired air as well as from their effect in producing a serious and disfiguring dermatitis when allowed to remain in contact with the skin. Since these effects have been repeatedly observed, industrial hygienists have taken great pains to see that proper controls have been established wherever these products are used. For example, the maximum allowable concentration of chlorinated diphenyl for an 8-hour working day is 1 milligram per cubic meter of air.

It is probable that nothing like an uncontrolled industrial exposure will occur in the laboratory. However, whether an individual is subjected to a possible acute exposure to chlorinated diphenyl and its serious consequences will depend upon the size of the melting-point bath, the caution with which it is used and the temperature to which it may be heated. Likewise, with

PENGAD-Bayonne, N. J.
PLAINTIFF'S EXHIBIT
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TM 5/31/94

MONS 031540

WATER_PCB-SD0000009367

careless handling of the material and the resulting contamination of the skin, clothing, laboratory towels, work table surfaces, etc., the way if left open for the producing of dermatitis. Scrupulous cleanliness must be insisted upon wherever this material is handled.

The foregoing remarks have been prompted by the belief that, in recommending the use of a material with which is associated a potential hazard from the health standpoint, it is very important that the possible consequence be presented together with recommendations for correct handling.

LITERATURE CITED

(1) Maglio, M. Martin, *Chemist Analyst*, 35, 94 (1946).

Short Cut in Routine Water Analysis

MAXEY BROOKE
Jefferson Lake Sulphur Company, Inc., Brazoria, Texas

The usual procedure in making routine water analyses, particularly of boiler salines, is to titrate a sample with sulfuric acid to the phenolphthalein end point. The titration is then continued to the methyl orange end point. These measurements of the phenolphthalein and methyl orange alkalinities are generally expressed in grains of $CaCO_3$ per gallon.

To measure the salinity, a fresh sample of the water is first titrated with sulfuric acid to the phenolphthalein end point. Then a few drops of a 5% solution of potassium chromate are added and the sample is titrated with silver nitrate. The salinity is expressed as grains of NaCl per gallon.

When a large number of samples are to be analyzed, it would save time if all three determinations could be run on the same sample. Since the chromate acts as an indicator only through a narrow *p*H range, some means must be used to increase the *p*H of the sample which has been acidified to the methyl orange end point. To accomplish this, the potassium chromate is dissolved in a 0.1 *N* sodium bicarbonate solution instead of the usual distilled water. Five drops of this indicator solution are sufficient to bring the *p*H of the sample within the desired range.

Duplicate tests were run with the buffered and unbuffered indicator. The results, expressed in grains per gallon, were as follows:

Sample	Methyl Orange Alkalinity $CaCO_3$	Salinity NaCl Unbuffered	Salinity NaCl Buffered
Neutral 0.390 *N* NaCl	0.0	1336	1336
Boiler saline	23.1	267	267
Tap water	55.0	72	72

Thus it will be seen that the short cut is fully as accurate as the standard method of analysis.

MONS 031541

WATER_PCB-SD0000009368

(Airmail)

St. Louis

December 17/51

Mr.W.E.Hamor, Ruabon
Mr.W.H.Ritchie, Ruabon
Dr.H.R.Newman, Ruabon
Mr.S.M.Kulifay, Krummrich
Dr.D.S.Weddell, St.Louis
Mr.F.T.Marshall, St.Louis

Mr. P. J. C. Haywood HR

Newport (Airmail)

AROCLORS: TOXICITY

Since writing my note of Dec.11/51 I have chanced to learn that Anniston people had quite serious skin troubles: boils, blackheads and the like, among workers in Aroclors, especially 1269, around 1933.

A little browsing into the literature reveals quite a history of skin troubles and liver troubles (including some fatal cases) attributed to heavy exposure to chlorinated diphenyls.

The chlorinated diphenyls are stated to be worse than chlornaphthalenes, and to be more harmful the more chlorine they contain. I still think, however, that the exposure in ordinary analytical work should not cause any trouble.

E. Mather

tm

RECEIVED
24 DEC 1951
RUABON

PLAINTIFF'S EXHIBIT 6
TM 5/31/94

WATER_PCB-SD0000009369

M...santo, Illinois

CC:Messrs.
H. S. Sobus - G.O.
W. W. Dalton
H. M. Kelly - G.O.
F. E. Meisler
E. W. Smith
F. G. Benignus - G.O.
E. J. Putzell - G.O.
E. G. Derner - G.O.

January 17, 1958

Mr. D. T. Mayer

W. G. K. Plant

PRECAUTIONARY LABELS ON CHLORINATED DIPHENYL

RMK to PEH 1/8/58

Confirming our discussion on the above subject the Production department will assume responsibility of precautionary labeling of all drummed Arocolors. This will not apply to Pyranol or Inerteen products as recommended by Dr. Kelly.

Please make arrangements to supply production with about 10,000 labels of the "come clean" type which reads: "Caution avoid prolonged and repeated contact with the skin - Avoid prolonged breathing of vapor and fumes".

ORIGINAL SIGNED BY
J. R. KELLOGG

J. R. Kellogg

mh

PLAINTIFF'S EXHIBIT 7 TM 5/3/94

Reg. for 2000 Sent to JWS 1/30/58
Proofs Copy

MONS 094572

WATER_PCB-SD0000009370

Analytical Chemistry
Special Study 71-7
Job No. 1348006

DETERMINATION OF POLYCHLORINATED BIPHENYL RESIDUES IN ALBINO RATS FROM A TWO-YEAR CHRONIC ORAL TOXICITY STUDY

INTRODUCTION

An integral portion of the Aroclor Environmental Project is to obtain a more complete understanding of the environmental behavior and impact of our past and current polychlorinated biphenyls (PCB) products. In order to accomplish this objective, several feeding studies were initiated at Industrial Bio-Test Laboratories (IBT). This report covers the results of the analyses of the tissues from IBT #B7298, "Two-Year Chronic Oral Toxicity Study of Aroclor 1242, Aroclor 1254, and Aroclor 1260 in Albino Rats", for PCB residues.

The specific objectives of this study were to establish the relationship between tissue storage levels and exposure period, exposure level, degree of chlorination, and observed toxic effects as well as determining the homolog distribution of the PCB residues.

SUMMARY

The residues retained in the tissues of the animals fed these products were isolated by solvent extraction and the level and type of PCB's determined by electron capture gas chromatography (Analytical Chemistry Method No. 71-35). Significantly lower residues were found in the animals fed Aroclor 1242 vs those fed the higher chlorinated products Aroclor 1254 and Aroclor 1260.

PCB residues from these Aroclor products were observed in all the tissues (liver, fat, kidney and muscle, at all levels fed (1, 10 and 100 ppm) and at each sacrifice interval (3, 12 and 24 months). The residue levels found in the tissues of the animals fed 1, 10 and 100 ppm of Aroclor 1242 and 1 ppm of Aroclor 1260 did not continuously increase, but instead began to plateau at some point after three months of exposure.

Alteration of the homolog distribution of all products was also observed. The alteration was greatest for Aroclor 1242 and least for Aroclor 1254 and Aroclor 1260. The dominant PCB homologs found in the residues were in all cases those which have been observed as environmental residues.

Although the observation of gross toxicity effects caused by the ingestion of the PCB products were few, the data indicated that they occurred (enlarged livers) when the PCB lipid storage levels were in the range of 500-1000 ppm.

DETAILS

All tissue samples were analyzed as outlined in Analytical Chemistry Method 71-35, with the exception that the chemical clean-up procedure (saponification and sulfuric acid extraction) were not necessary. Th

PLAINTIFF'S EXHIBIT 9
Tm 5/31/94

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DETAILS (Cont'd)

procedure employed involved maceration of the weighed tissue sample in the presence of hexane and sodium sulfate followed by an alumina column clean-up of the hexane extracts and detection of the type and level of PCB's retained in the tissue by electron capture gas chromatography.

Standard solutions of the Aroclor fed were used to prepare the calibration curves for quantitation in the cases of Aroclor 1254 and Aroclor 1260. In the case where Aroclor 1242 was fed standard solutions of Aroclor 1254 were used to prepare the calibration curves, since the principal isomers found in the tissue extract were those that are dominant in production Aroclor 1254.

The PCB residue levels found in each of the tissue samples are shown in Tables I and II. The values in Table I were calculated using the original wet weight of the tissue, those in Table II were calculated on a hexane soluble lipid weight basis.

A graphical interpretation of these data demonstrating the observed trends are shown in Figures I - V.

Figures I - III are semi-logarithmic plots of the average PCB residue level found in the tissues (muscle, fat and liver) at each feed level vs the oral exposure period. Examination of these figures indicates that the level of PCB's stored in the tissues for all products generally increases as the exposure level and period increase. Apparent exceptions to this generalization are the residue storage levels for Aroclor 1242 at all feed levels and Aroclor 1260 at the lowest feed level. It appears that the storage levels with these materials, at the feed levels noted, begin to plateau after approximately three months of feeding.

Figure IV is a linear plot of the average PCB residue found vs the exposure period for each Aroclor at the highest feed levels. It simply illustrates the marked difference that exists between Aroclor 1242, the lowest chlorinated biphenyl fed and Aroclor 1254 and Aroclor 1260. After 24 months of exposure the ratio of the residue levels for Aroclor 1254 and Aroclor 1260 to Aroclor 1242 at the 100 mg feed level were 8.4/1 and 24.5/1, respectively.

The relationships between the average tissue storage levels at each fed level, after 24 months of exposure, and the degree of chlorination are shown in Figure V. It clearly demonstrates that as the degree of chlorination of the PCB fed and the exposure level are increased that the tissue storage level increases, especially when the product fed contains dominant amounts of the higher chlorinated isomers (penta, hexa, hepta, etc.).

Chromatograms I, II and III compare a typical tissue extract against the Aroclor fed. Isomeric alterations were observed with each Aroclor at all feed levels. Aroclor 1242 was altered to a greater extent than either Aroclor 1254 or Aroclor 1260. The chromatographic conditions

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DETAILS (Cont'd)

employed while ideal for quantitation of the PCB residues in the tissues are not suitable for the identification of the specific isomers which are retained. Nevertheless with these limitations, the chlorine number(s) of the principal isomer(s) have been shown above each peak on the chromatogram. An inspection of the chromatograms reveals that the less chlorinated isomers are degraded while the higher chlorinated isomers are retained. To get an appreciation of this effect, one has to ratio the peak heights of the early eluting isomers to the peak heights of the later eluting isomers and then compare the ratio for the standard vs the ratio for the tissue extract. In most cases, the response of the detector for the tissue extract has been amplified to get sufficient area for good quantitation and this tends to obscure the fact that some isomers are almost completely removed while others are drastically reduced. It should also be noted that the animals were fed the Arocior containing feeds right up to the point of sacrifice.

REFERENCES

1. "Two Year Chronic Oral Toxicity Study of Aroclor 1242, Aroclor 1254 and Aroclor 1260 In Albino Rats", Industrial Bio-Test Laboratories Report (IBT #7298).

2. "Statistical Analysis of Bio-Test Oral Toxicity Study - Albino Rats", Statistics Special Study 71-14.

db

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TABLE I

ppm Wet Weight Fa...

Two Year Chronic Oral Toxicity Study Of Aroclor In Albino Rats

		1 ppm			10 ppm			100 ppm		
		3 mo.	12 mo.	24 mo.	3 mo.	12 mo	24 mo.	3 mo.	12 mo.	24 mo
Aroclor 1242	Muscle	07	1	1.8	1.4	6	14	5	33	73
	Liver	0.1	02	05	02	06	1	09	5	5
	Fat	6	7	6	12	30	43	60	144	220
Aroclor 1254	Muscle	2	2	13	8	131	98	46	14	351
	Liver	0.1	04	1.2	1	23	6	15	24	133
	Fat	6	19	45	75	632	314	1205	774	1533
Aroclor 1260	Muscle	6	8	15	8	50	116	10	411	705
	Liver	02	1	0.8	2	3	5	18	53	107
	Fat	28	56	50	417	224	295	485	[illegible]	[illegible]

1) Calculated as Aroclor 1254

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TABLE II

ppm Lipid Weight Basis

Two Year Chronic Oral Toxicity Study Of Aroclor In Albino Rats

		1 ppm			10 ppm			100 ppm		
		3 mo.	12 mo.	24 mo.	3 mo.	12 mo.	24 mo.	3 mo.	12 mo.	24 mo.
4) Aroclor 1242	Muscle	8	6	5	16	38	74	76	236	239
	Liver	11	16	18	26	40	52	77	241	234
	Fat	6	8	9	13	32	47	67	151	227
Aroclor 1254	Muscle	10	11	38	96	(721)	389	756	1092	3161
	Liver	18	24	82	115	(914)	307	1137	869	1810
	Fat	6	19	55	76	(608)	348	821	860	1994
Aroclor 1260	Muscle	16	47	44	60	259	436	146	2247	5154
	Liver	20	50	56	102	189	442	1677	1752	6310
	Fat	32	60	62	138	262	354	866	2143	5060

4) Calculated as Aroclor 1254

MONS 021453

WATER_PCB-SD0000009375

FIGURE I

Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats

PCB Lipid Storage Level as a Function of Exposure Period and Level

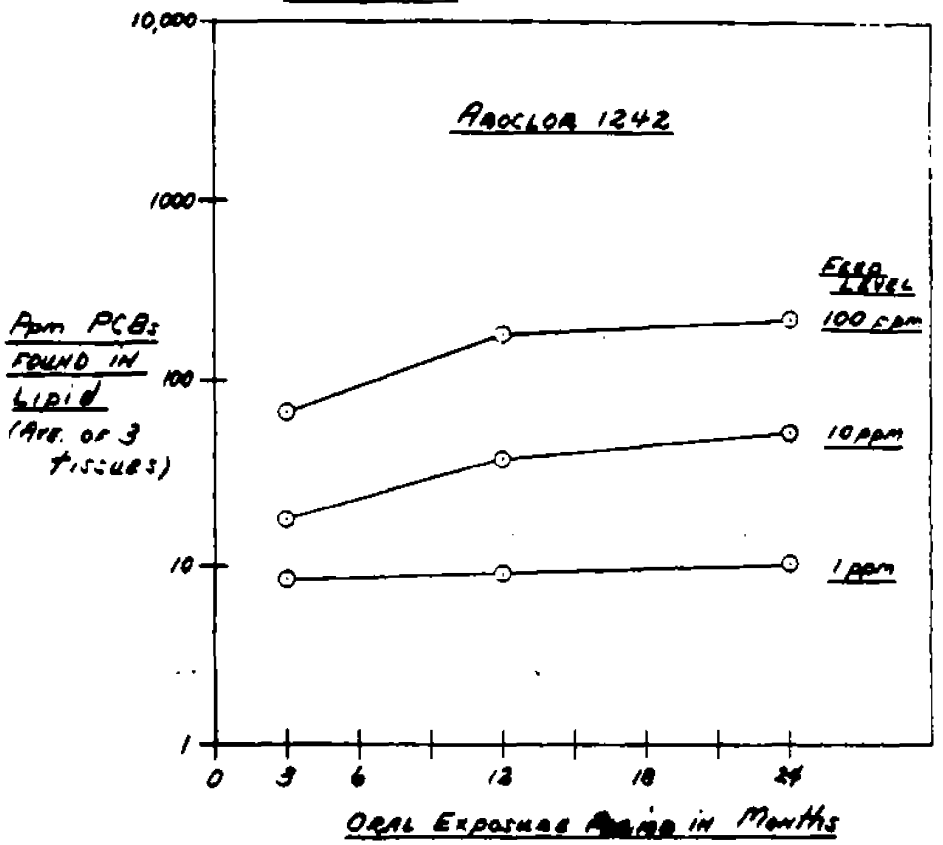

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FIGURE II

Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats

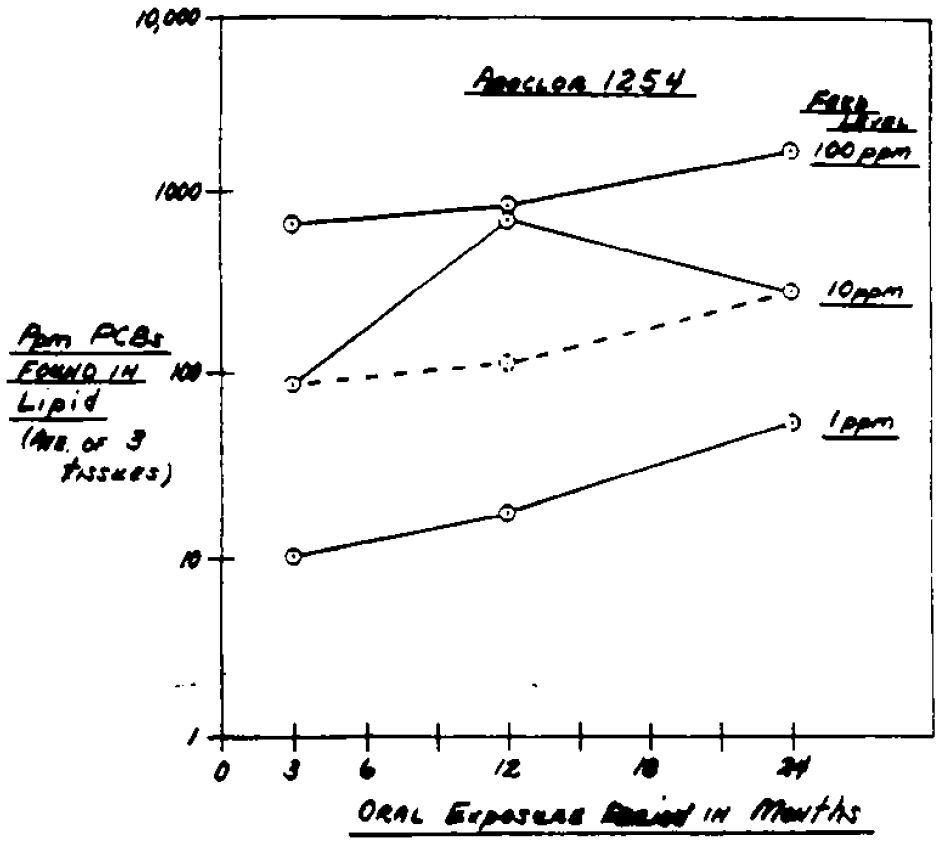

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FIGURE III

Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats

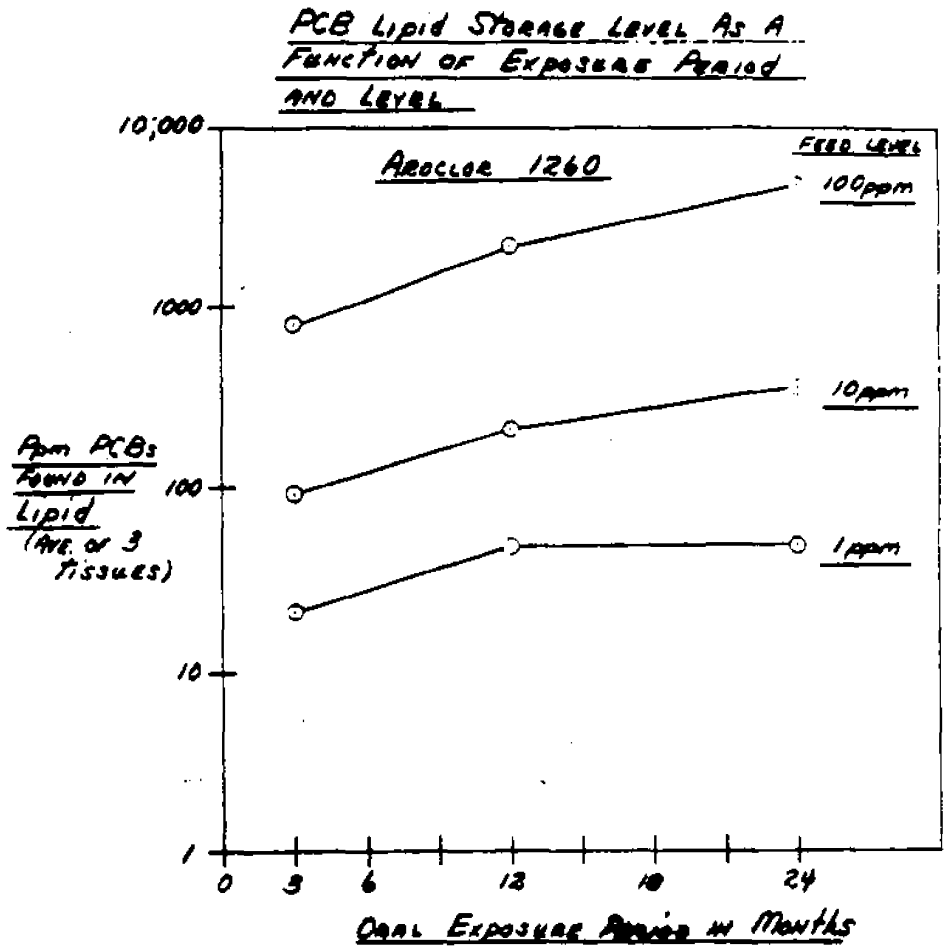

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FIGURE IV

"Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats"

PCB Lipid Storage Level as a Function of Aroclor and Oral Exposure Level

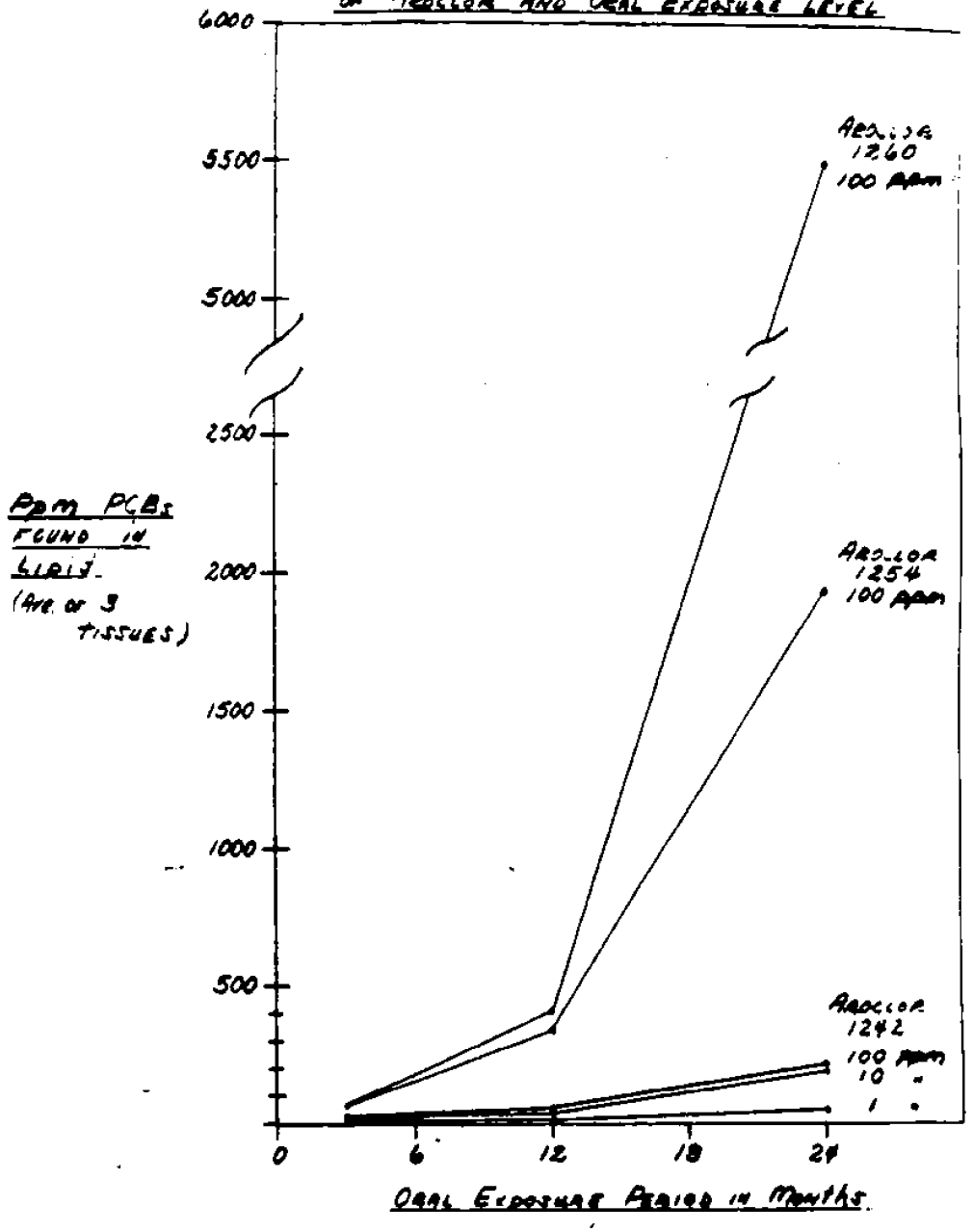

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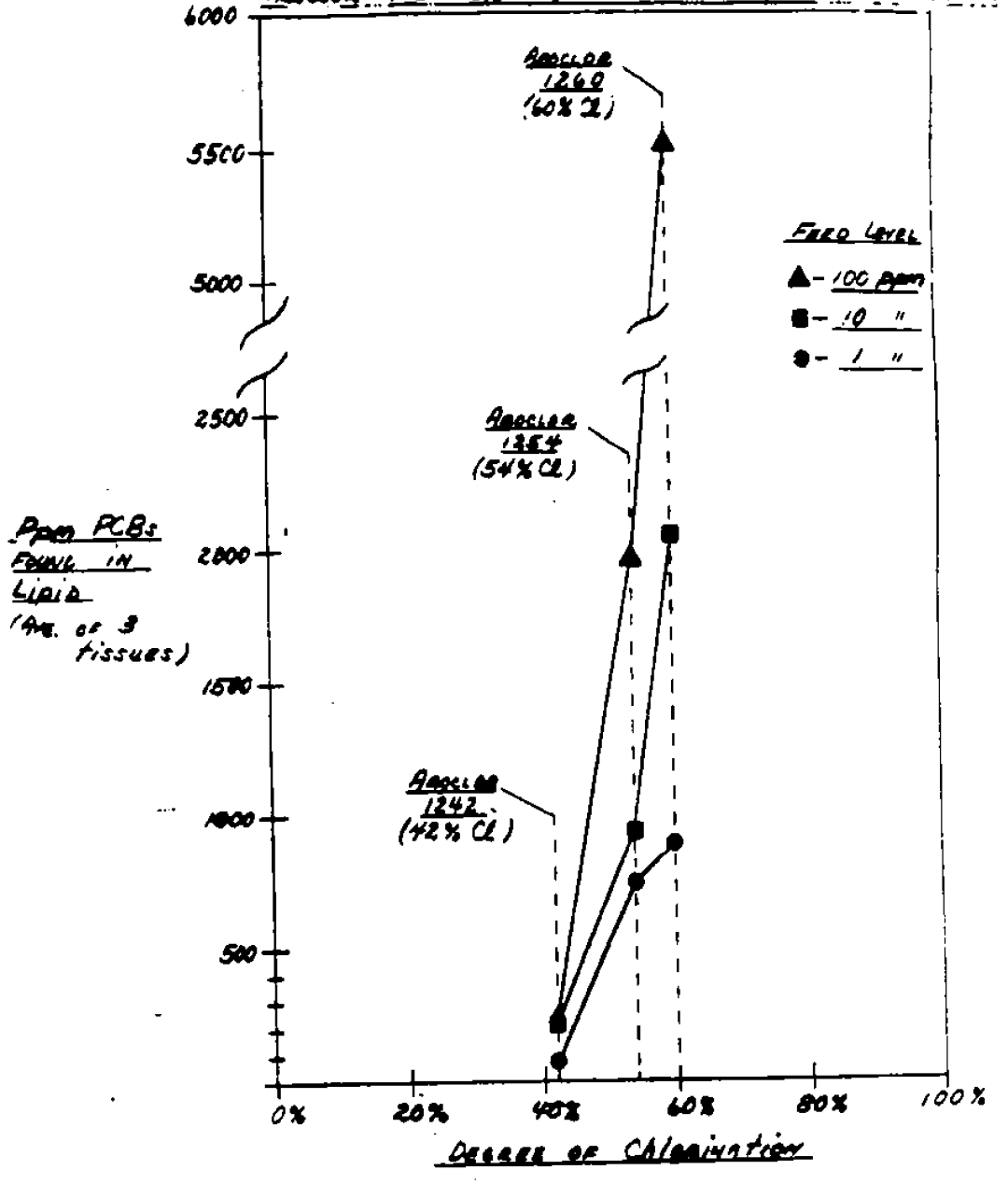
FIGURE V

"Two Year Chronic Oral Toxicity Study of Aroclor in Albino Rats."

PCB Lipid Storage Level as a Function of Aroclor and Oral Exposure Level After 24 Months



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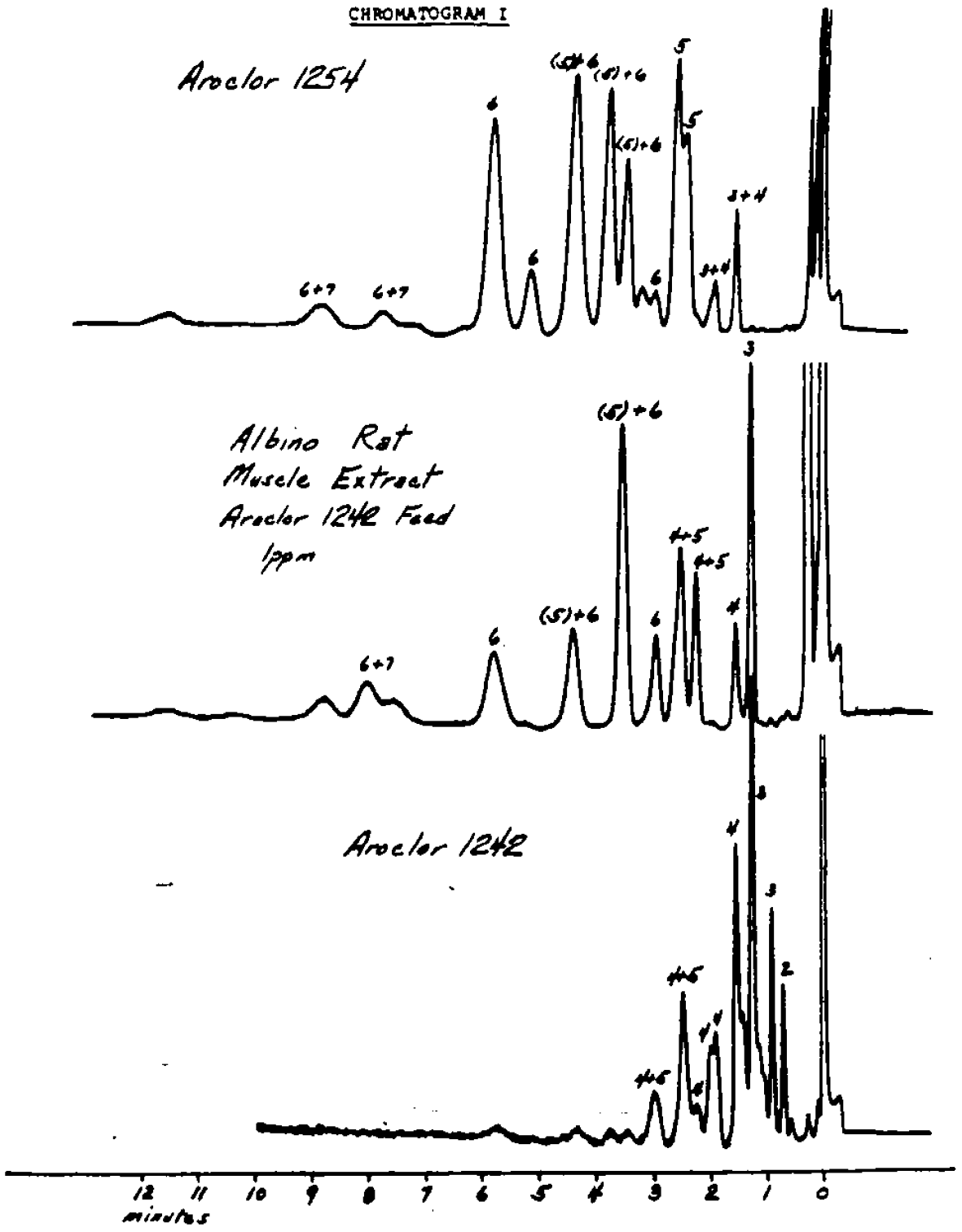
CHROMATOGRAM I



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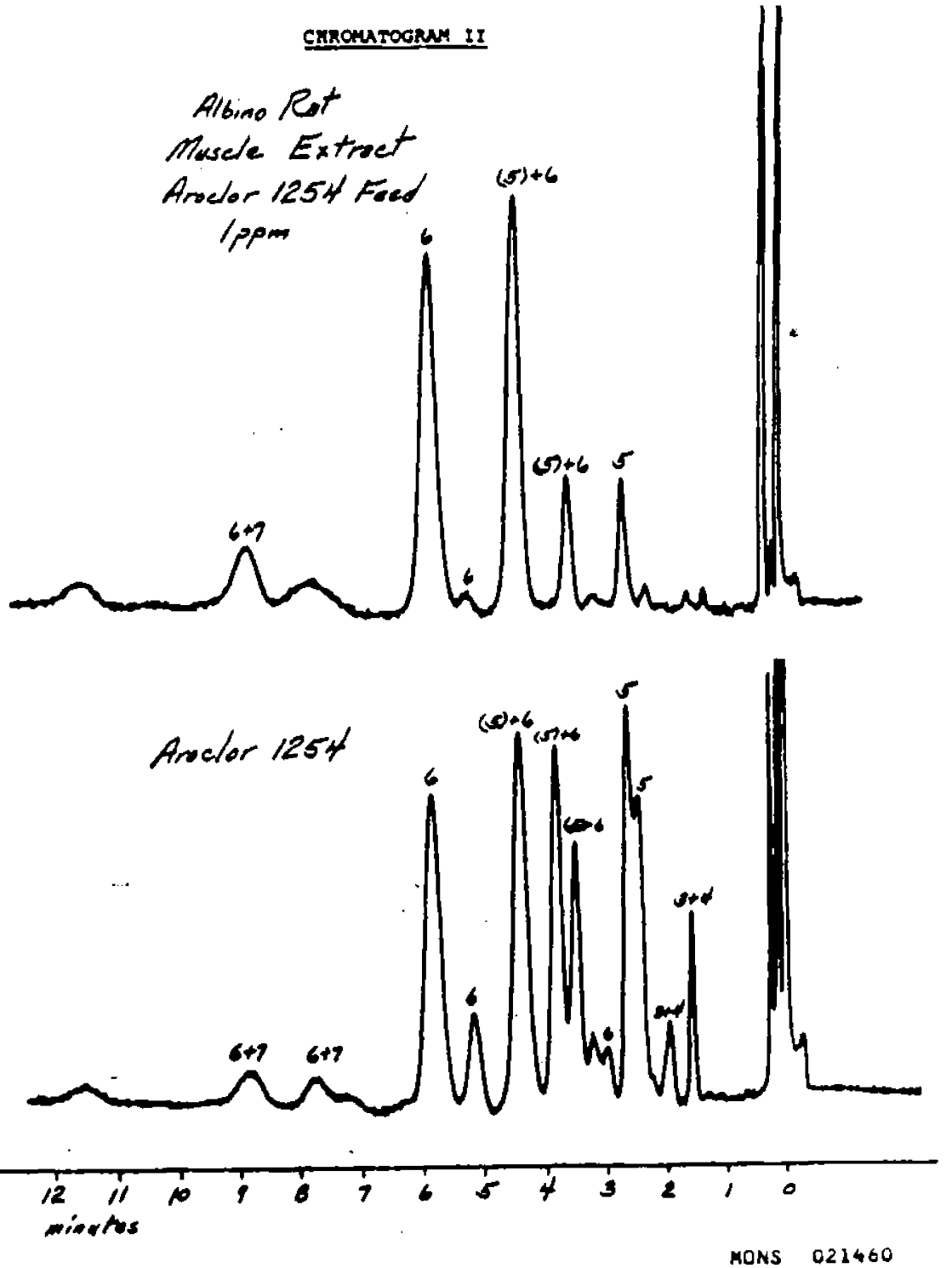
WATER_PCB-SD0000009381

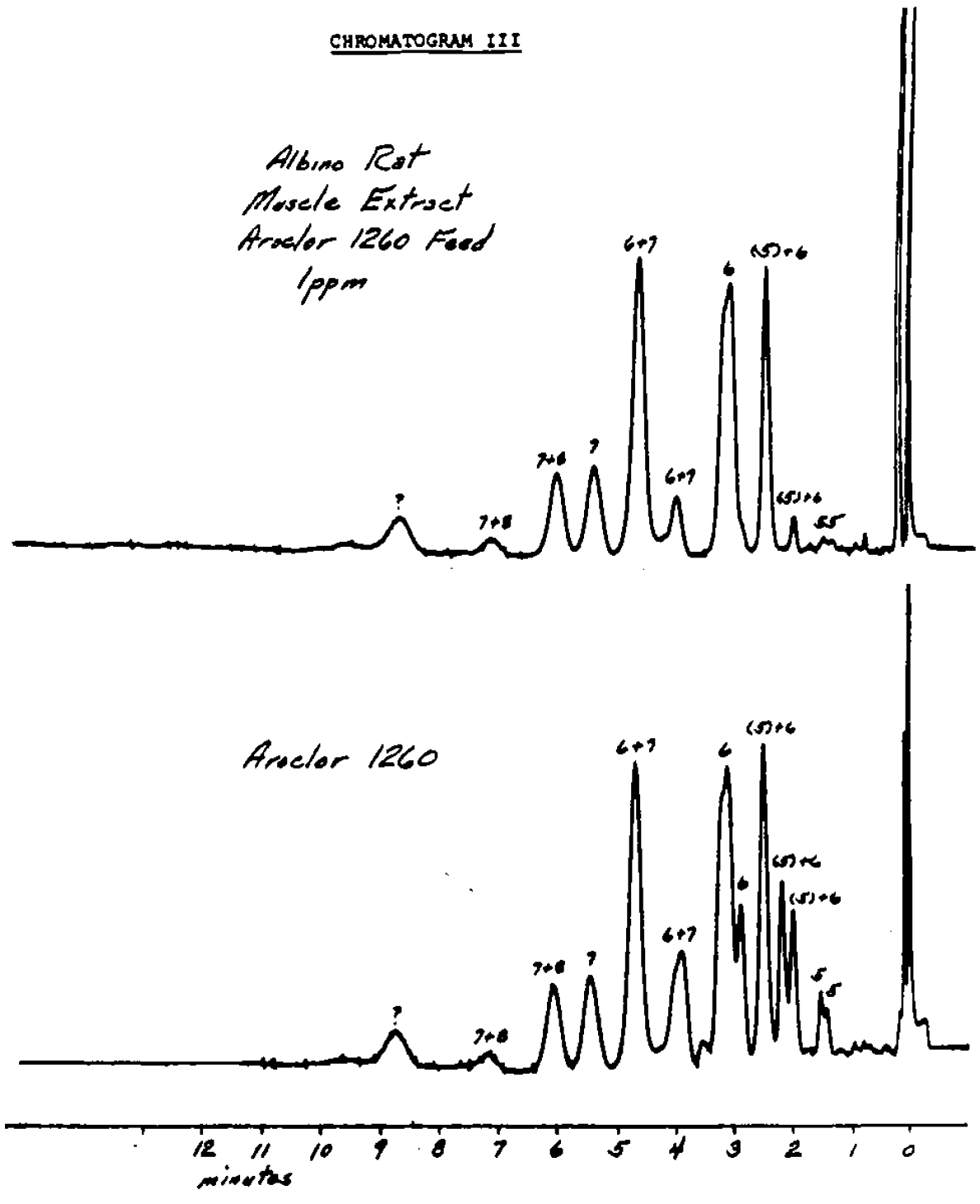
CHROMATOGRAM II



MONS 021460

WATER_PCB-SD0000009382

CHROMATOGRAM III



MONS 021461

WATER_PCB-SD0000009383

Analytical Chemistry
Special Study 71-3
Job No. 1348006

DETERMINATION OF POLYCHLORINATED BIPHENYL RESIDUES IN WHITE LEGHORN CHICKENS FROM A TOXICITY, REPRODUCTION AND RESIDUE STUDY WITH AROCLOR 1242, AROCLOR 1254, AND AROCLOR 1260

INTRODUCTION

An integral part of the overall Aroclor Environmental Program involved obtaining a more complete understanding of the environmental behavior and impact of our polychlorinated biphenyl (PCB) products. In order to accomplish this a number of laboratory feeding studies with beagle dogs, albino rats, and white leghorn chickens were initiated at Industrial Bio-Test Laboratories (IBT).

This report covers the results of the analysis of biological samples from IBT's study #J7300, "Toxicity, Reproduction, and Residue Study with Aroclor 1242, Aroclor 1254 and Aroclor 1260 in White Leghorn Chickens" and a supplementary IBT study #8746 with only Aroclor 1242.

The specific objectives were to establish the relationships between tissue storage levels and exposure period, exposure level, degree of chlorination, and any observed toxic effects as well as determine the homolog distribution of the retained PCB residues. Enough chickens were also included in these studies to determine the rate at which the PCB residues declined when the birds were put on PCB-free diets.

SUMMARY

PCB residues from the Aroclor products fed were observed at all exposure levels (1, 2, 4, 8, 10 and 100 ppm), at each sacrifice period (24 and 28 weeks), and in all of the samples (muscle, liver, fat, egg and chicks) analysed.

The PCB residue levels found in the tissues decreased as the exposure level was reduced and as the chlorine content of the product fed decreased.

Significant differences in the PCB residue levels were observed between males and females, and between the muscle, liver and fat tissues. Significantly lower PCB residue levels were observed when the birds were put on a recovery diet that contained no PCBs.

The homolog distributions of all of the products fed were altered. The alterations were most pronounced with Aroclor 1242 and least with Aroclor 1254 and Aroclor 1260.

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DETAILS

Analyses of the tissues were carried out according to Analytical Chemistry Method No. 71-35 with the exception that the chemical clean-up procedure was necessary only with the chick samples.

Standard solutions of the material fed were used to prepare calibration curves for the quantitation of the PCB residues.

In the initial residue studies all of the samples were analyzed. In subsequent tissue residue studies, including these chicken studies, a statistical approach was employed to minimize the number of samples requiring analysis. In this manner, both the elapsed time and manpower requirements were significantly reduced with little real loss in either accuracy or precision. The approach involved subjecting the results from the residue analysis of a balanced subset of samples, along with the appropriate study variables (tissue type, exposure period, exposure level, sex, and Aroclor fed) and the most probable variable interactions to multiple regression statistics. In this way an interpolation equation was generated for predicting the PCB residues. The initial equation was then smoothed by deleting data more than two standard deviations from the predicted values and the variable interaction terms not significant at the 95% confidence level. The final equations were then used to calculate the PCB residue levels in the unanalyzed tissues.

The validity of each predicting equation was established in the following manner. The respective residual standard deviations of each equation were compared to those obtained for the equations developed for the studies in which all of the tissues were analyzed. The 95% confidence limits calculated for these studies from the log of the residual standard deviations indicated that in all studies the actual values determined by analysis were within ~0.5-2 times the predicad values.

The equations resulting from the statistical analysis used to predict the complete sets of PCB residue levels are shown in Tables III and VI.

Figures I thru III are semi-logarithmic plots of PCB residue levels vs. time for the different exposure levels for each of the Aroclor products tested. The plots clearly illustrate a considerably slower rate of recovery for the liver tissue. Apparently the liver is the primary site for metabolism and/or collection point for elimination of the test material from the animal.

Shown in Table VII are biological half lives for the Aroclor products tested in chicken tissues. Once again significant differences

WATER_PCB-SD0000009385

between tissues were observed. Also apparent are differences in the rate of recovery with the Aroclor product fed.

Calculations based on average body weight, feed consumption and lipid content indicate that only 11% of the total Aroclor 1242 ingested was retained by the animal. The corresponding figures for Aroclor 1254 and Aroclor 1260 were 28 and 49% respectively. Figure IV, which is a plot of PCB residue level vs. degree of chlorination, further illustrates the differences in storage level due to test material fed. It demonstrates that as the degree of chlorination decreases the PCB residue level decreases.

Figure V is a semi-logarithmic plot of PCB residue level vs. exposure level for each sex for the three Aroclor products fed. This figure illustrates the bias, which increases with degree of chlorination, toward higher PCB residue levels in the males. The higher PCB residue levels in males were also observed in the recovery sacrifice samples in the same ratios.

Chromatograms I, II and III compare typical tissue extracts from the residue and final sacrifices with the material fed for Aroclor 1242, Aroclor 1254, and Aroclor 1260. The alterations were greatest with Aroclor 1242 and least with Aroclor 1260. It is apparent upon inspection of the chromatograms that the lower chlorinated isomers are metabolized and/or excreted quite rapidly. Further comparisons between the residue and final sacrifice extracts indicate that some of the higher chlorinated isomers also undergo metabolism and/or excretion but at much slower rates.

Chromatogram IV is comparison of chicken tissue, egg, and chick extracts in the case where Aroclor 1242 was fed. Once again, it is apparent that the lower chlorinated homologs are readily metabolized and/or excreted.

The gas chromatographic conditions employed do not completely resolve the Aroclor products into their component homologs. Nevertheless, the numbers above the chromatographic peaks indicate the dominant homolog(s) in that peak.

TOXICITY

Some toxic effects were observed with the groups fed Aroclor 1242 at 10 ppm and 100 ppm, and Aroclor 1254 at 100 ppm. Consequently a supplementary study with Aroclor 1242 at the 2, 4 and 8 ppm exposure levels was initiated. The toxic effects, primarily related to hatchability, are discussed in detail in the referenced Industrial Biotest Laboratories reports.

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REFERENCES

"Toxicity, Reproduction, and Residue Study with Aroclor 1242, Aroclor 1254 and Aroclor 1260 in White Leghorn Chickens," Industrial Bio-Test Laboratories Report (IBT #J7300).

"Toxicity, Reproduction, and Residue Study with Aroclor 1242 in White Leghorn Chickens," Industrial Bio-Test Laboratories Report (IBT #8746).

Residue Study - Aroclor and White Leghorn Chickens, Statistics Special Study 71-24.

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WATER_PCB-SD0000009387

TABLE I

IBT#1300 Toxicity Reproduction and Residue Study of Aroclor in White Leghorn Chickens

ppm PCB in Chicken Tissues (Wet Weight Basis)

		Residue Sacrifice						30 Day Check Sacrifice			1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	Final Sacrifice					
		1 ppm		10 ppm		100 ppm		1 ppm	10 ppm	100 ppm	1 ppm				10 ppm				100 ppm				1 ppm		10 ppm		100 ppm	
		♂	♀	♂	♀	♂	♀	♂ ♀	♂ ♀	♂ ♀	30 Day Recovery Period												♂	♀	♂	♀	♂	♀
Aroclor 1262	Muscle		0.06				2	0.07	0.05																			
	Liver				2			0.4	0.2																			
	Fat	26	17																									
	Eggs			5		38									3	0.6	0.5		26	30	19	34						
Aroclor 1254	Muscle			0.9	0.7			0.02																				
	Liver		0.8				50	0.09																				
	Fat			561	194																							
	Eggs	0.7				192					2	0.5	0.4						68	75	46							
Aroclor 1260	Muscle		0.2				11	0.06	0.8																			
	Liver				6			0.09	0.2																			
	Fat	153	15			672	457																					
	Eggs	1		13							1	0.7			13	8												

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TABLE II

IBT #U7300 Toxicity, Reproduction and Residue Study of Aroclor in White Leghorn Chickens

ppm PCB in Chicken Tissues (Lipid Weight Basis)

		Residue Sacrifice						30 Day Chick Sacrifice			1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	Final Sacrifice					
		1 ppm		10 ppm		100 ppm		1 ppm	10 ppm	100 ppm	1 ppm				10 ppm				100 ppm				1 ppm		10 ppm		100 ppm	
		♂	♀	♂	♀	♂	♀	♂ & ♀	♂ & ♀	♂ & ♀	30 Day Recovery Period												♂	♀	♂	♀	♂	♀
Aroclor 1242	Muscle		13				901	9	12															8		3		63[illegible]
	Liver				52			14	12															10		23		[illegible]
	Fat	30	22			246[illegible]	1310																	4				[illegible]
	Eggs			37		472									33	5	5		385	361	249	368						
Aroclor 1254	Muscle			517	240			2																		61		
	Liver		18				1475	4																7				1[illegible]
	Fat			892	197																					78		
	Eggs	10				1410						14	6	5						1[illegible]	6[illegible]	832						
Aroclor 1260	Muscle		40				[illegible]	5	125															13				[illegible]
	Liver				86			6	6																	50		
	Fat	183	16			2[illegible]	1305																	11				[illegible]
	Eggs	12		146							13	7			135	71												

MONS 021409

TABLE III

IBT #J7300 Toxicity, Reproduction and Residue Study of Aroclor in White Leghorn Chickens

Predicted ppm PCB in Chicken Tissues (Lipid Weight Basis)

		Residue Sacrifice						30 Day Chick Sacrifice			1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	Final Sacrifice					
		1 ppm		10 ppm		100 ppm		1 ppm	10 ppm	100 ppm	1 ppm				10 ppm				100 ppm				1 ppm		10 ppm		100 ppm	
		♂	♀	♂	♀	♂	♀	♂ & ♀	♂ & ♀	♂ & ♀	30 Day Recovery Period												♂	♀	♂	♀	♂	♀
Aroclor 1242	Muscle	23	12	175	119	1491	1152																10	6	92	56	901	--
	Liver	12	7	114	69	1164	569																12	7	114	63	--	(1141)
	Fat	23	12	196	119	1841	1172																10	6	92	56	0	541
	Eggs	3		40		493					2	0.9	0.6	0.4	25	16	10	7	324	362	346	283						
Aroclor 1254	Muscle	68	22	657	213	6101	2067																26	8	247	81	2467	782
	Liver	34	11	326	106	3263	1027																85	8	2265	77	1,288	734
	Fat	69	22	667	213	6321	2067																24	8	669	81	2467	782
	Eggs	7		92		1141					6	5	4	3	80	66	54	44	1040	881	730	602						
Aroclor 1260	Muscle	198	58	1776	580	16,000	5,200																62	10	579	90	5,199	900
	Liver	57	29	530	281	5,041	2,747																36	10	464	87	3,827	845
	Fat	198	58	1776	580	16,000	5,200																62	10	579	90	5,199	900
	Eggs	11		140		1728					12	13	14	15	187	235	283	331	1791	2,248	2,706	3,164						

Chicken Regression Equation: log ppm PCB = − 0.5311 + 0.7858 (log ppm fed) + 0.7344 (if female) + 0.0438 (% Cl_2) + 0.2708 (if rec. time) − 0.0056 (% Cl_2) if time − 0.0076 (% Cl_2) if rec. − 0.0226 (% Cl_2) if female

Egg Regression Equation: log ppm PCB = − 0.7476 − 1.1774 (rec. time) + 1.0920 (log ppm fed) + 0.0300 (% Cl_2) + 0.5316 (rec. time × log ppm fed) + 0.0202 (rec. time × % Cl_2) − 0.0096 (rec. time × log ppm fed × % Cl_2)

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TABLE IV

IDT # 8746 Toxicity, Reproduction and Residue Study of Aroclor in White Leghorn Chickens

ppm PCB in Chicken Tissues (Wet Weight Basis)

		Residue Sacrifice			30 Day Chick Sacrifice			1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	Final Sacrifice		
		2 ppm	4 ppm	8 ppm	2 ppm	4 ppm	8 ppm	2 ppm				4 ppm				8 ppm				2 ppm	4 ppm	8 ppm
		8 & 9	8 & 9	8 & 9	8 & 9	8 & 9	8 & 9	30 Day Recovery Period												8 & 9	8 & 9	8 & 9
Aroclor 1242	Muscle			1	0.02	0.04	0.03													0.5		1
	Liver		4		0.3	0.2	0.2														2	
	Fat			56	2	3	5													11		43
	Eggs	1							1		1	2		1			4					

MONS 021411

TABLE V

IBT #8746 Toxicity, Reproduction and Residue Study of Aroclor in White Leghorn Chickens

ppm PCB in Chicken Tissues (Lipid Weight Basis)

		Residue Sacrifice			30 Day Chick Sacrifice			1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	1st wk	2nd wk	3rd wk	4th wk	Final Sacrifice		
		2 ppm	4 ppm	8 ppm	2 ppm	4 ppm	8 ppm	2 ppm				4 ppm				8 ppm				2 ppm	4 ppm	8 ppm
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]													[illegible]	[illegible]	[illegible]
Aroclor 1016	Aroclor			64	5	8	13													19		71
	Liver		30		15	19	17														17	
	Fat			73	3	5	9													14		56
	Eggs	14							14		15	22		25			42		28			

MONS 021412

TABLE VI

IBT #8746 Toxicity, Reproduction and Residue Study of Aroclor in White Leghorn Chickens

Predicted ppm PCB in Chicken Tissues (Lipid Weight Basis)

		Residue Sacrifice			30 Day Chick Sacrifice			Adult 2 ppm				Adult 4 ppm				Adult 8 ppm				Final Sacrifice		
		2 ppm	4 ppm	8 ppm	2 ppm	4 ppm	8 ppm													2 ppm	4 ppm	8 ppm
		d/g	d/g	d/g	d/g	d/g	d/g													d/g	d/g	d/g
Adult	Muscle	31	62	123	7	9	11													15	27	58
	Liver	18	36	71	15	15	15													17	33	66
Chick	Fat	31	62	123	6	6	6													15	29	58
	Eggs	7	15	32				4	2	1	25	8	5	3	1	19	12	7	4			

Chick Regression Equation - log ppm PCB = a 7486 + a 4335 (% liver) + a 3317 (log ppm feed - % muscle)

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TABLE VII

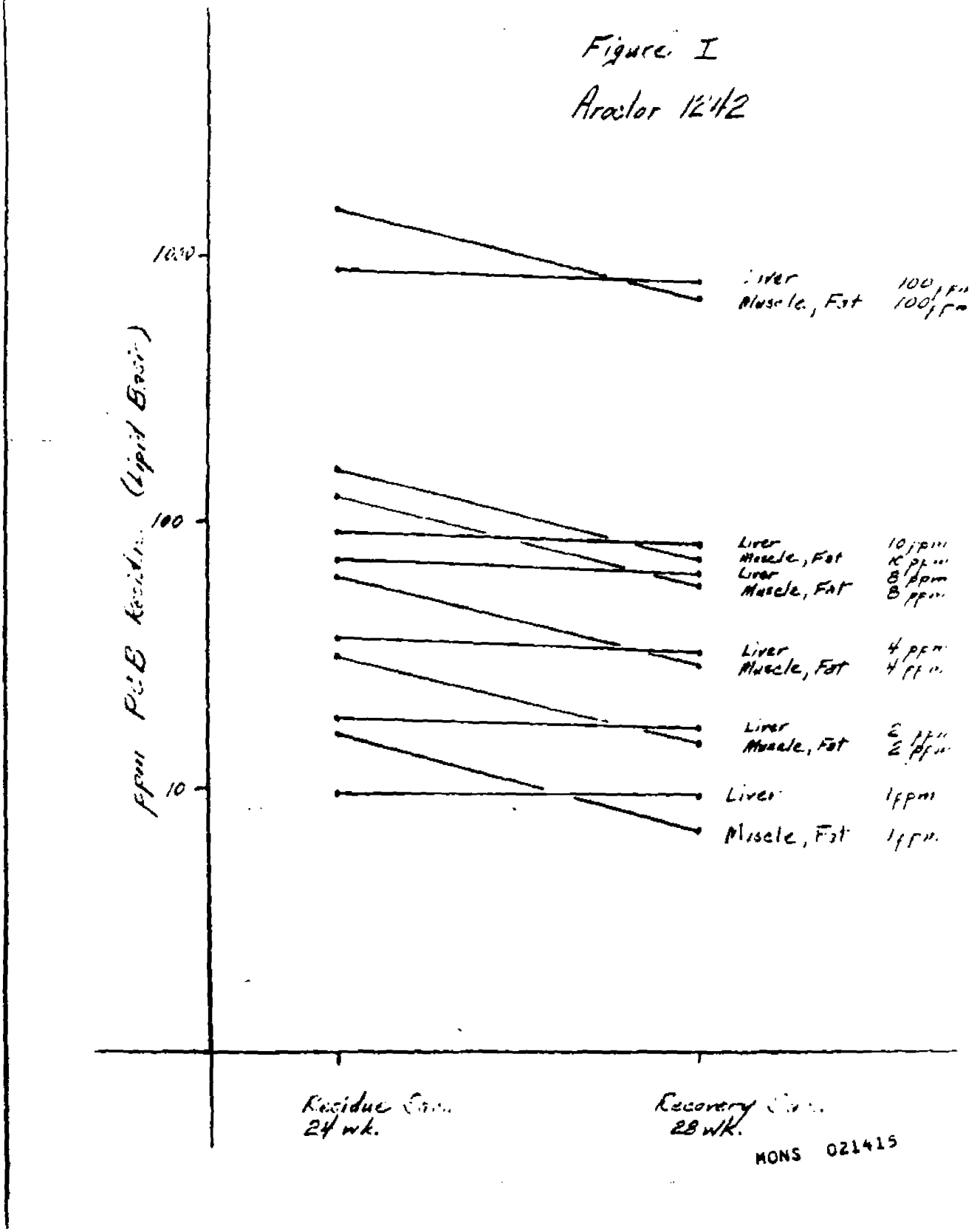
BIOLOGICAL HALF-LIFE

Material	Tissue	Biological Half-Life
Aroclor 1242	Muscle, Fat	27.6 days
" "	Liver	245.4 days
Aroclor 1254	Muscle, Fat	21.4 days
" "	Liver	69.3 days
Aroclor 1260	Muscle, Fat	19.3 days
" "	Liver	51.0 days

WATER_PCB-SD0000009394

Figure I

Aroclor 1242

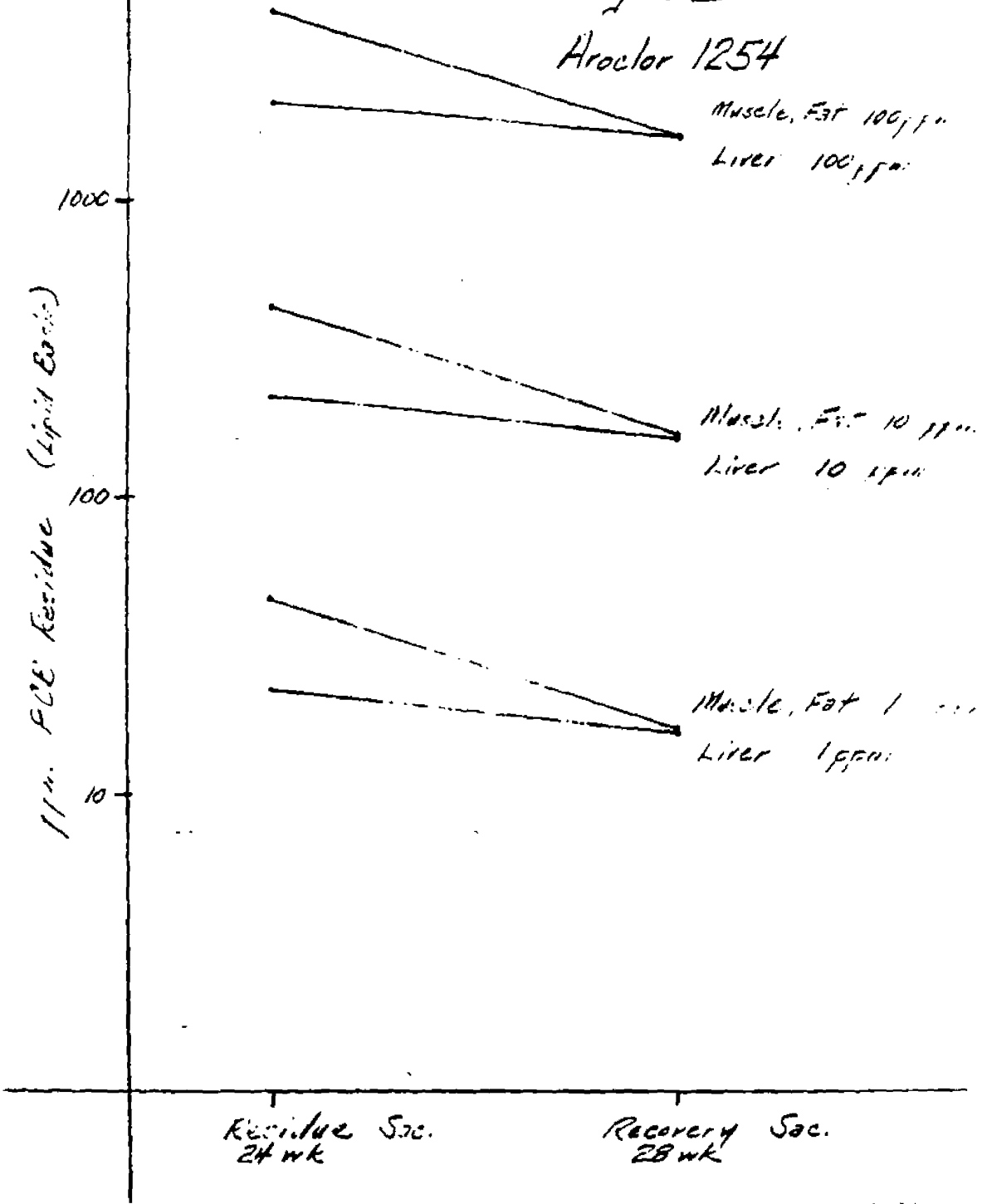


MONS 021415

WATER_PCB-SD0000009395

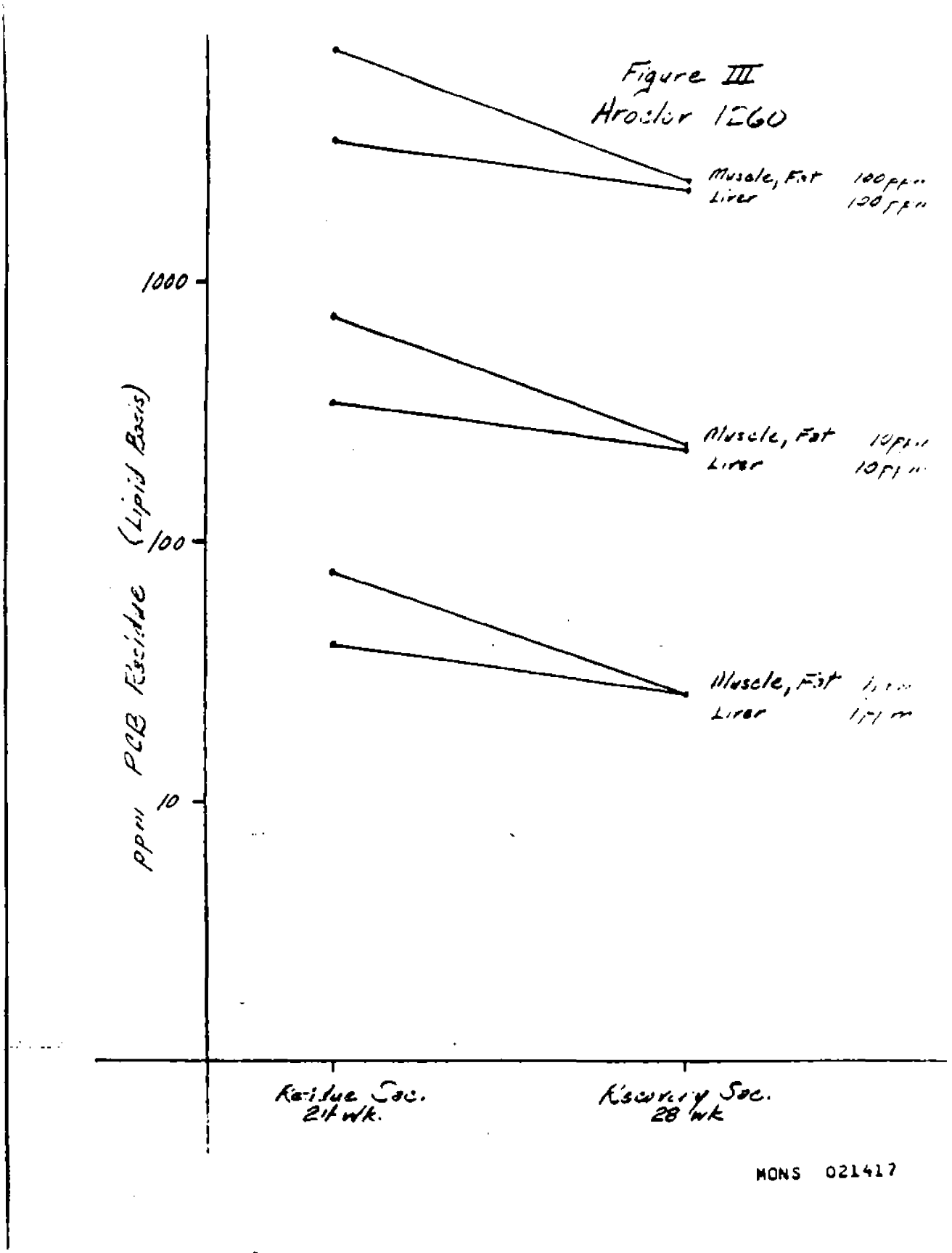
Figure II

Aroclor 1254



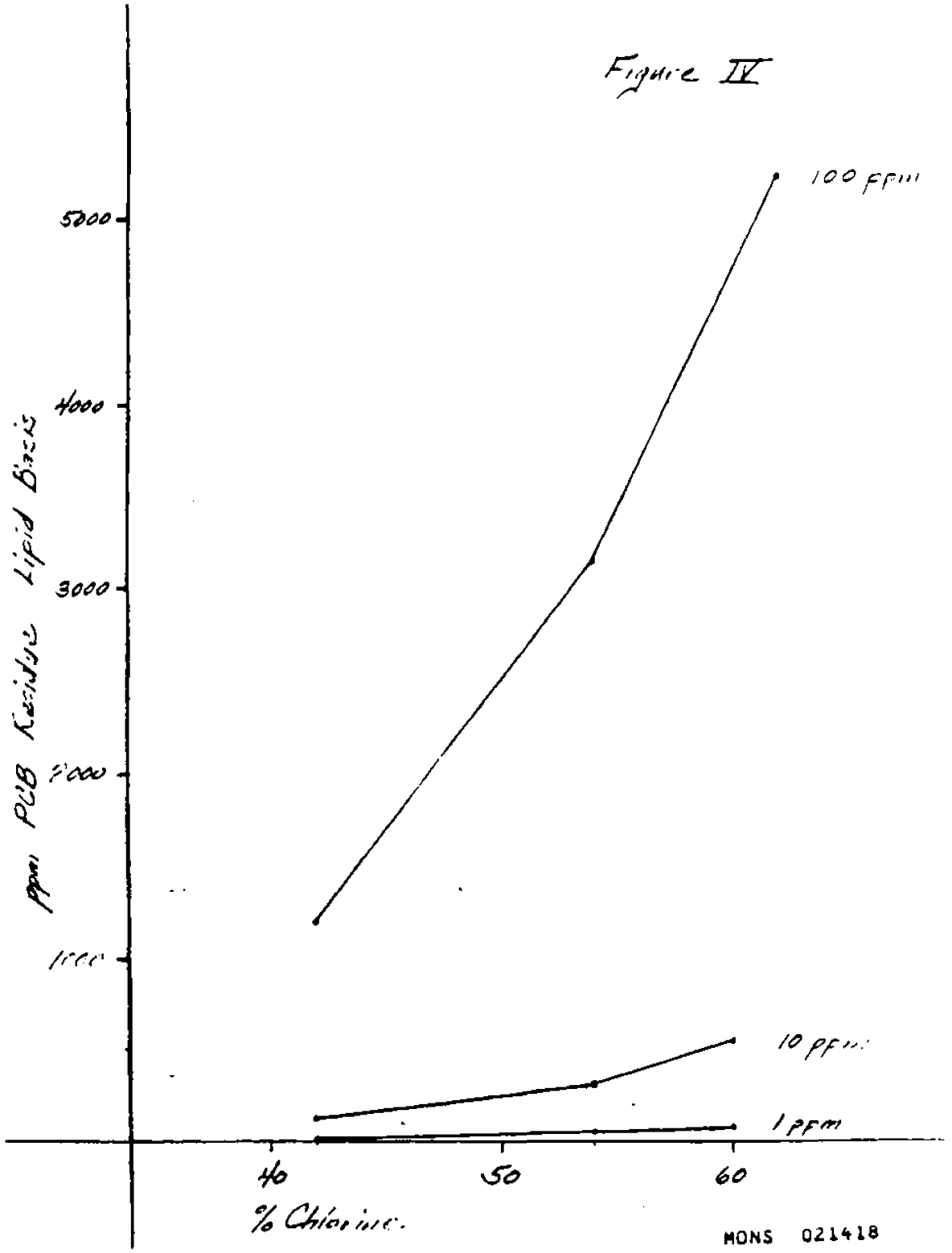
MONS 021416

WATER_PCB-SD0000009396



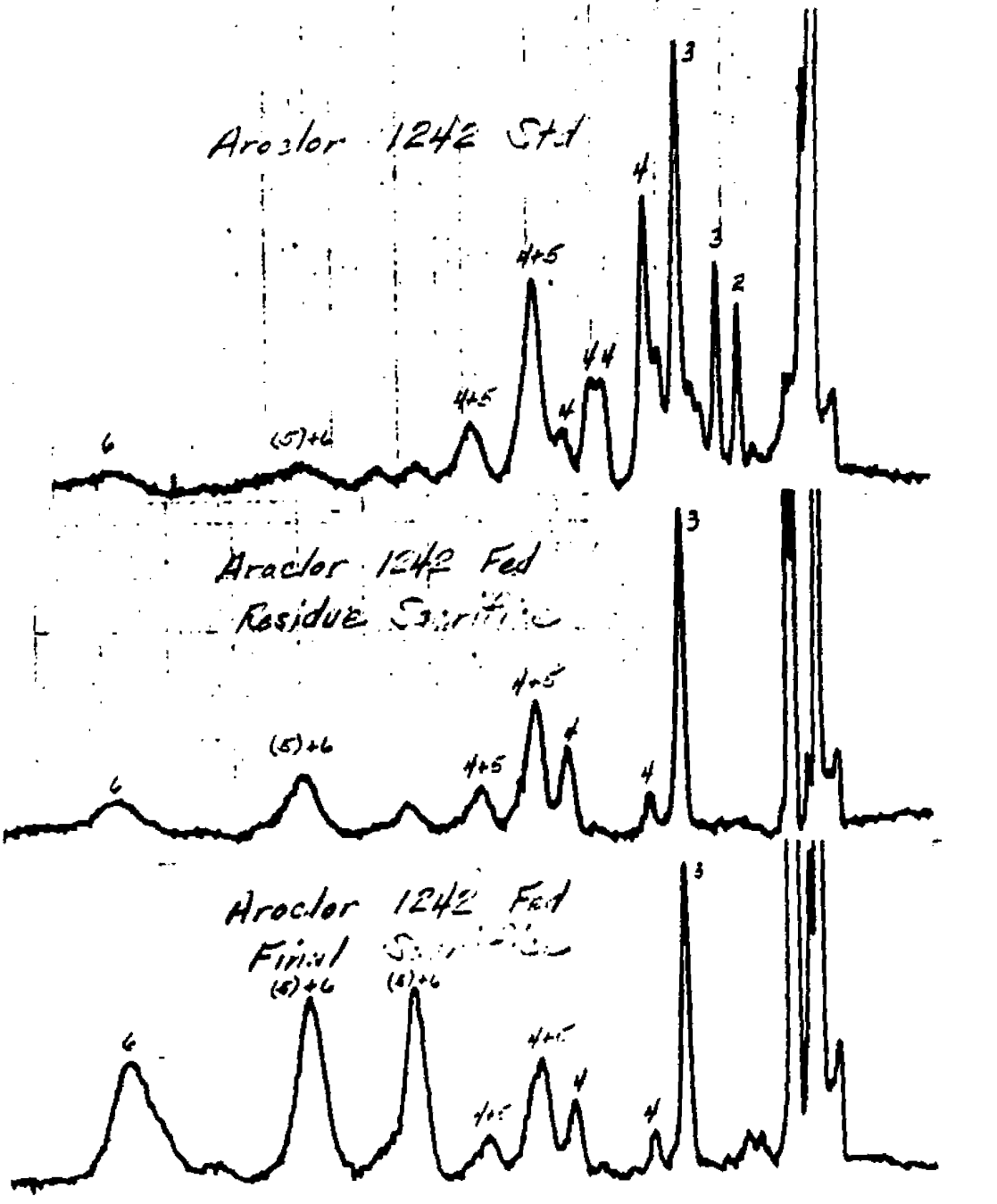
WATER_PCB-SD0000009397

Figure IV



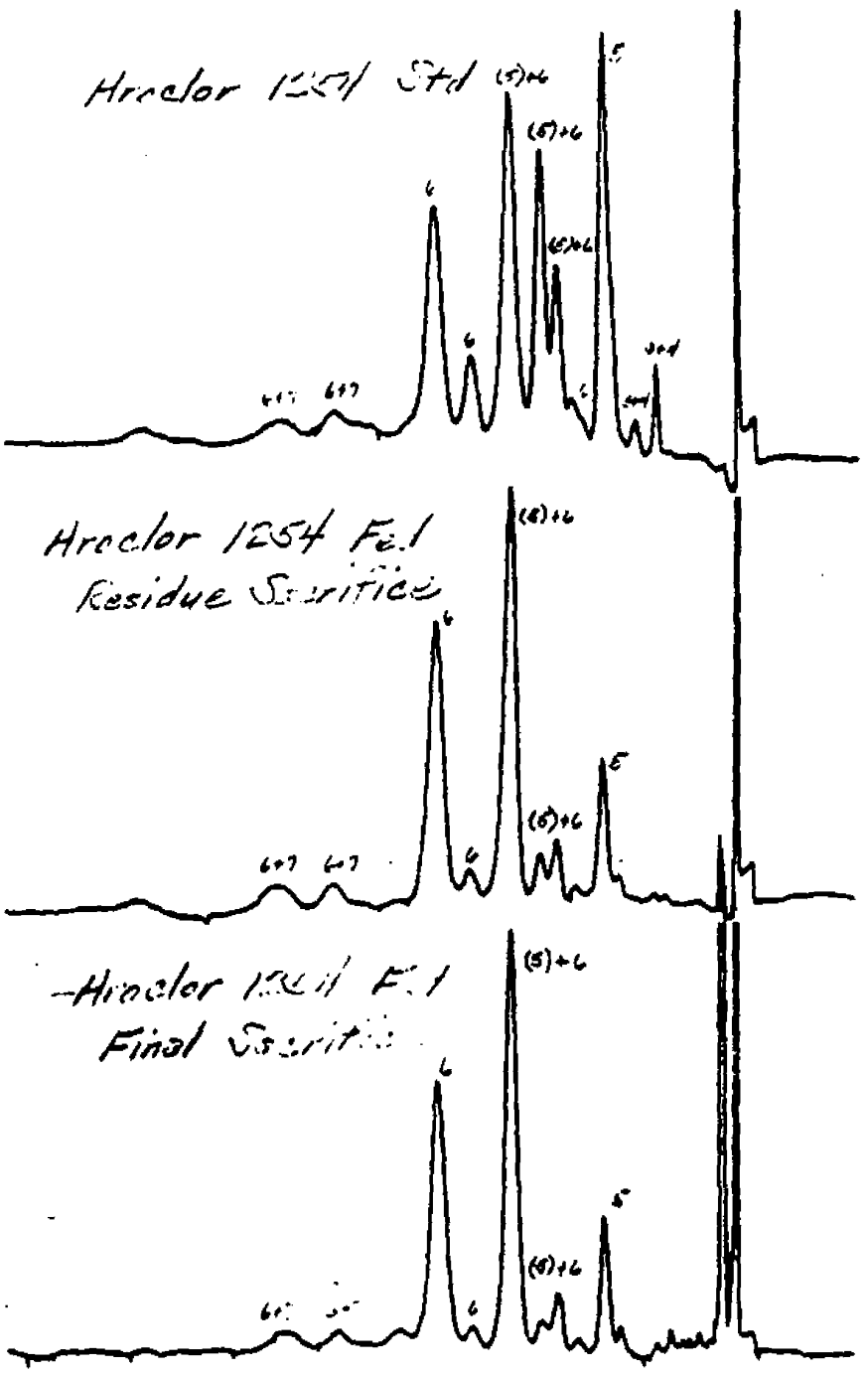
WATER_PCB-SD0000009398

Chromatogram I



WATER_PCB-SD0000009399

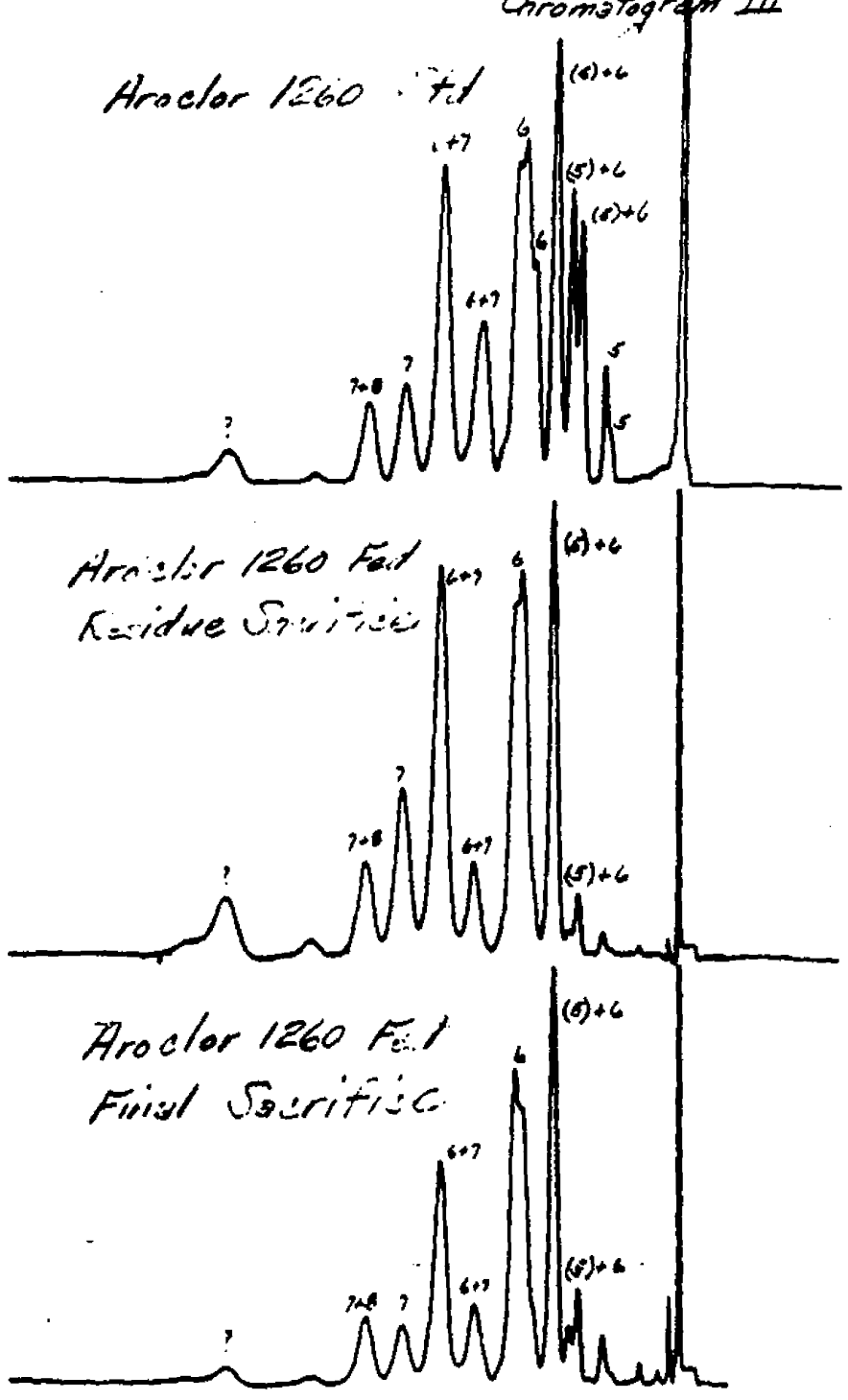
Chromatogram II



MONS 021421

WATER_PCB-SD0000009400

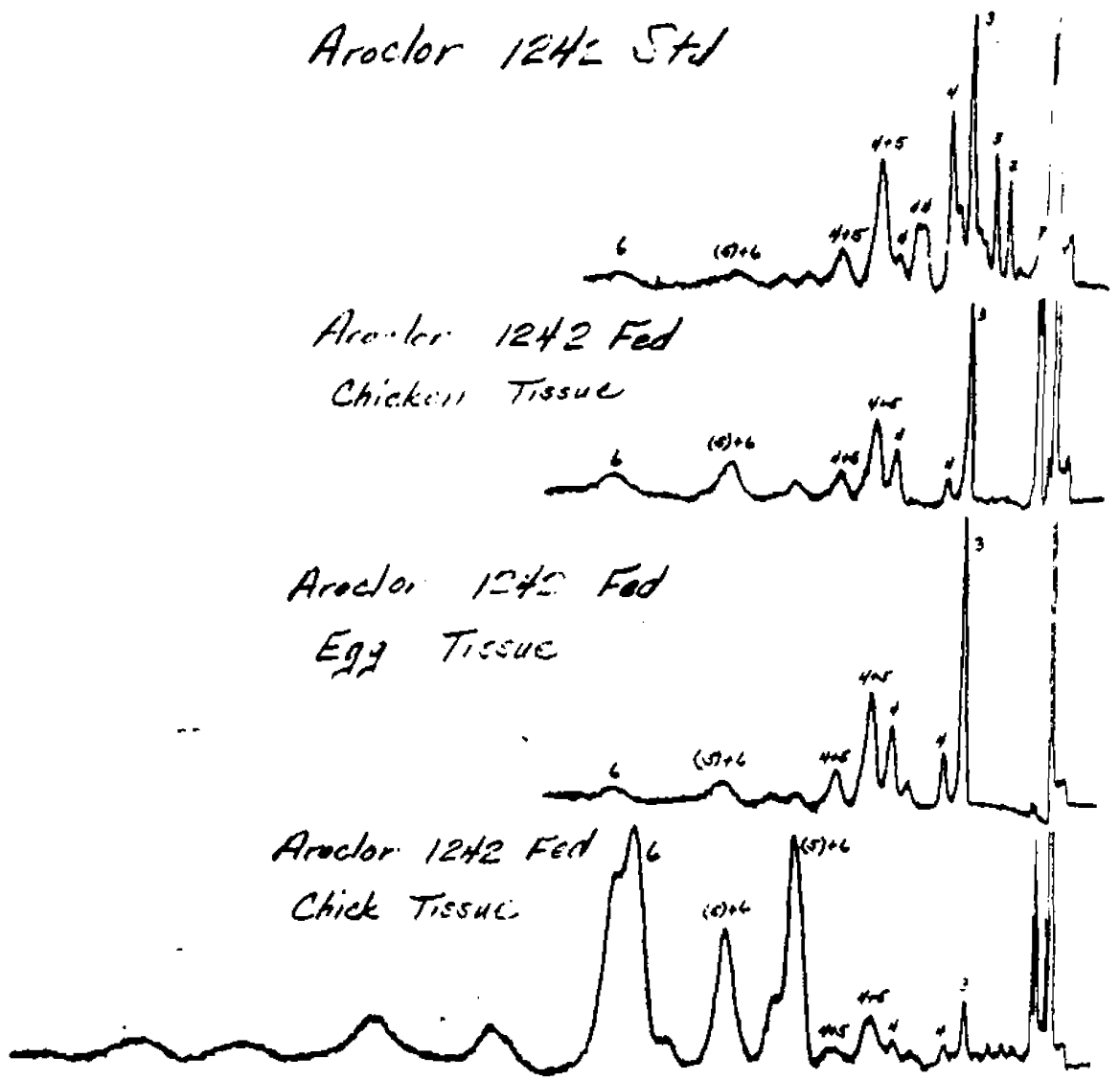
Chromatogram III



MONS 021422

WATER_PCB-SD0000009401

Chromatogram IV



MONS 021423

WATER_PCB-SD0000009402

Analytical Chemistry
Special Study 71-9
Job No. 13840

DETERMINATION OF POLYCHLORINATED BIPHENYL RESIDUES IN BEAGLE DOG TISSUES FROM A TWO YEAR ORAL CHRONIC TOXICITY STUDY

INTRODUCTION

This report covers the results of the analysis of tissues from IBT # C7299, "Two Year Chronic Toxicity Study with Aroclor 1242, Aroclor 1254, and Aroclor 1260 in Beagle Dogs", for PCB residues.

The specific objectives of this study were to establish the relationship between tissue storage levels and exposure period, exposure level, degree of chlorination and any observed toxic effects as well as determining the homolog distribution of the retained PCB residues. Enough animals were also included in this study to determine the rate at which the retained residues washed out once oral exposure to the PCB products was ceased.

SUMMARY

The PCB residues found in the dogs were an order of magnitude less than the PCB residues found in a similar study with rats.(1) Material balance calculations indicate that in all cases less than 1% of the total test material ingested was stored in any of the animal tissues.

Significant alterations of the homolog distributions of all products were observed. The amount of alteration was greatest for Aroclor 1242 and least for Aroclor 1260.

The estimated biological half lives of the residues retained from each product were: Aroclor 1242 - 47 days; Aroclor 1254 - 108 days; and Aroclor 1260 - 301 days. These half lives were found to be independent of both tissue type and exposure level.

DETAILS

The samples were analyzed as outlined in Analytical Chemistry Method 71-35. The method involves isolation of the PCB's by solvent extraction, followed by chemical and alumina column clean-up of the extract, and detection of the type and level of PCB's retained in the tissues by electron capture gas chromatography (EC/GC).

Standard solutions of the Aroclor fed were used to prepare the calibration curves for quantitation in the cases of Aroclor 1254 and Aroclor 1260. For Aroclor 1242, the Aroclor 1254 standard solutions were used to prepare the calibration curves, since the principal isomers found in the tissue extracts were those that are dominant in production Aroclor 1254.



WATER_PCB-SD0000009403

The PCB residue levels found in each of the tissue samples are shown in Tables I and II. The values in Table I were calculated using the wet weight of the tissue, those in Table II were calculated on the basis of the hexane soluble lipid weight.

After the 24 month sacrifice samples had been analyzed, the large number of samples (180 total) and hence time and money needed for analysis of the complete set of samples prompted a reevaluation. It was decided that little information would be lost by analyzing only a balanced subset of the recovery samples and using multiple regression statistics to predict the remaining points.(2) The open boxes in Tables I and II represent the samples which were not analyzed. The regression equation obtained indicated that, relative to the rat study completed earlier, there was more scatter in the dog data. This increased variability is attributable to the lower storage levels observed and to the fact that the tissue samples from the recovery sacrifices were from individual animals rather than group composite samples analyzed in the rat study. However, an acceptable regression equation was obtained by eliminating results where the difference between the predicted and actual values exceeded two standard deviations. The predicted PCB residue levels (lipid weight basis) are shown in Table III.

Figures I thru IX are semi-logarithmic plots relating average PCB residue level to exposure period for each Aroclor and for each tissue (muscle, liver, and fat) at three exposure levels (1, 10 and 100 ppm). On these plots solid lines were used for actual data while dashed lines were used for predicted data. These figures illustrate the decrease of PCB residue levels with time in those animals placed on a recovery diet. The figures also show that the recovery was much slower for those animals fed the higher chlorinated products such as Aroclor 1254 and Aroclor 1260. There is little evidence, at least under the conditions employed in this study, that exposure level or tissue differences influenced the residue washout rate.

The significantly higher PCB residue levels found in liver seem to indicate this tissue is a primary storage area and/or site of metabolism.

Chromatograms I, II and III compare the typical homolog distributions of the retained residue to that of the Aroclor fed. Isomeric alterations were observed with each Aroclor at all feed levels. Aroclor 1242 was altered to a greater extent than either Aroclor 1254 or Aroclor 1260.

The chromatographic conditions employed while suitable for quantitation of the PCB residues in the tissues are not ideal for the identification of the specific isomers which are retained. Nevertheless with these limitations, the chlorine number(s) of the principal isomer(s) are shown above each peak on the chromatogram. An inspection

WATER_PCB-SD0000009404

of the chromatograms reveals that the less chlorinated isomers are metabolized and/or excreted rapidly. Further inspection of the chromatograms from the recovery samples shows that the ratios of the peak heights continue to change which along with the decrease in PCB residue levels, indicates that the higher chlorinated isomers can also be metabolized and/or excreted, albeit more slowly. Chromatogram IV is a comparison of the extracts from the animals after 60 days on a recovery diet free from PCB's. It is evident, that the isomers observed are the same irrespective of the material fed. This again illustrates the much lower wash out rate encountered with the higher chlorinated isomers.

TOXICITY

No untoward behavorial reactions or significant abnormalities were observed during the two year study.(1)

REFERENCES

1. "Two Year Chronic Oral Toxicity Study With Aroclor 1242, Aroclor 1254, and Aroclor 1260 in Beagle Dogs", Industrial Bio-Test Laboratories Report (IBT # C7299).

2. "PCB Residues in Beagle Dogs", Statistics Special Study 71-25.

db

Monsanto Industrial Chemicals Company
Applied Sciences Section
St. Louis, Missouri

12/72 - W. M. Mees, E. S. Tucker, W. J. Litschgi, J. Cowell

WATER_PCB-SD0000009405

TABLE I

IBT #C7299 Two-Year Chronic Oral Toxicity Study of Aroclor in Beagle Dogs

ppm PCB in Dog Tissues (Wet Weight Basis)

Material	Tissue	1 ppm						10 ppm						100 ppm						Exposure - oral orifice
		24 mo.		30 d.		60 d.		24 mo.		30 d.		60 d.		24 mo.		30 d.		60 d.		
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	S.
Aroclor 1242	Muscle	0.07	0.08	0.09	0.06			0.3	0.2		0.2		0.04	0.6	0.5	0.3	0.4	0.5		
	Liver		0.08	0.3	0.01		0.04	0.2	0.1		0.1	0.05		0.6		0.4	0.3			
	Fat	2	2	1	0.5	0.5		1	1		2	1	2	4	4	9	2			
Aroclor 1254	Muscle	0.3	0.06	0.2		0.1	0.1	0.7	0.3		0.7			4	3					3
	Liver	0.1	0.2		0.2			0.4	0.7			0.5		2	2	1				
	Fat	4	3	2			2	5	4		18			75	73					34
Aroclor 1260	Muscle	0.2	0.4		1		0.2	1	0.4		6		3	26	10		34	26		
	Liver	0.2	0.1	0.1			0.3	2	0.7	2	1	0.9	1	11	4		2	9		
	Fat	11	14		14		4	101	31	40	47		62	75	221		352	173		

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WATER_PCB-SD0000009406

TABLE II

IBT #C7299 Two-Year Chronic Oral Toxicity Study of Aroclor in Beagle Dogs

ppm PCB in Dog Tissues (Lipid Weight Basis)

Material	Tissue	1 ppm						10 ppm						100 ppm						Exposure Level
		24 mo.		30 d.		60 d.		24 mo.		30 d.		60 d.		24 mo.		30 d.		60 d.		Sacrifice
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	Sex
Aroclor 1248	Muscle	2	2	1	2			6	3		2		1	19	20	10	10	6		
	Liver		4	11	2		2	8	8		9	4		29		23	18			
	Fat	2	3	1	1	06		1	2		2	2	2	6	7	13	3			
Aroclor 1254	Muscle	10	4	4		2	2	18	18		9			61	25				32	
	Liver	8	6		9			23	40			43		110	130	111				
	Fat	5	3	3			2	6	10		22			128	132				42	
Aroclor 1260	Muscle	9	7		8		3	78	20		66		37	716	100		491	301		
	Liver	17	13	11			21	175	43	112	135	55	120	762	235		81	699		
	Fat	14	18		20		5	159	39	54	72		78	1261	287		459	239		

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WATER_PCB-SD0000009407

TABLE III

IBT #C7299 Two-Year Chronic Oral Toxicity Study of Aroclor in Beagle Dogs

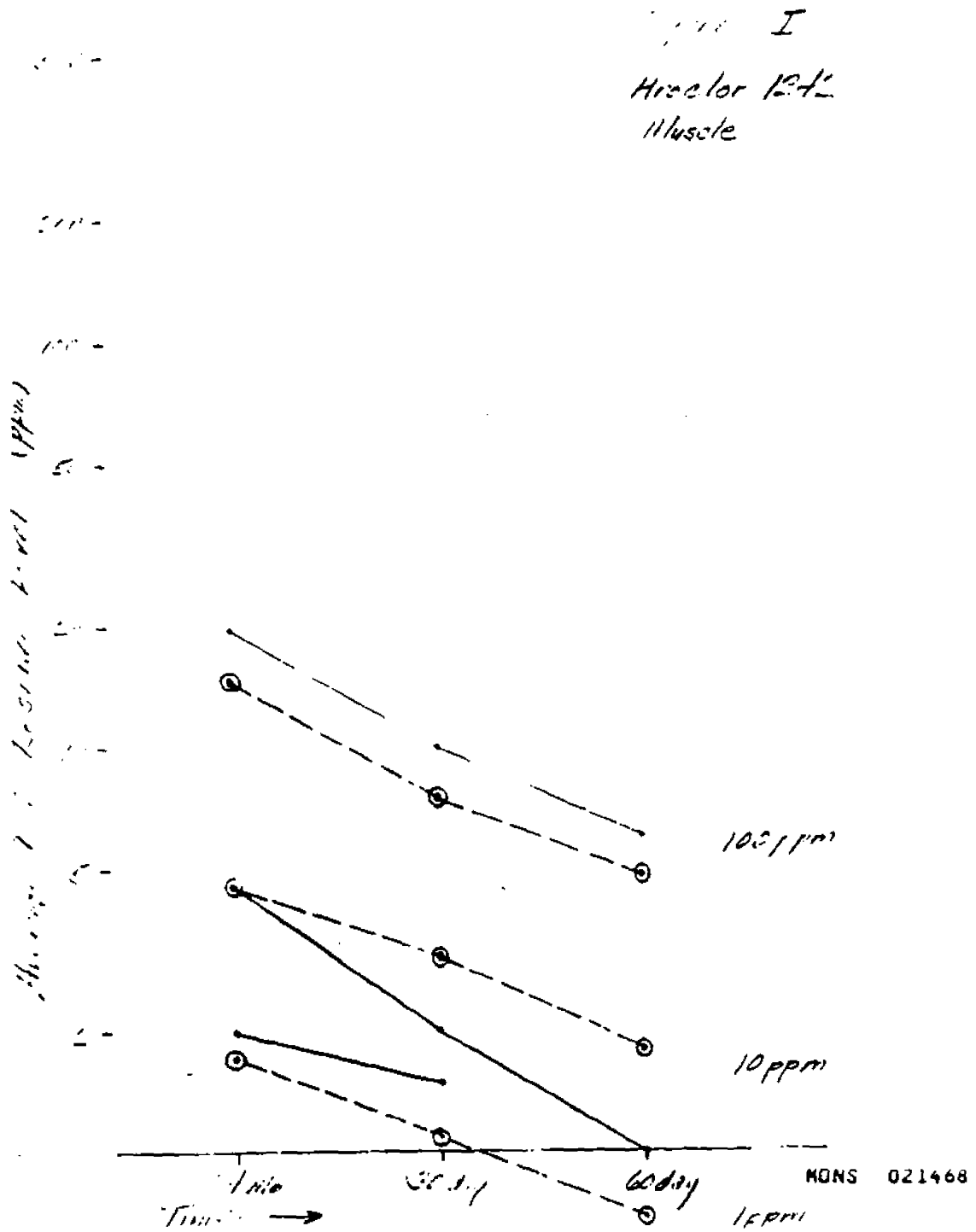
Predicted ppm PCB in Dog Tissues (Lipid Weight Basis)

Material	Tissue	1 ppm						10 ppm						100 ppm					
		24 mo		30 d.		60 d.		24 mo.		30 d.		60 d.		24 mo.		30 d.		60 d.	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Aroclor 1242	Muscle	2	2	1	1	0.7	0.7	5	4	4	3	2	2	20	10	9	6	6	4
	Liver	3	3	2	2	1	1	10	8	7	5	5	4	28	18	18	12	11	8
	Fat	2	2	1	1	0.7	0.7	5	4	4	3	2	2	20	10	9	6	6	4
Aroclor 1254	Muscle	5	5	4	4	3	3	24	20	20	16	16	13	121	80	100	65	80	54
	Liver	10	10	8	8	6	6	47	38	39	31	33	26	238	156	195	128	157	103
	Fat	5	5	4	4	3	3	24	20	20	16	16	13	121	80	100	65	80	54
Aroclor 1260	Muscle	8	8	8	8	7	7	54	44	50	40	47	38	355	233	333	217	308	202
	Liver	16	16	14	14	14	14	106	84	48	80	91	74	698	457	654	426	605	397
	Fat	8	8	8	8	7	7	54	44	50	40	47	38	355	233	333	217	308	202

Regression Equation – log ppm PCB = −1.3450 − 0.0190 (dry recovery) − 0.3388 (log ppm fed) + 0.2921 (if liver) + 0.0376 (% Cl_2) + 0.5702 (log ppm fed × % Cl_2) − 0.0917 (log ppm fed − [illegible]

MONS 021467

WATER_PCB-SD0000009408

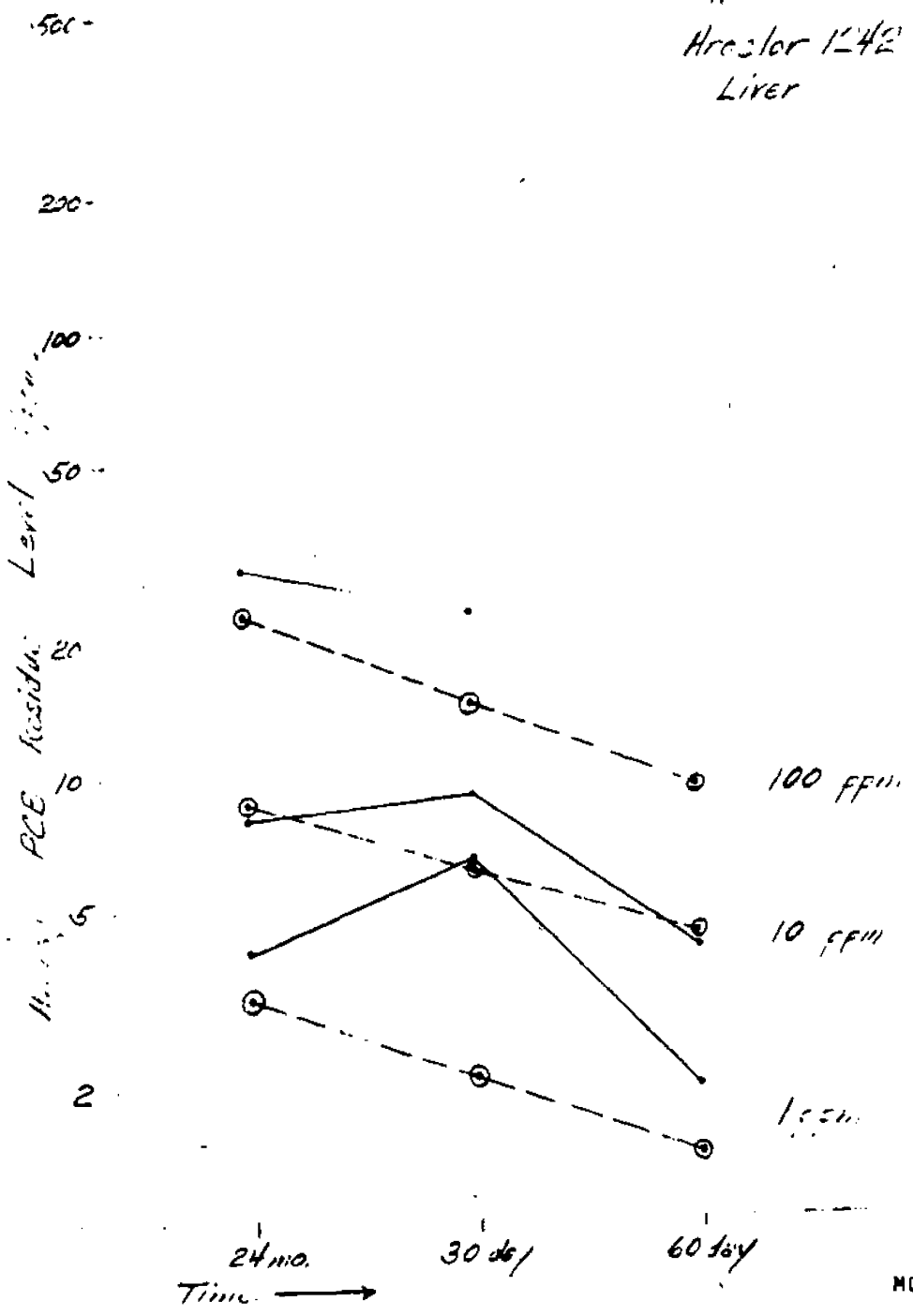


WATER_PCB-SD0000009409

Figure II

Aroclor 1242

Liver



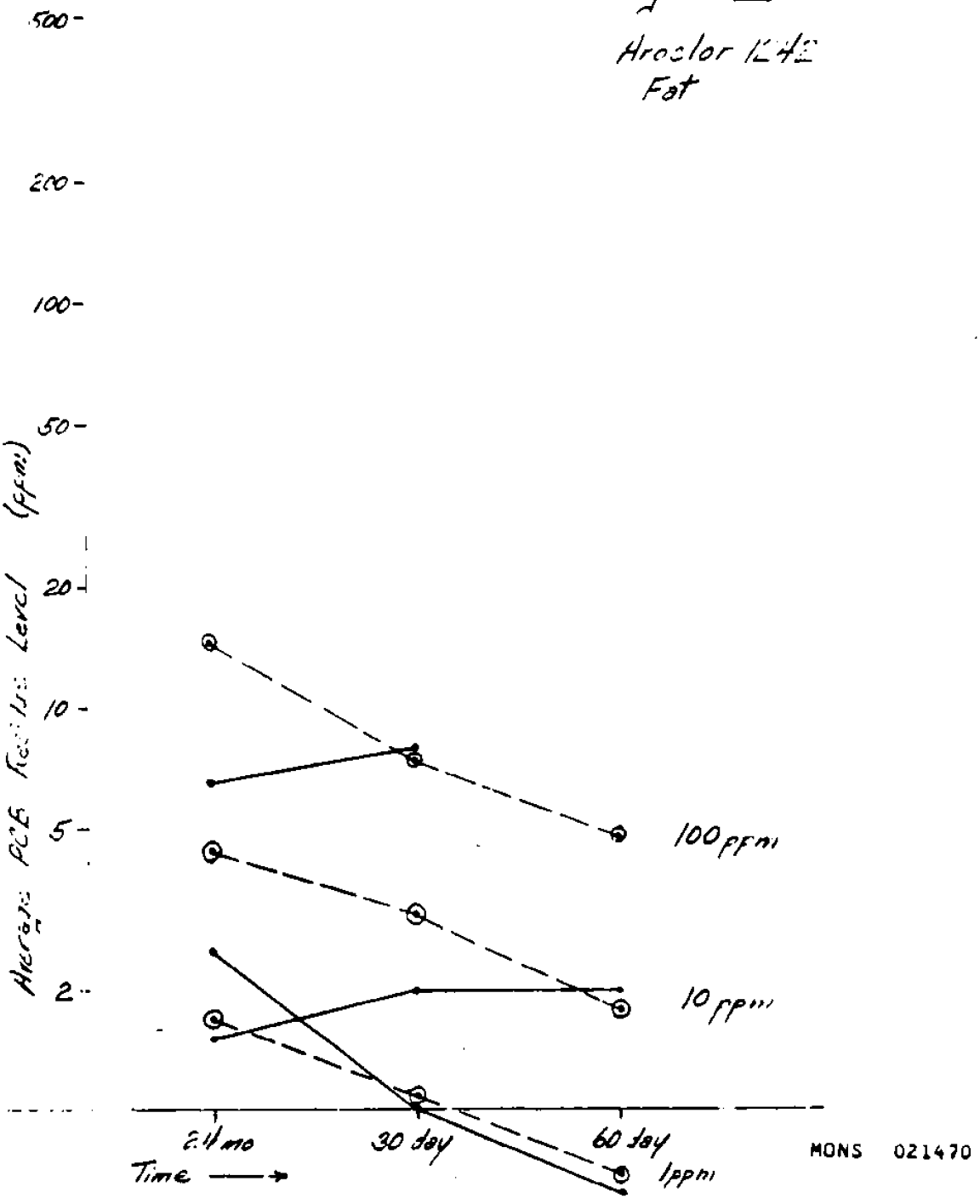
MONS 021469

WATER_PCB-SD0000009410

Figure III

Aroclor 1242

Fat



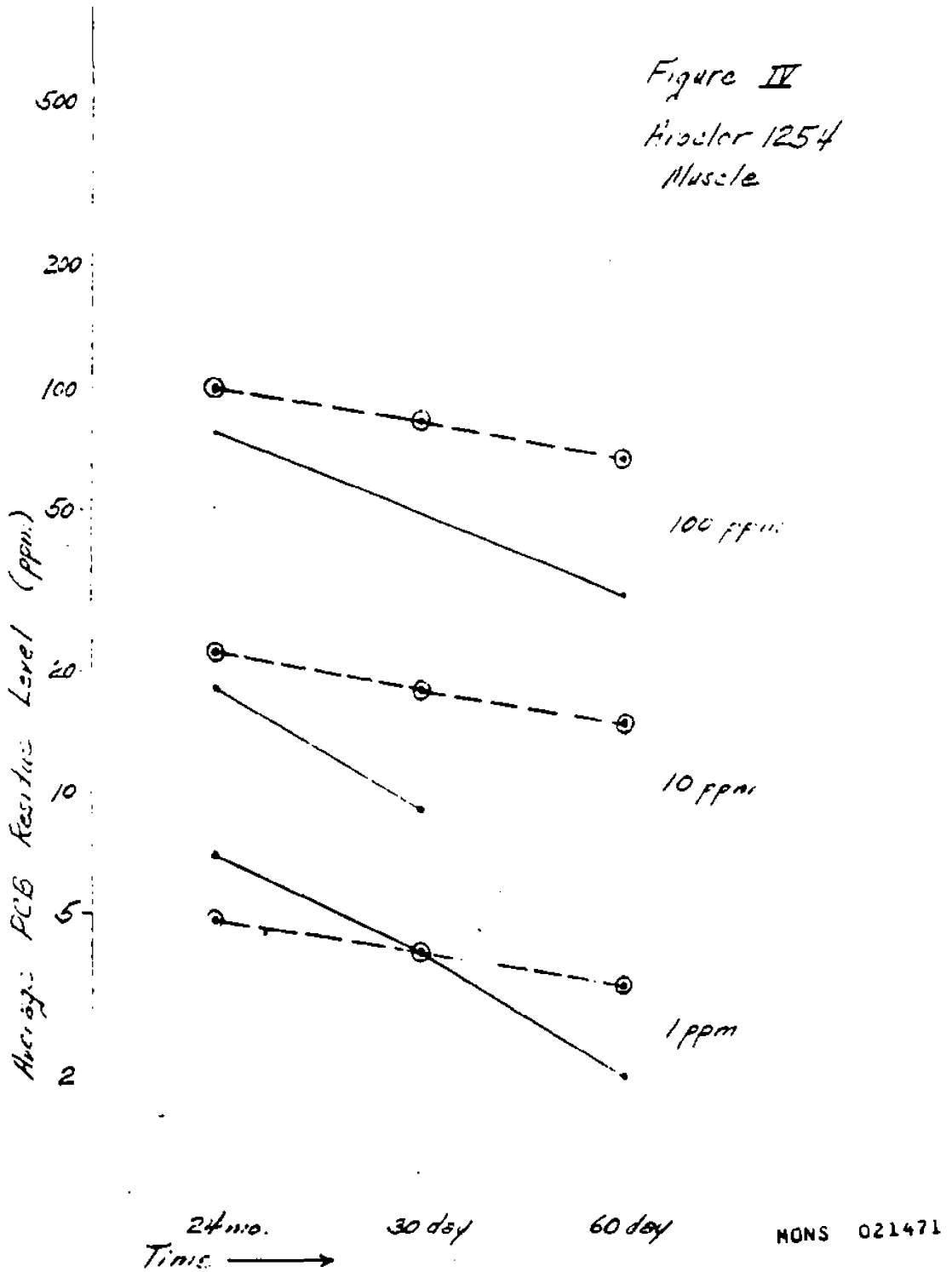
MONS 021470

WATER_PCB-SD0000009411

Figure IV

Aroclor 1254

Muscle



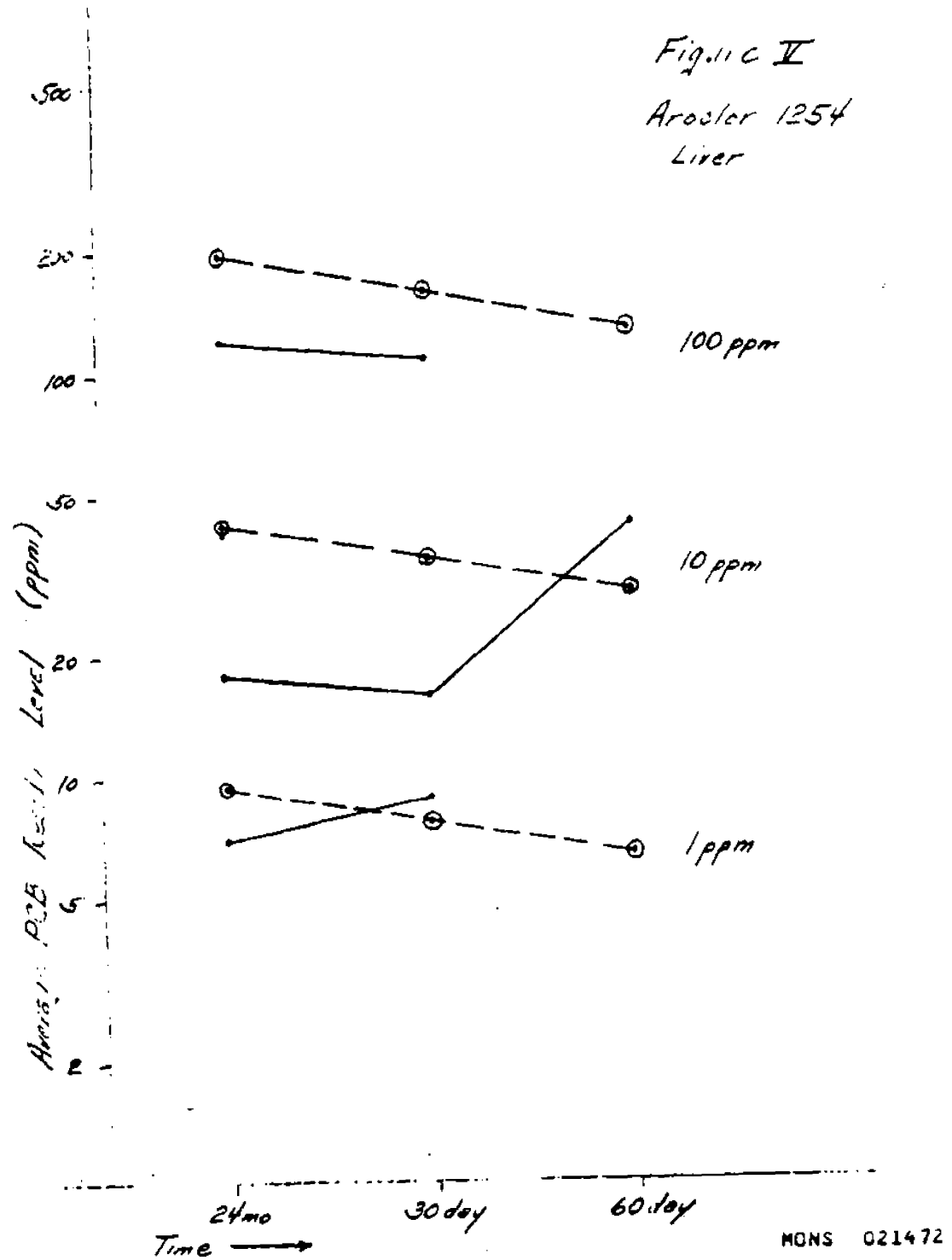
MONS 021471

WATER_PCB-SD0000009412

Fig. II c V

Aroclor 1254

Liver

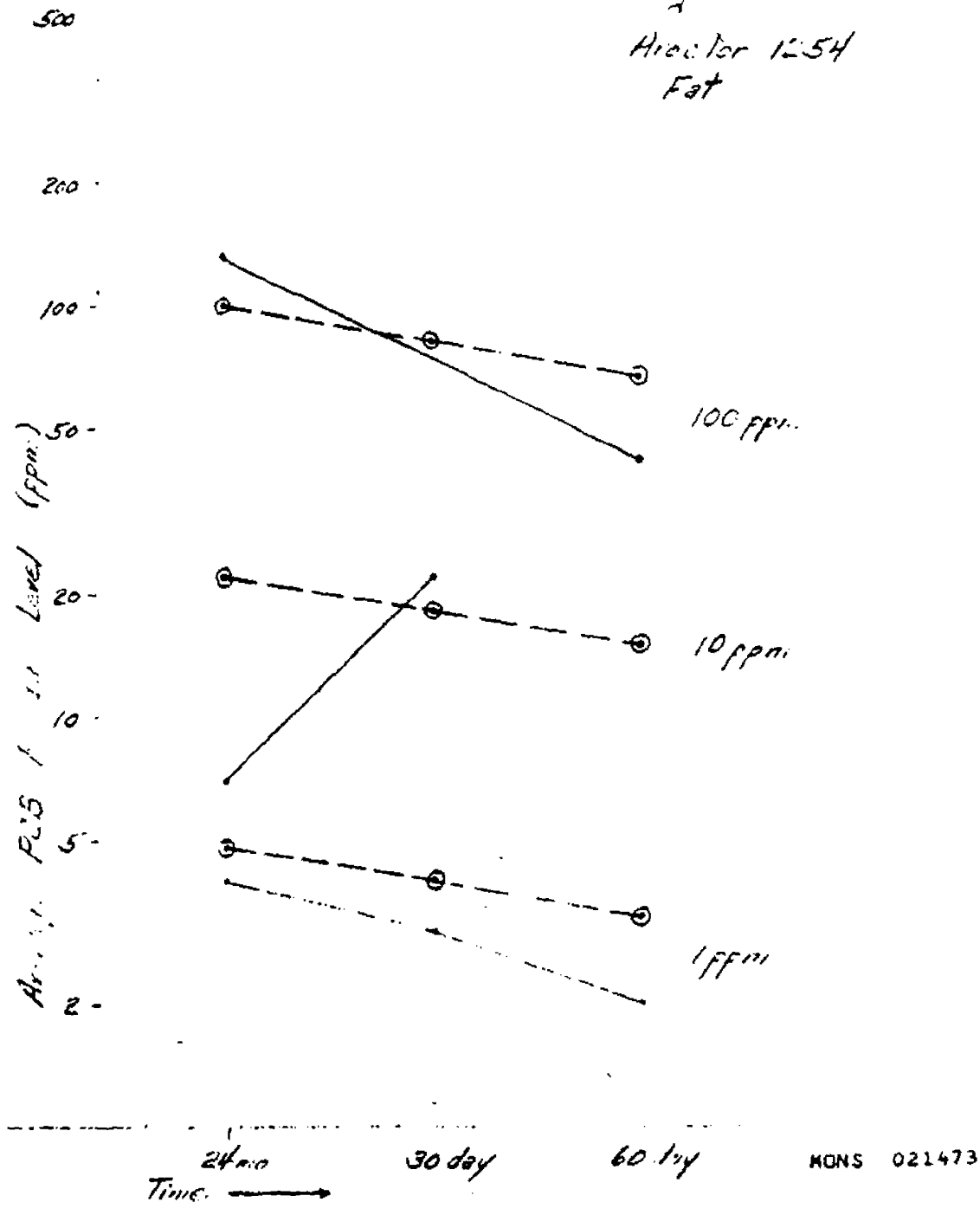


MONS 021472

WATER_PCB-SD0000009413

Figure VI

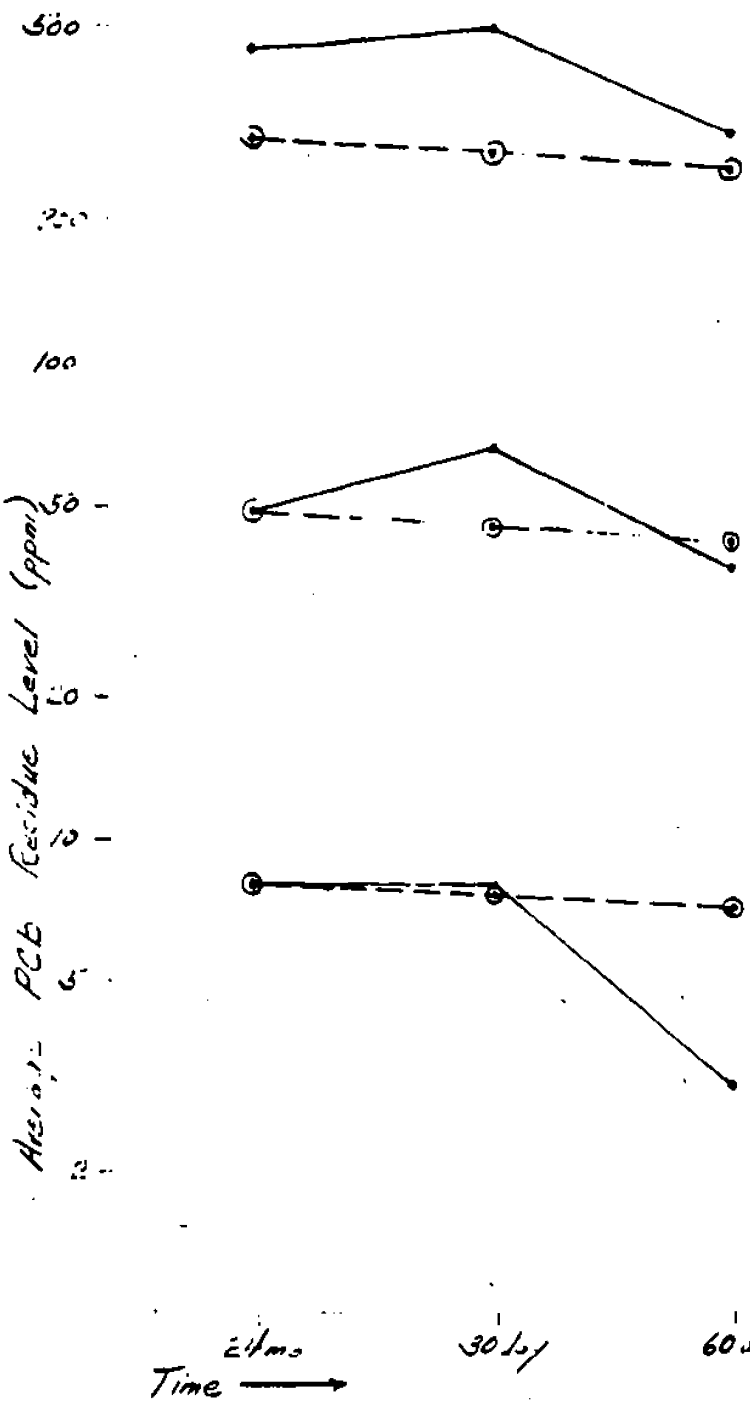
Aroclor 1254
Fat



MONS 021473

WATER_PCB-SD0000009414

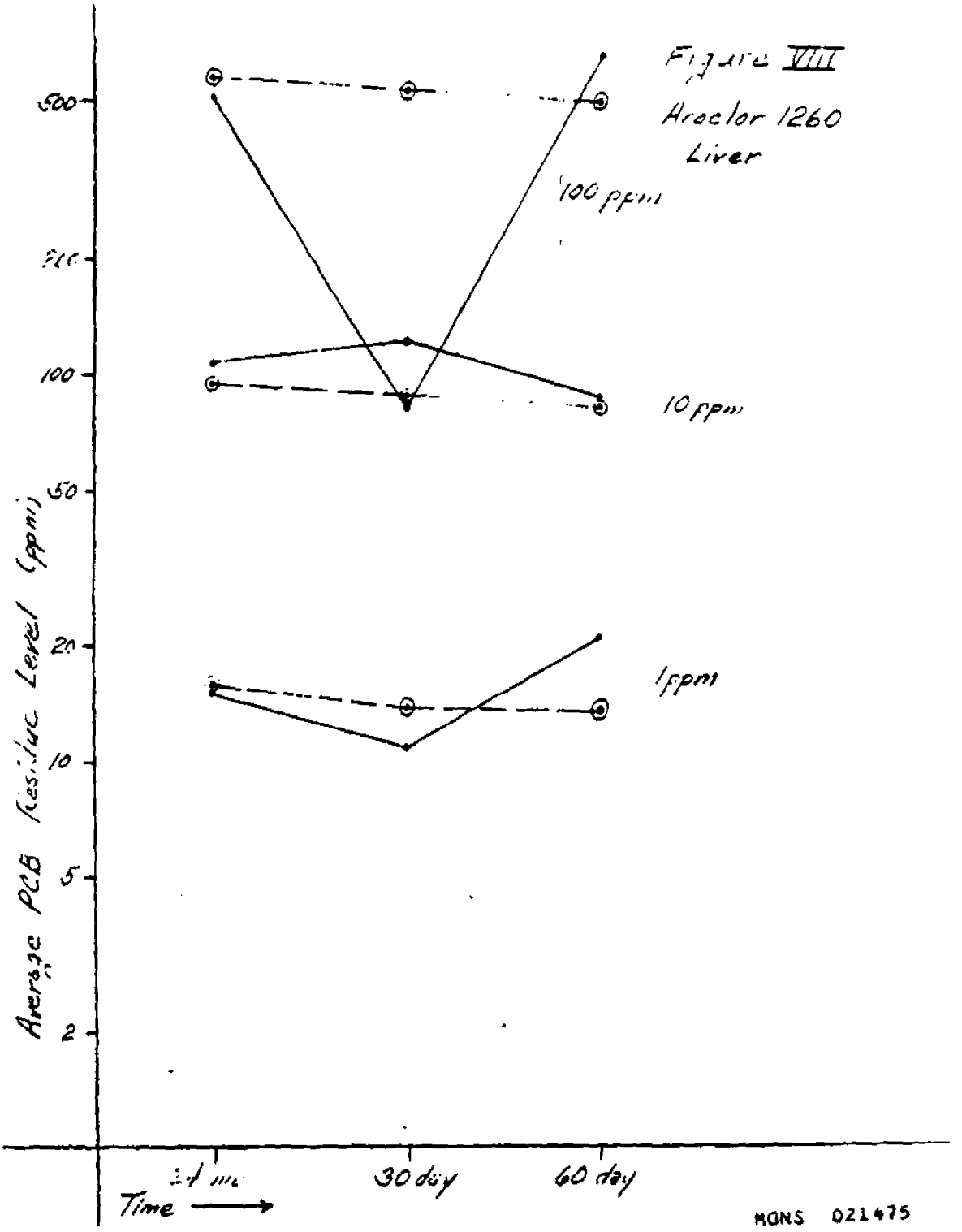
Figure VII



Aroclor 1260
Muscle

MONS 021474

WATER_PCB-SD0000009415



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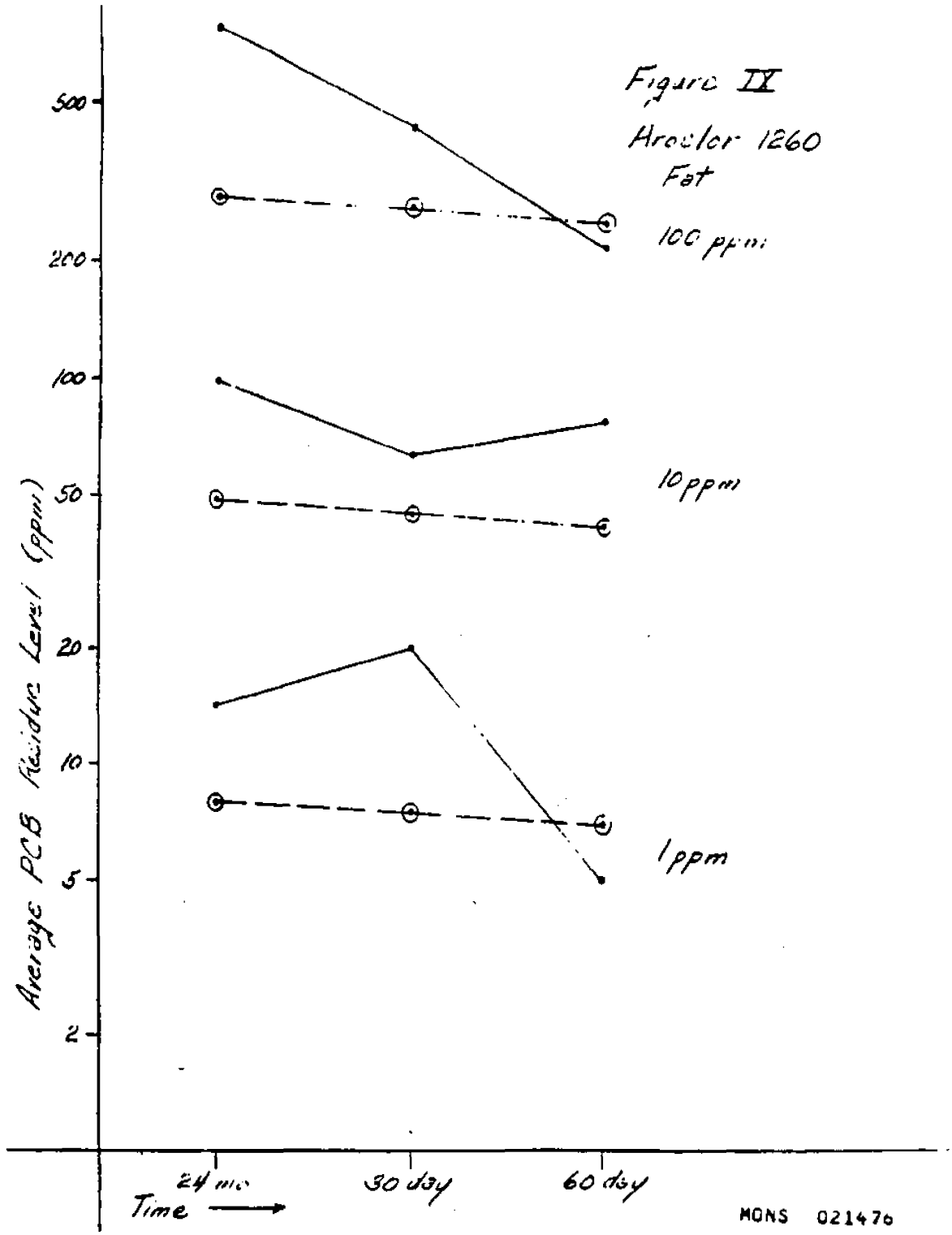

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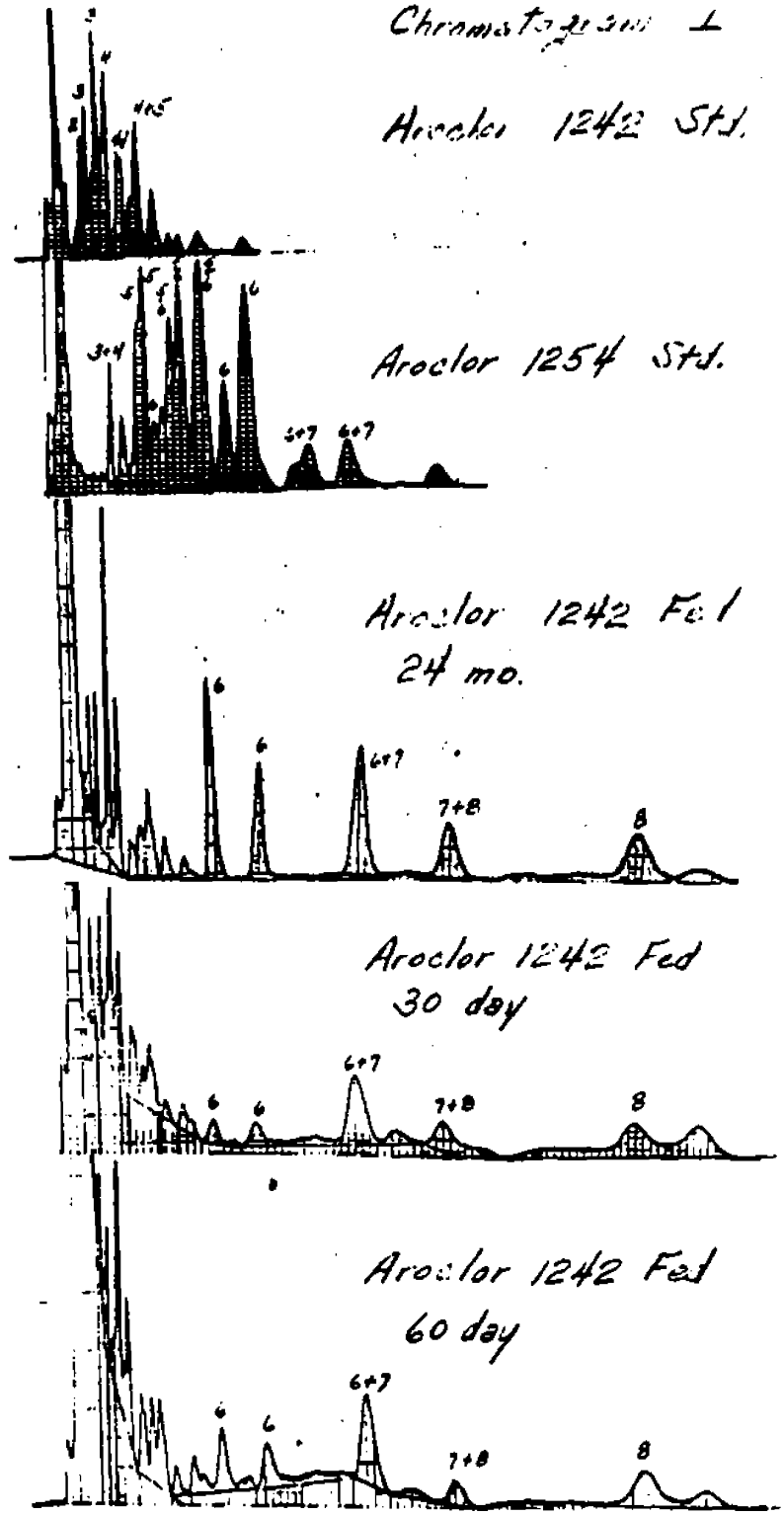
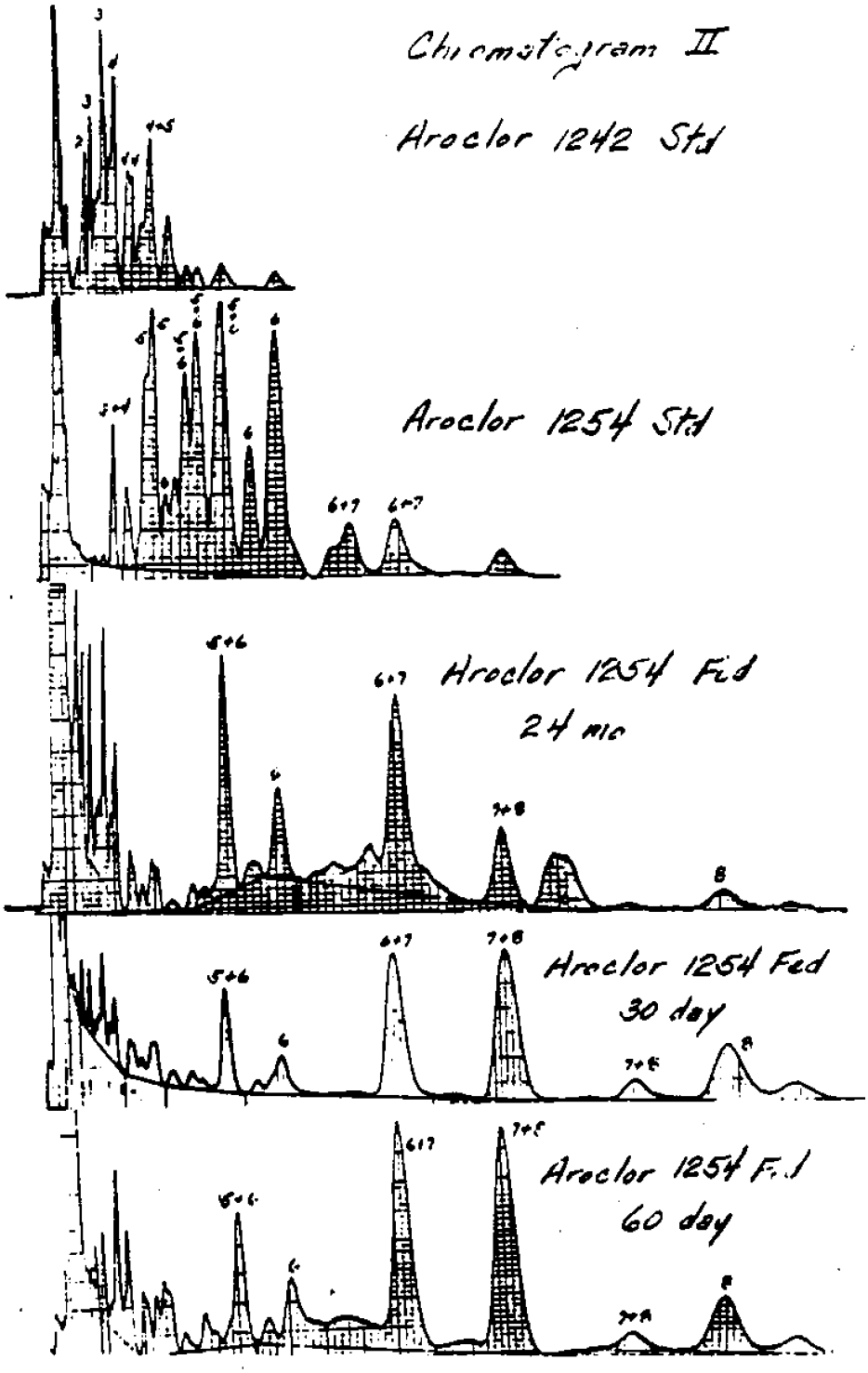


MONS 021477

WATER_PCB-SD0000009418

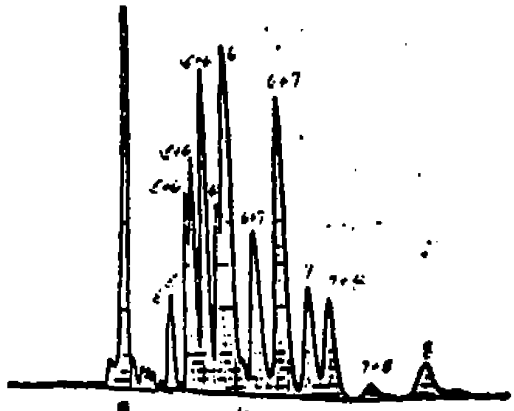
Chromatogram II



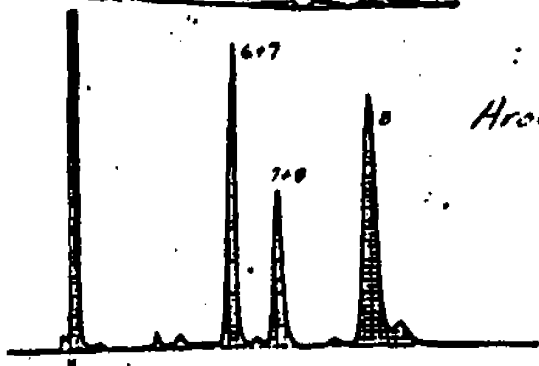
MONS 021478

WATER_PCB-SD0000009419

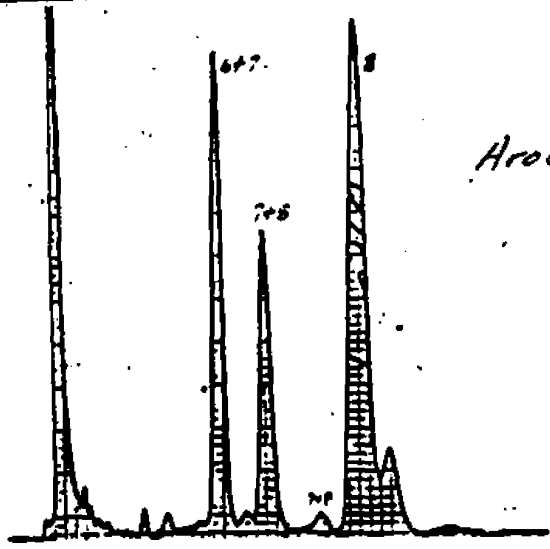
Chromatogram III



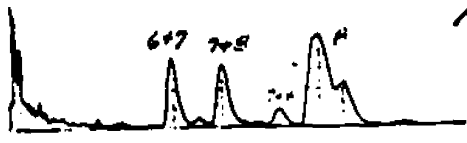
Aroclor 1260 Std



Aroclor 1260 Fld
24 mo



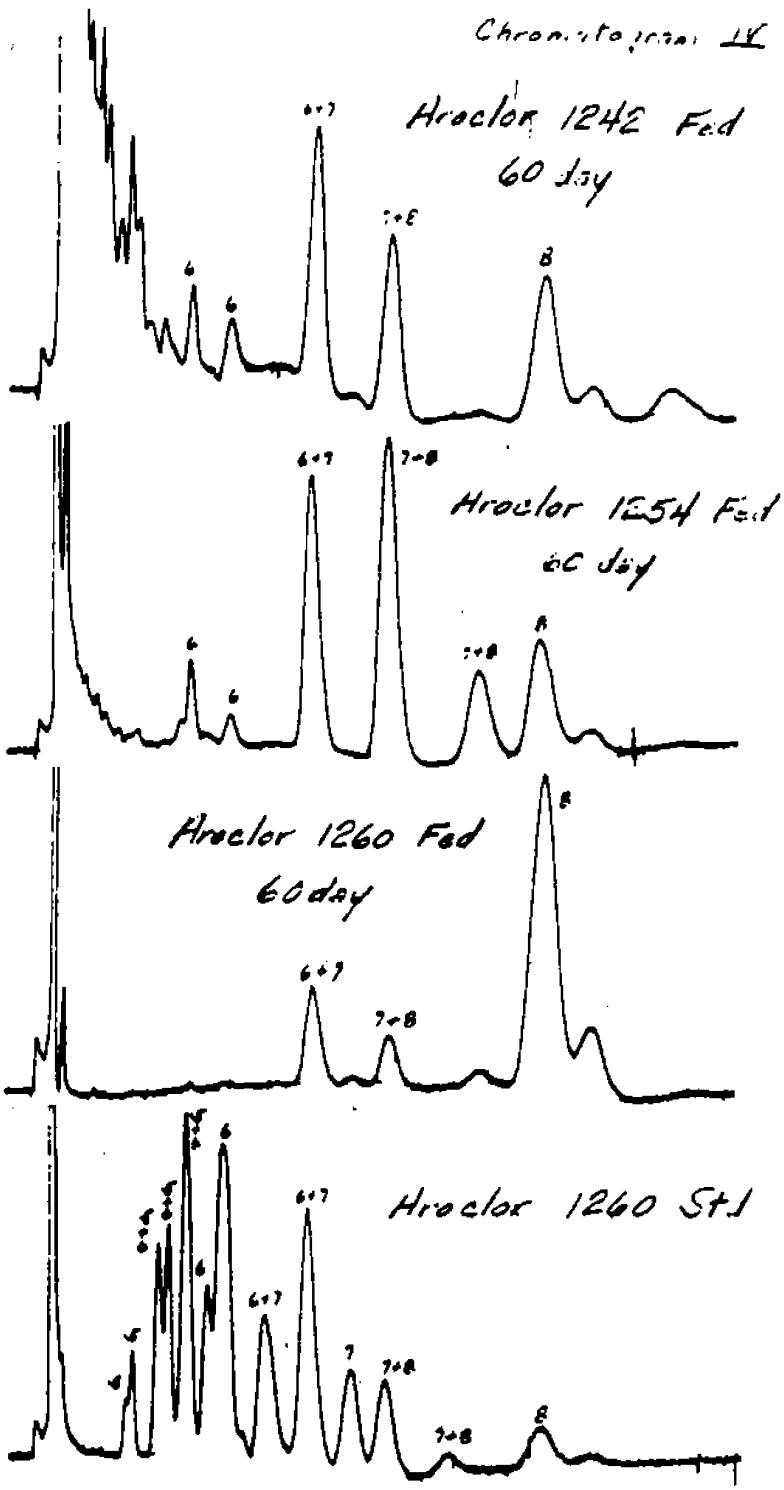
Aroclor 1260 Fcl
30 day



Aroclor 1260 Fld
60 day

MONS 021479

WATER_PCB-SD0000009420



MONS 021480

WATER_PCB-SD0000009421

From the desk of
HOWARD S. BERGEN JR.

6/24/68

→ "~~H.L. Mitchell~~ LR
2/ H S ~~Bergen~~ (Rodor)
To give you a "feel" ~~as~~
to why Monsanto has
to protect themselves
on this toxicity
question. Dr R E Kelly
says burning of NCR poses a
problem here - along with all others.
Howard.

MONS 072195

PLAINTIFF'S
EXHIBIT
11
TM 5/31/94

PENGAD-Bayonne, N. J.

CONFIDENTIAL

TO: DR. J.W. BARRETT.

19th August 1955.

DVNH/MEB

AROCLORS -
TOXICOLOGICAL EXAMINATION

c.c. Dr. J.A. Gardner.
Dr. W.McG. Morgan.
Mr. W.E. Hamer
Mr. O.G. Wickham
Dr. H.R. Newman.
Dr. D.S.P. Roebuck.
Mr. J.S. Hunter
Mr. E.L. Pixton.
Mr. N.G.H. Thomas.
Mr. J.A. Brindle.

Further to my memo of 9th August, I propose to summarise the present position on Aroclor vapour toxicity as an essential background to our policy and to our consideration of the Battelle proposal for a programme of toxicological work.

I have indicated in my summary of the two reports by The Kettering Laboratory that prolonged exposure (7 hours a day for 150 days) to Aroclor 1254 vapour at 1.5 mgrm./m^3 caused slight but positive signs of injury in test animals and that similar experiments with Aroclor 1242 gave negative results at 1.9 mgrm./m^3. As I see it this positive result with 1254 would be construed by Public Health Authorities as an indictment of Aroclors as a class, and the negative result with 1242 would not rank as a clearance for that particular chlorinated diphenyl. To upset the one positive result with 1254 would require much more than a simple re-investigation, since it would be necessary to demonstrate by an even more exhaustive and searching investigation that the Kettering observations were mistaken. Even then, the work would probably not be decisive until confirmed by an independent authority.

During the near future, at any rate, our consideration of the suitability of Aroclors for specific applications must be governed by this finding that prolonged exposure to Aroclor vapour at 1.5 mgrm./m^3 can produce damage to the liver and kidneys of test animals. In translating this finding to the human being it is the recognised practice to employ a safety factor of 10; in other words when the maximum, safe concentrations for test animals has been located, the corresponding value for the human being is taken as one tenth of it. With 1254 we now know that 1.5 mgrm./m^3 is above the maximum permissible concentration for

MONS 095215



WATER_PCB-SD0000009423

test animals so that the maximum for human beings must be placed below 0.15 mgrm./m^3, and must be regarded as applying to all Aroclors, on account of their similar chemical constitution.

Our own analytical work with a room painted with Aroclor 1248 plasticised Lustrex Latex paint affords evidence that Aroclor concentrations of the order of 0.5 mgrm./m^3 can prevail for a month; we have not so far attempted to develop the more refined analytical technique necessary to determine with reasonable precision concentrations in the range of 0.1-0.5 mgrm./m^3. This development would be a difficult assignment and when available it would only permit us to determine the time to reach 0.15 mgrm./m^3 and hence the time during which a person could be exposed to concentrations greater than what must now be regarded as the maximum permissible.

Previously on the basis of published work the value has been taken variously at 0.5 or 1 mgrm./m^3 and Monsanto has normally used the higher figure. On that basis it could be argued that exposure to a concentration at or above the maximum permissible would be of short duration and that any hazard was of marginal significance.

However, we now have to reckon with a fairly long exposure to concentrations above the new maximum, and hence the hazard must be rated much greater. There is yet a further consideration that is always taken into account by Health Authorities, and this relates to the idiosyncrasy factor. So far we have considered the <u>average</u> human being, but there will always be a minor proportion more susceptible than the rest. This may be due to the natural variability of resistance or predisposition existing among healthy individuals, or to functional disability, and in assessing a human hazard consideration is always given to those individuals who are more likely to suffer injury; in this case presumably those possessing impaired livers and kidneys would be most likely to suffer first.

If the argument I have presented above is accepted then we must now line up with M.C.C. in withdrawing our recommendation that Aroclors be used as plasticisers in Lustrex Latex paints. As regards the use of Aroclors in P.V.A. paints, we have so far made no measurements of Aroclor concentrations in painted rooms, but I see no reason for believing that materially reduced concentrations would be found.

We have still to examine the position of Aroclors in ordinary paints. Here I have argued that the rate of volatilisation will be greatly reduced and probably governed by the rate of migration within the dry paint. It now seems possible that a hazardous concentration could

WATER_PCB-SD0000009424

be attained in a room in which a large area is painted with Aroclor-containing paint. Certainly we must say that these paints must not be used on hot surfaces such as radiators and hot-water pipes.

D.V.H. HARDY.

MONS 095217

WATER_PCB-SD0000009425

1. TOXICITY COSTS

Dr. Kelly first outlined the various schemes of toxicity tests that M.C.C. arrange to have conducted on their products.

Minimum LD_{50} tests cost $50-75.
If the product is liquid, dermal tests and ocular damage tests are also carried out bringing the total cost to about $200. Inhalation, saturated air at room temperature or volatalisation from a heated plate cost a further $75. Sub acute toxicity, one-tenth LD_{50} test for 10 days would bring the whole total to $400.

The 90 day test, orally to two species of rats and one of rabbits, together with 20-30 day inhalation tests cost $2,000. If the products are to be used as food wraps for meat, etc., then extraction studies with lard and water with 2 years feeding to rats and 1 year to dogs cost a further $30,000. For foods such as bread, etc., this full test is not required although it can be called for by the appropriate State or Federal Department.

The Medical Department of M.C.C. is allocated $20,000 for arranging the $400 tests, $10,000 for further tests if required and $5000 for any odd work. If the tests cost more than $400 it is billed back to the appropriate Division.

It was estimated that it would cost M.C.C. some $200,000 a year to carry out their own toxicity investigations and consequently the work is farmed out to consulting firms and costs up to $40,000. In the light of these figures there is no justification for setting up toxicity facilities by M.C.C.

Patch tests are not of very great value.

2. AROCLORS ELECTRICAL

The indications are that there are no serious toxic hazards in this application. The electrical industry has never requested or permitted Arcolor vapour levels to be determined in their plants. Capacitor impregnation is always carried out in fan exhausted closed ovens.

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3. AROCLORS - HEAT EXCHANGE

There has been some trouble in the use of Aroclors as heat exchange fluids but this is always associated with poorly designed and leaking equipment. In one case three people suffered liver damage in about a week's exposure, but the vapour concentration must have been excessively high as the equipment was full of leaks and was in a badly ventilated shed. Dr. Benignus keeps a careful check on sales of Aroclor and if the replacement rate is high he has the situation investigated.

4. AROCLORS AND PHOSPHATES - HYDRAULIC

M.C.C. had little to add to present published knowledge. They produce low ortho T.T.P. from cresol containing 4% ortho cresol, for plasticisers and hydraulic applications, and high ortho content from 20% ortho containing cresol for use in petrol. Toxicity does not appear to be important, they have had no trouble in the plant even with the high ortho material. Leaks in equipment should be prevented and exhaust fans fitted if the equipment demands them. They have had no complaints regarding Pydraul F.9. Aroclor 1242 is slightly more volatile than Aroclor 1248 and consequently precautions will have to be somewhat tighter.

5. AROCLORS - LATEX PAINTS

M.C.C. had first considered that styrene based paints could not compete on price or performance with the styrene - butadiene paints. Also, having found that the vapour concentrations in a painted room were higher than the permitted level, they barred the use of Aroclors 1242 and 1248 in Lustrex latex paints. The use of higher Aroclors with other plasticisers had not been considered. On the basis of the M.C.L. results no danger should exist in rooms painted with Aroclor 1248 plasticised latex paints but no case could be presented in court for such paints, should it happen that someone using the painted rooms contracted liver damage from some other cause or injury, connected it with Aroclor and brought action against the Company. It is therefore a question of company policy whether to recommend Aroclor as Lustrex latex plasticiser in view of the risk of the above taking place, although this risk may be negligible.

M.C.C. are running inhalation tests at 3 ags. per cubic metre per 8 hour day on animals. At 7 ags. per cubic metre

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concentration, animals had suffered liver damage. A limit of 1 mg. per cubic metre is quite safe for plants working on 8 hour shifts.

The wire covering industry has now changed completely from chlorinated naphthalenes to Aroclors on account of reduced toxicity.

6. SKYDROLS 7000 and 500

M.C.C. had been somewhat over optimistic about Skydrol 7000 in stating in the Bulletin that it is non-toxic as its level is of the order of Skydrol 500. However, they had not received any complaints regarding skin troubles etc. in the case of either fluid. The inhalation of the vapour or spray in a plane should cause no trouble even if extended to the time required to bring the plane to its landing point. In the case of prolonged inhalation it is no worse than mineral oil. There should be no necessity for safety precautions in handling the fluids if ordinary personal hygiene measures are adopted, gloves and barrier creams are of doubtful value.

7. SANTICISER 141 AND B.16

Santicizer 141 is safe as a food wrapper plasticiser based on the two year test. It is not absorbed nor metabolised, but it is more extractable than B.16. It would be toxic if administered intravenously. The latter is a safer material to use in food and meat wrappers, it has been fed to rats for 2 years at 20,000 p.p.m. of diet without ill effect. Dr. Kelly is however rather critical of this 2 year test. Santicizer E.15 is in the same category as B.16. D.O.P. has not been approved as it is more easily extracted than 141.

8. PHENYL PHENOLS

The only data available is that published by Dow.

9. DIPHENYL

Diphenyl is not permitted in the States by the Food and Drug Committee but nevertheless it is still sold there for citrus fruit preservation and no complaint has yet been lodged. A

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comprehensive toxicity evaluation costing $40,000 was initiated by the Ford Reneer Craft Board Institute but the standards were set too high and diphenyl failed the tests. A further $36,000 will be spent on another evaluation in which the metabolism of the chemical in dogs will be studied. M.C.C. are subscribing $5,000.

10. METHYL SALICYLATE

The material is not a highly toxic substance and no difficulties have arisen from its use as a food flavouring agent. However products containing over 5% should be labelled "Use other than as directed may be dangerous and the product should be kept out of reach of children to prevent accidental poisoning".

11. SACCHARIN

An extensive investigation was carried out by the Food & Drugs Committee some two years ago on a number of sweetening agents, Saccharin and Sucaryl were cleared without reservation.

12. ASPIRIN

Aspirin can cause poisoning in children under three years of age due to their inability to metabolise the compound. Under certain conditions they can accumulate the aspirin in the system and elevation of temperature, instead of lowering, occurs, often with unfortunate results. Labels should be marked "Not for children under 3 years of age".

14. SODIUM BENZOATE AND BENZOIC ACID

Dr. Kelly knew of no information on the toxicity of these materials other than the mammoth work put out by the U.S. Department of Agriculture in 1909 which gave the comprehensive results of three independent investigations on the benzoates and which gave a complete clearance to these substances. He suggested that adverse comments suggesting that the benzoates were not as harmless as first thought had been spread around by competitors with potential new food preservatives.

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With regard to the forthcoming enquiry by our own Ministry on food preservatives in which the benzoates will be reviewed, he suggested that we write to the M.C.C. legal advisor, Mr. Charles Caspari, Jnr.

15. HYDROXY BENZOIC ACIDS

Dr. Kelly has no information.

16. SALICYLAMIDE

The severe reaction reported by Malmö General Hospital is quite consistent with specific drug allergy. There is no evidence to doubt the low toxicity figures quoted for the material but the "under 3 rule for children" should also be applied.

17. PENTACHLORPHENOL FORMULATIONS AND SANTOBRITE

Weed-killing formulations containing penta have caused the death of three Porto Ricans, one Hawaiian and one Australian. In all cases the men were inadequately clothed, their legs became heavily coated with the spray and excessive skin absorption must have resulted. The symptoms were severe liver damage. St. Louis would be prepared to carry out tests on our 15% emulsion concentrate and Development will forward a sample to Dr. Kelly. Our literature should detail the necessary precautions. St. Louis are writing a new bulletin on toxicity of penta products.

18. SOPANOX AND THIURAD

Thiurad is a skin irritant and sensitiser, its oral toxicity is higher than Actamer and is not suitable for use in soap. Also its incorporation into self-sterilising PVC sheet has shown it to have skin irritant properties. M.C.C. have a better material than Actamer on the stocks.

Little information is available on Sopanox, it has been used in one hand lotion, but is not recommended for use in dentifrice as its long term action on enamel is unknown.

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19. ISOCYANATES

Dr. Kelly will be visiting Bayer and will pass on any information he acquires. According to I.C.I., 1.5 naphthylene diisocyanate is a strong asthma producer.

20. SANTOCEL AND SYTON

Early toxicity evaluations of Santocels with rats had given misleading results. It is now reasonably certain that Santocel does not cause silicosis in animals although it does cause some degree of fibrosis and irritation in the lungs. Du Pont now label their product "Caution - haruful dust" and M.C.C. use a similar phrase to the effect that the material should be handled with care and users should not expose themselves unnecessarily to the dust.

Although Syton does not produce silicosis, it has been shown that it tends to aggrevate tuberculosis. Animals who have been given a sublethal dose of tuberculosis from which they would normally recover, die when subjected to doses of Syton spray.

Extensive sampling tests of the air of numerous U.S. factories using Syton, failed to detect the presence of Syton. In India the conditions in the factories are very favourable to the formation of Syton dust and the mills should be cautioned to take greater care in their processing and to supply their workers with masks.

21. AROCLORS 4465 AND 5460 IN AGRICULTURAL FORMULATIONS.

These Aroclors act as insecticide bonding agents on the leaf and increase the activity of the preparations. They are mostly chlorinated terphenyls and have greater toxicity than the lower members.

It is difficult to decide whether there is any hazard in using these compounds in greenhouse sprays as the conditions as to quantity sprayed and the size of the droplets is so indeterminate. Aerosol sprays giving fine droplets will have a long suspension time in the air.

W.B. BROWN.

WBB/MEB
26.11.54.

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