

SUPREME COURT OF THE STATE OF NEW YORK
COUNTY OF BROOME

JAMES L. and BARBARA A. FURCH,
et al.,

Plaintiffs,

Vs.

Index No. 1370/1982
RJI No. 86-1107-M

GENERAL ELECTRIC COMPANY, et al.

Defendants.

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VOLUME I
DEPOSITION OF WILLIAM B. PAPAGEORGE, P.E.
On behalf of Plaintiffs
April 27, 1999

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GENERAL ELECTRIC COMPANY, et al.

Defendants.

DEPOSITION OF WILLIAM B. PAPAGEORGE, P.E.,
 produced, sworn and examined on behalf of the
 Plaintiffs, April 27, 1999, between the hours of eight
 o'clock in the forenoon and six o'clock in the afternoon
 of that day, at the offices of Husch & Eppenberger, 100
 North Broadway, St. Louis, Missouri, before FAITH A.
 OLLIGES, a Registered Professional Reporter and a
 Notary Public within and for the State of Missouri.

A P P E A R A N C E S

Plaintiffs were represented by Mr. Kevin F.
 McDonough of the law firm of Ball, McDonough, Artz &
 Farnetti, 117 Hawley Street, Binghamton, New York
 13902-1740.

Defendant Monsanto was represented by Mr. John C.
 Sabetta of the law firm of Seyfarth, Shaw, Fairweather &
 Geraldson, 1270 Avenue of the Americas, Suite 2500, New
 York, New York 10020-1801 and Mr. Timothy Peck of the
 law offices of Smith, Helms, Mulliss & Moore, L.L.P.,
 300 North Greene Street, Suite 1400, Greensboro, North
 Carolina 27420.

Defendant General Electric was represented by
 Mr. Eric E. Grondahl of the law offices of Cummings &
 Lockwood, CityPlace I, 185 Asylum Street, Hartford,
 Connecticut 06103-3495 and Ms. Effa G. Farnsworth, 3135
 Easton Turnpike, Fairfield, Connecticut 06431.

Also present was Plaintiff James Furch.

1 IT IS HEREBY STIPULATED AND AGREED by and
2 between Counsel for the Plaintiffs and Counsel for the
3 Defendants that this deposition may be taken in
4 shorthand by FAITH A. OLLIGES, a Registered Professional
5 Reporter and Notary Public, and afterwards transcribed
6 into typewriting.

7 o-o-o

8 WILLIAM B. PAPAGEORGE, P.E.,
9 of lawful age, being produced, sworn, and examined on
10 the part of the Plaintiffs, deposes and says:

11 DIRECT EXAMINATION

12 QUESTIONS BY MR. McDONOUGH:

13 Q. Mr. Papageorge, my name is Kevin McDonough,
14 and I represent the plaintiffs in this proceeding. I'm
15 going to ask you some questions. If you don't
16 understand my question, don't worry about just saying,
17 "I don't understand, rephrase it," and I will. You have
18 to give your answers orally. Are we agreed?

19 A. Yes.

20 MR. McDONOUGH: And we're going to do this
21 deposition under our standard stipulations?

22 MR. SABETTA: Yes.

23 MR. McDONOUGH: So all objections waived
24 except as to form. Do you want it signed?

25 MR. SABETTA: Yes. I'd like him to read it

1 and sign it.

2 MR. McDONOUGH: Waive filing of the
3 deposition. As I understand it, Monsanto is producing
4 Mr. Papageorge.

5 MR. SABETTA: Well, he's appearing as a
6 former employee, someone who has knowledge of events and
7 subjects relevant to the litigation. He retired I think
8 about ten or 12 years ago now, but he's agreed to appear
9 voluntarily. We requested that he appear, and he agreed
10 to do so.

11 MR. McDONOUGH: And it's my understanding I
12 can use his testimony just as an employee, someone
13 produced by Monsanto?

14 MR. SABETTA: I can't stipulate to that,
15 but I think you can probably use his testimony under
16 other provisions of the CPLR since he's going to be more
17 than a hundred miles from the courthouse and so forth,
18 and we haven't decided at this stage obviously whether
19 we would call him. Obviously, if we called him, you
20 could use his deposition for any and all purposes. But
21 he is a former employee, and he's not -- I had said to
22 you, I guess, informally one occasion that he was a
23 consultant to the company, and that's incorrect. He had
24 a relationship with one of the law firms that represents
25 Monsanto in some cases, but he's not had any consulting

1 agreement with Monsanto as such. So I don't regard him
2 as an agent of Monsanto. He's certainly not an employee
3 of Monsanto. But I don't think the use of his
4 deposition will be an issue because I think it will be
5 otherwise admissible since -- I think it's 3117 or 3217.
6 I've forgotten the number of the CPLR provision that
7 allows for use of depositions of persons with knowledge
8 who are not available or at a great distance from the
9 courthouse.

10 MR. McDONOUGH: I'm familiar with that, but
11 it is my understanding that Monsanto produced him. I
12 didn't subpoena him. Is that incorrect?

13 MR. SABETTA: Yeah. I mean, you requested
14 that he appear, and we made that request of him. We
15 don't have the power to order him to appear. We asked
16 that he do so, and he agreed to do so.

17 Q. Mr. Papageorge, will you state your full
18 name and address for the record, please?

19 A. William B. Papageorge, 321 Pebble Valley
20 Drive, St. Louis, Missouri, 63141-8039.

21 Q. Are you employed, Mr. Papageorge?

22 A. Self-employed.

23 Q. What are you self-employed as?

24 A. Technical consultant.

25 Q. Okay. Tell me what you're a technical

1 consultant in. What fields?

2 A. Its basis is chemistry, chemical
3 engineering, and it does involve matters such as the
4 environment and the introduction of chemicals into
5 society and the environment.

6 Q. Do you consult for the Monsanto Chemical
7 Company?

8 A. No.

9 Q. Do you consult for a firm?

10 A. I'm sorry?

11 Q. Do you consult for a firm?

12 A. Yes.

13 Q. What's the name of the firm?

14 A. Smith, Helms, Mulliss & Moore.

15 Q. Can you tell me --

16 A. And I have consulted for Syntex Company and
17 Chrysler Corporation.

18 Q. Can you tell me the nature of that firm?
19 What's its --

20 A. Which firm?

21 Q. The firm you consult for.

22 MR. SABETTA: Smith, Helms I think he's
23 referring to.

24 A. Oh, Smith, Helms? Oh, it varies, of
25 course, with the time. I have been involved in

1 tutorials in which I try to introduce the subject of PCB
2 in the environment to attorneys. It involves such
3 things as the preparation of TV tapes, which are I
4 understand used as background information for
5 individuals unfamiliar with the subject. I share with
6 anyone asking the questions what my experience has been
7 regarding chemicals and the environment. Those are the
8 broad areas that come to mind at the moment.

9 Q. Is Smith, Helms a law firm?

10 A. Yes.

11 Q. Does it provide defense work for the
12 chemical industry?

13 MR. SABETTA: Objection to form. You can
14 answer.

15 A. I'm only aware that they represent the
16 Monsanto Solutia team. I don't know who else they
17 provide law services for.

18 Q. What's the Monsanto Solutia team?

19 A. Up until 1997, that entity was identified
20 as Monsanto. At times it was Monsanto Company.
21 Sometimes it was Monsanto Chemical Company, and so on.
22 In 1997, I think that's correct, late '97, the chemical
23 portion of Monsanto was renamed Solutia, S-O-L-U-T-I-A,
24 and the Monsanto name was assigned to that activity
25 which involved the use of scientific technical knowledge

1 in agricultural activities.

2 Q. Do you know what happened to the plants
3 that made Aroclors in this reorganization that you've
4 told me about?

5 A. Yes.

6 MR. SABETTA: I have an objection to the
7 form. You can answer it.

8 A. They were assigned to the Solutia company.

9 Q. Is that a publicly stock held company?

10 A. Yes.

11 Q. These tapes that you made and these
12 conferences that you participate in with Smith, Helms,
13 are they with respect to other law firms who provide
14 defense work?

15 A. Yes. On occasion there would be attorneys
16 involved from other law firms.

17 Q. Have you ever consulted with a plaintiff's
18 lawyer with respect to a plaintiff's case on PCB
19 exposure?

20 A. I don't recall any.

21 Q. This consulting arrangement that you have
22 with Smith, Helms, are you paid on an annual basis or a
23 per diem basis, or how does your remuneration take
24 place?

25 A. I'm paid on an annual basis.

1 Q. Do you mind telling me how much?
2 A. It's \$8,500 a month.
3 Q. Are you also reimbursed expenses for your
4 work?
5 A. Only travel expense.
6 Q. Do you also receive a pension from Monsanto
7 or Monsanto Company or Monsanto Chemical?
8 A. I do.
9 Q. How old are you, Mr. Papageorge?
10 A. 76.
11 Q. Could you give me your birth date?
12 A. September 7th, 1922.
13 Q. Could you give me your Social Security
14 number?
15 A. 500-18-0780.
16 Q. Did you receive any education beyond high
17 school?
18 A. Yes.
19 Q. Would you tell me what it was?
20 A. Is this education limited to formal
21 institutions or --
22 Q. Let's start with formal institutional
23 education.
24 A. I attended Washington University located in
25 St. Louis and received a Bachelor of Science degree in

1 Chemical Engineering in 1943. I attended the same
2 institution in 1946 through 1947 and achieved -- was
3 awarded a Master of Science in Chemical Engineering.
4 That completes what I call the formal schooling.

5 Q. Could I ask a few more questions before I
6 go to the informal?

7 A. Certainly.

8 Q. Did you attend any other class work in an
9 educational institution after your Master's degree?
10 Let's limit that to credit earning courses.

11 A. Yes.

12 Q. Could you tell me about those, please?

13 A. I almost forgot those. I attended courses
14 held by the then Oklahoma A&M College, which were
15 intended to give me the appropriate credits for a Doctor
16 of Science in Chemical Engineering.

17 Q. How many credits were you able to achieve
18 in that program?

19 A. As I remember, I was able to achieve 12
20 hours.

21 Q. How many did you need for the Ph.D.?

22 A. Oh, as I remember, I needed six more plus
23 an acceptable research project and thesis.

24 Q. Had you engaged in any research project as
25 part of that Ph.D. program?

1 A. I did not get started.

2 Q. Had you done any research project as part
3 of a Master's program?

4 A. Yes.

5 Q. What was your research in?

6 A. It was in electrochemistry, the use of
7 electrochemical techniques in the production of organic
8 chemicals.

9 Q. Did you write a paper?

10 A. Yes.

11 Q. What was its title? If you can't remember,
12 you can tell me that.

13 A. I'd be guessing because that's five decades
14 ago. I can't remember the specific words.

15 Q. Have you written any other papers since
16 that paper? Let me withdraw the question. Have you
17 written any papers that were submitted for peer review
18 in the area of chemistry?

19 A. No.

20 Q. Have you written any papers that were
21 submitted for peer review in any area of science?

22 A. No.

23 Q. When you say electrochemistry with respect
24 to organic chemicals, can you tell me whether any of
25 that involved Aroclors or polychlorinated biphenyls or

1 monophenyls?

2 A. No.

3 Q. What did you do between 1943 and 1946?

4 A. I served in the military.

5 Q. What branch?

6 A. Army.

7 Q. What did they have you doing?

8 A. It varied with the progression of the war.

9 Q. Was any of it involved in chemistry or your
10 field that you had been trained in?

11 A. There was a period in which I was assigned
12 the task of locating and properly destroying chemical
13 warfare materials in Japan.

14 Q. Do you recall generally what the chemical
15 warfare materials were?

16 A. Not totally or specifically. I do remember
17 mustard gas and phosgene and chlorine as best we could
18 translate the Japanese hieroglyphics.

19 Q. Where were you born, Mr. Papageorge?

20 A. St. Louis.

21 Q. After you finished your Master's degree,
22 did you obtain a job?

23 A. Yes.

24 Q. Where did you go to work?

25 A. I went to work in Bartlesville, Oklahoma.

1 Q. What was the name of the company?

2 A. Phillips Petroleum Company.

3 Q. Had you worked for any chemical companies
4 prior to this job for Phillips?

5 A. No.

6 Q. All right. How long did you work for
7 Phillips?

8 A. Four years.

9 Q. What was the nature of your work?

10 A. There were two types of assignments.
11 Initially I worked in the Research Department in
12 activities associated with oil well drilling and what
13 was called at that time secondary recovery.

14 Q. Did that pertain to recovery of oil?

15 A. Yes.

16 Q. Did you indicate there was another job
17 scope that you were involved with?

18 A. Yes. In the last two years, I was assigned
19 to refinery engineering. That's not the official
20 designation, but the activity involved engineering for
21 refining of crude oil.

22 Q. Did any of that work involve
23 polychlorinated biphenyls?

24 A. No.

25 Q. Did it involve any of the products that are

1 used to make Pyranol, P-Y-R-A-N-O-L?

2 A. No.

3 Q. Did you go to work someplace else in 1951?

4 A. Yes.

5 Q. Where was that?

6 A. Monsanto Company.

7 Q. Where physically did you work?

8 A. At the John F. Queeny plant located in St.

9 Louis.

10 Q. What was your job title?

11 A. The initial job was Process Engineer, I

12 believe, as best I can remember.

13 Q. What were you involved with as a Process

14 Engineer?

15 A. I was assigned the engineering activities

16 associated with part of the process in making an organic

17 chemical.

18 Q. Was there particular organic chemicals that

19 you participated in the process of --

20 A. Yes.

21 Q. -- making? What chemicals?

22 A. The product that was the object of all of

23 this activity was phthalic anhydride, P-H-T-H-A-L-I-C,

24 anhydride, A-N-H-Y-D-R-I-D-E.

25 Q. Any other chemicals during this process?

1 A. Well, there were, of course, chemicals
2 involved in starting the process, and then there are
3 waste chemicals, undesirable materials.

4 Q. Were polychlorinated diphenyls or biphenyls
5 used in that process?

6 A. I hesitate because my ears pick up
7 "phenols," which is a different chemical from phenyls.

8 Q. Okay. Phenyls.

9 A. Y-L?

10 Q. Y-L.

11 A. Y-L instead of O-L. You're referring to
12 the diphenyls?

13 Q. Yes.

14 A. No.

15 Q. What about the "nols"?

16 A. No.

17 Q. Where did you work next after this 1951
18 assignment? Let we withdraw that. How long did you
19 stay in that assignment?

20 A. A couple of years.

21 Q. That would take us to about 1953. What did
22 you start doing then?

23 A. I was assigned as an assistant supervisor
24 in a production unit out in the plant.

25 Q. What was the unit involved in producing?

1 A. This particular unit made products called
2 plasticizers.

3 Q. What are plasticizers?

4 A. These are materials that are added to
5 plastics to make the plastic flexible.

6 Q. Did that process include using PCBs?

7 A. No.

8 Q. Were you ever involved in manufacturing
9 plasticizers using PCBs?

10 A. No.

11 Q. Do you know of other manufacturers that
12 made plasticizers using PCBs? Do you know of other
13 manufacturers who made plasticizers that used PCBs?

14 A. I'd be guessing. I don't know
15 specifically.

16 Q. How long did you work in that position
17 starting in 1953?

18 A. About a year.

19 Q. Then what position did you obtain?

20 A. I was given my own department to supervise
21 instead of being an assistant supervisor.

22 Q. Was that the same department?

23 A. No.

24 Q. What department were you supervising?

25 A. I don't know that it had any formal name.

1 It had a number at the time. But, nevertheless, it was
2 a unit that produced chemicals that were starting
3 chemicals for the eventual manufacture of materials that
4 ended up in rubber blending, rubber additives.

5 Q. How long did you work at that job?

6 A. About one or two years.

7 Q. That would take us up to 1955 or 1956?

8 A. That's about right, yes.

9 Q. Were any PCBs involved in those rubber
10 additives?

11 A. No.

12 Q. What are PCBs?

13 A. They are chemicals that are described by
14 the chemists as consisting of the configuration of
15 benzene, which is a hexagon-shaped molecule, and the two
16 benzenes nose to nose form the biphenyl. Now,
17 associated with each of the corners of that six-cornered
18 formation, there is a hydrogen attached. To make
19 polychlorinated biphenyls, the hydrogen in one or more
20 of these positions is removed and a chlorine is
21 substituted. So the "polychloro" part of the name
22 refers to the fact that there are more than one chlorine
23 attached.

24 Q. And did Monsanto Chemical Company make
25 those PCBs?

1 A. Yes.

2 Q. Do you know of any other company in the
3 United States that made PCBs besides Monsanto?

4 MR. SABETTA: At any time?

5 Q. At any time.

6 A. Well, I understood that there were at least
7 two companies mentioned in my study of the PCB
8 situation.

9 Q. Could you give me their names?

10 A. Oh, the names? Dow Chemical Company
11 aggressively tried to enter the market, and then later
12 there was a company down in Texas. I'm having
13 difficulty remembering its name. Its name started with
14 a C. That was I'm going to use the word rumored to be
15 selling -- making and selling PCBs to Monsanto's
16 ex-customers who were no longer supplied by Monsanto.

17 Q. What time period was that that they were
18 rumored to be selling?

19 A. Between '70 and '75, 1970 and 1975.

20 Q. What ex-customers of Monsanto would this be
21 that they were rumored to be selling to? Was it
22 particular fields?

23 A. I can mention the fields. I cannot give
24 you specific names.

25 Q. That's okay. What fields?

1 A. The initial sales were made to those who
2 used PCBs as plasticizers. Later I understood that they
3 were sold to customers who had a need for heat transfer
4 fluids and for hydraulic fluids.

5 Q. Would you know any of the names of those
6 heat transfer fluid customers?

7 A. I never could get that.

8 Q. Were you trying to get that information at
9 some point?

10 A. Yes.

11 Q. For what purpose?

12 A. Oh, my purpose at the time was to avoid an
13 incident occurring with this material manufactured and
14 distributed and sold by another entity creating a
15 problem that the blame would be placed on Monsanto.
16 That was my purpose, and I tried to get the EPA to help
17 me in that then. They never came back with an answer,
18 so I don't know what they knew.

19 Q. Did you provide information to the EPA at
20 that time?

21 A. Yes. I told them what I had understood.

22 Q. Did you give them written information at
23 that time?

24 A. No.

25 Q. What's the EPA?

1 A. I'm sorry?

2 Q. What is the EPA that you're referring to?

3 A. It's a federal agency, the Environmental
4 Protection Agency.

5 Q. Who did you deal with there on this
6 particular matter?

7 A. I don't remember the specific person.
8 There were so many. I just don't remember.

9 Q. You said that Dow Chemical was aggressively
10 trying to enter the market. Do you know about what time
11 that was?

12 A. I can only give you a broad period. This
13 was before the environmental issues on PCBs came up.

14 Q. When would that be approximately?

15 A. Oh, approximately the 1950's.

16 Q. Could we do any better as to whether it was
17 the early '50's or mid '50's or late '50's?

18 A. I can't help you on that. I just don't
19 remember any.

20 Q. Do you have any factual knowledge that Dow
21 did try to enter the market at that time?

22 MR. SABETTA: Objection to the form.

23 Q. I'll withdraw it. Where did you get this
24 information that you're telling me about as to Dow
25 aggressively trying to enter the market at that time?

1 A. I got it from representatives of Monsanto's
2 marketing team who picked this up as they made calls on
3 the customers.

4 Q. Was any of that information conveyed to you
5 in writing?

6 A. No.

7 Q. When was that information conveyed to you?

8 A. 1970, '71.

9 Q. Is this the same Dow Chemical that made
10 Agent Orange?

11 A. That's the only Dow Chemical I know of, so
12 it must be.

13 Q. Did Monsanto also make Agent Orange?

14 A. Yes.

15 Q. Didn't Monsanto have the patent for PCBs?

16 MR. SABETTA: Objection to the form.

17 A. No.

18 Q. Did Monsanto ever have the patent on PCBs?

19 MR. SABETTA: Objection to form.

20 A. Monsanto had a patent that I recall on the
21 new approach to how to manufacture the material.

22 Q. Do you know when it obtained that patent?

23 A. I just don't remember the date.

24 Q. Do you remember that Monsanto purchased the
25 patent rights from Swann Chemical?

1 MR. SABETTA: Objection to form.

2 A. I'm not aware of that at all. I'm not
3 aware of any patents being in existence when the
4 purchase was made.

5 Q. Were you aware of why Monsanto purchased
6 Swann?

7 MR. SABETTA: Objection to form.

8 A. Well, since I wasn't there, sir, I really
9 would be speculating. I don't know.

10 Q. Well, have you seen any records that would
11 give you information as to the purpose of purchasing
12 Swann Chemical?

13 A. I've never seen such a record.

14 Q. Now, I think we got up to 1955 or 1956 with
15 respect to your work for Monsanto. Can you tell me what
16 you did at that time?

17 A. Following that period? Immediately?

18 Q. Following that period, yes.

19 A. I was assigned to the plant's maintenance
20 department as a Supervisor of Small Project
21 Construction.

22 Q. Did that involve your chemistry education?

23 A. No, it didn't.

24 Q. How long did you work in that capacity?

25 A. Again, about a year or two.

1 Q. Which would take us up to 1957 or 1958?

2 A. That's close, yes.

3 Q. Had you had any involvement in PCBs up to
4 that time period?

5 A. During that time period or up to it?

6 Q. Up to that time period, 1957, 1958.

7 A. Well, during the period some of the
8 projects that my team or crew was involved with involved
9 the use of PCBs in the equipment that was installed.

10 Q. What was your team's involvement in the use
11 of PCBs in the equipment?

12 A. Of course, it varied. I could give you an
13 example. When they installed a hydraulic -- I'm sorry.
14 When they installed an air compressor, and the project
15 called for a fire-resistant fluid in that compressor,
16 they would, of course, install the compressor, and they
17 would fill it with a PCB-type fluid.

18 Q. Who is the "they" who would fill it? Some
19 employee of Monsanto?

20 A. Yes. It depended on the activity and who
21 that activity was assigned to in terms of the various
22 classifications.

23 Q. Was that your first encountering of PCBs in
24 that time period? Knowledge of PCBs is what I'm
25 referring to.

1 A. Yes.

2 Q. Now, you said that Monsanto had a patent on
3 new approaches to manufacturing PCBs. What was the
4 nature of that process? Can you tell me generally?

5 A. The whole process or the new approach?

6 Q. The new approach.

7 A. The new approach really related to the use
8 of a process that would be called continuous where the
9 biphenyl would be exposed to chlorine as it went from
10 tank to tank, and it would pick up the chlorine as it
11 progressed through the system, as distinguished from the
12 older approach where a tank would be full of biphenyl
13 and chlorine would bubble through it to get that
14 chlorine to attach itself to the biphenyl group.

15 Q. Do you know when that new approach was
16 patented by Monsanto?

17 A. You asked me this before. I can't place
18 it.

19 Q. I'm sorry. I didn't remember that I did.

20 A. I just can't place the date.

21 Q. Do you know whether the new approach was a
22 closed system?

23 MR. SABETTA: Objection to form.

24 A. Well, I have difficulty with the definition
25 of closed because they are all intended to be closed. I

1 have trouble making the distinction.

2 Q. Do you know whether the old system was
3 considered a closed system?

4 MR. SABETTA: Same objection.

5 A. The only time the old approach was open is
6 when the operator would remove the cover on an opening
7 into which he would introduce lime to neutralize any
8 acid that was in the completed batch.

9 Q. Do you know what the temperature of the
10 contents of that tank was?

11 A. Over 300 degrees Fahrenheit.

12 Q. Do you know what time period that process
13 was employed by Monsanto?

14 MR. SABETTA: Do you mean how many years or
15 months?

16 MR. McDONOUGH: Yes. Or dates.

17 MR. SABETTA: The old system you're talking
18 about?

19 MR. McDONOUGH: Yes. The system where the
20 operator would remove the cover of a tank and put in
21 lime.

22 A. From the time they purchased the process
23 from Swann until they shut down the units in 1977.

24 Q. They still used that process until 1977,
25 Monsanto?

1 A. Yes.

2 Q. Was that in a particular plant that that
3 process was being used?

4 A. All plants.

5 Q. I may have misunderstood you, but I
6 understood there was a new approach that was patented
7 about continuing the biphenyl from tank to tank with
8 exposure to chlorine which didn't involve opening the
9 tanks. Did I misunderstood you in that regard?

10 A. No. No.

11 Q. Was that process used also by Monsanto --

12 A. Yes.

13 Q. -- to make PCBs?

14 MR. SABETTA: Let him finish the question.

15 MR. McDONOUGH: Did you get an answer?

16 THE REPORTER: Yes.

17 Q. What time period was that process used
18 through? I understand you don't remember when it
19 started.

20 A. Again, I don't have a date.

21 Q. Okay.

22 A. I just don't remember the date.

23 Q. You don't know if that process continued
24 through 1977 when you discontinued manufacture of PCBs?

25 A. Oh, I know that, but I don't know when it's

1 introduced.

2 Q. That's what I'm trying to ascertain now. I
3 understand you don't know when it was introduced, but
4 was it still employed up through the time that Monsanto
5 discontinued manufacturing PCBs?

6 A. Yes.

7 Q. Was that employed in particular plants?

8 A. I know that the Anniston, Alabama plant and
9 the plant referred to as the W. G. Krummrich plant
10 located in Sauget, Illinois, S-A-U-G-E-T, had units of
11 that type.

12 Q. Did both of those plants have units of both
13 types?

14 A. Yes.

15 Q. Where did you get this information as to
16 these processes that you've described for me?

17 A. Of course, I read the process manual that
18 describes the units and what the operator should be
19 doing under what conditions, but in addition to that, I
20 personally walked the department. I saw all the
21 activities. I was aware of what each vessel was doing.

22 Q. I believe we have you up through about 1958
23 in terms of your employment with Monsanto. Can you tell
24 me what you did after you stopped being a Supervisor of
25 Small Projects Construction?

1 A. I was appointed as Superintendent of
2 Maintenance.

3 Q. How long were you Superintendent of
4 Maintenance?

5 A. A couple, three years.

6 Q. Were you on the fast track?

7 A. I'm sorry?

8 Q. I withdraw it. As the Supervisor of Small
9 Products Construction, did you receive any materials
10 from Monsanto as to how the PCBs were to be handled or
11 not handled, as the case may be?

12 A. Certainly.

13 Q. And what kind of instruction was that? Was
14 it in writing?

15 A. It was in writing, yes, and it was also
16 shared with the employees at scheduled safety meetings.

17 Q. What was the writing called?

18 A. Well, it changed through the years. It had
19 the words "safe handling" or "toxicity information" or
20 that kind of terminology.

21 Q. Was it contained in a particular booklet,
22 employee safety manual perhaps, something of that sort?

23 A. Yes.

24 Q. Would you tell me what that booklet was
25 called back in the time that you were Supervisor of

1 Small Project Construction?

2 A. I don't know that we had a -- that we just
3 had a specific name for it. It was a three-ring
4 notebook with sheets for all the chemicals that a
5 particular group might be exposed to. They were
6 encouraged to read this.

7 Q. Did people refer to it as, oh, "that damn
8 thing" or did they use a name with respect to it?

9 A. No. They -- Each one would use words like
10 "the safety manual" or "the safety booklet" or "the
11 chemical information".

12 Q. When you became Supervisor of Maintenance,
13 can you tell me --

14 MR. SABETTA: He said superintendent. Did
15 you say superintendent, Mr. Papageorge? What was the
16 correct --

17 THE WITNESS: Well, I was both. I was a
18 supervisor.

19 MR. SABETTA: And then thereafter you
20 became superintendent?

21 THE WITNESS: Superintendent.

22 MR. SABETTA: That's what I thought we were
23 discussing.

24 Q. When you became Superintendent of
25 Maintenance, what generally were your duties?

1 A. Well, I was responsible for the activities
2 of six or seven supervisors, each with a team of the
3 various craftsmen, welders, pipefitters, millwrights,
4 carpenters, and so on.

5 Q. Did that entail a particular plant?

6 A. Yes.

7 Q. What plant?

8 A. The John F. Queeny plant in St. Louis.

9 Q. Could you spell that last name for me?

10 A. Queeny, Q-U-E-E-N-Y.

11 Q. How long did you function in that capacity?

12 A. I thought we answered that. A couple,
13 three years.

14 Q. Oh, you did. I'm sorry. What did you do
15 in a couple, three years? What was your next job?

16 A. Oh, my next job, I was assigned to the
17 Plant Engineering Department as a superintendent.

18 Q. Were there job descriptions associated with
19 these particular jobs that you did? Written job
20 descriptions I'm referring to.

21 A. I don't remember any formal job
22 description, no.

23 Q. In the Plant Engineering Department, as the
24 superintendent, what did you do?

25 A. I supervised the activities of engineers

1 and technicians, and the number would vary depending on
2 the workload.

3 Q. Was there a particular area of work that
4 you were assigned to as opposed to just supervising
5 engineers and technicians?

6 A. I was supervising the individuals I
7 mentioned in their activities relating to assigned
8 production units scattered throughout the plant.

9 Q. Did any of those production units involve
10 PCBs?

11 A. Yes.

12 Q. How long a period of time did you function
13 as a superintendent in Plant Engineering?

14 A. A couple years.

15 Q. That would take us up to 1963 about?

16 A. Yes.

17 Q. And what did you do in 1963?

18 A. I was appointed a general superintendent of
19 a multi-department unit that included warehousing,
20 shipping, receiving, the utilities department, a
21 blending station, a chemical product blending station,
22 the waste disposal unit. In other words, all of the
23 activities that support the manufacturing departments
24 other than maintenance.

25 Q. You mentioned blending station. Did

1 Monsanto blend Pyranol at that time?

2 A. Yes.

3 Q. How long had they been blending Pyranol to
4 your knowledge?

5 MR. SABETTA: At that location or at any
6 location?

7 Q. We'll start with that location.

8 A. That location, starting in '63.

9 Q. How long had they been blending Pyranol at
10 other locations?

11 A. I was led to believe that that service
12 started to be provided just before World War II.

13 Q. Do you know why it was started to be
14 provided?

15 A. No, I don't.

16 Q. So that would make it just before World War
17 II? 1940, 1941?

18 A. That's close as best I can recall, yes.

19 Q. What plant was involved in that blending
20 prior to 1963 or plants?

21 A. Anniston, Alabama.

22 Q. Was that the only plant involved in
23 blending up through 1963, blending Pyranol?

24 A. Pyranol, yes.

25 Q. Do you know the plant that started blending

1 in 1963 was the John F. Queeny plant?

2 A. Yes.

3 Q. Do you know what the particular reason was
4 that that plant started blending Pyranol in 1963?

5 A. Oh, the basic reason was that there was a
6 need for a facility that could blend many products.
7 Whenever there was available time, in other words, there
8 were idle tanks and pumps and so on, the schedule would
9 be arranged such that some Pyranols were sent through
10 the system, or if the Pyranol in the inventory reached a
11 certain level, they'd stop that and make some other
12 product through that blending system.

13 Q. John F. Queeny started blending because of
14 the demand for Pyranol?

15 A. No.

16 Q. What was the reason?

17 A. The reason for what?

18 Q. That John F. Queeny started blending in
19 1963.

20 A. The increase in demand for many products
21 that Monsanto was selling, and somebody decided to put
22 that unit at the Queeny plant.

23 Q. Was that a new unit that was constructed
24 for that particular process blending?

25 A. Yes.

1 Q. Do you know how much that cost?

2 A. I don't remember.

3 Q. Do you know if the unit was cleaned after
4 Pyranol was blended and before another chemical was
5 blended?

6 A. Always.

7 Q. How was it cleaned?

8 A. Oh, I can't sit here and tell you the
9 specifics. It had to be cleaned to the point where a
10 sample of the wash water at the end would pass a
11 specific criteria, specific tests.

12 Q. You're testifying that in 1963 Monsanto was
13 testing the wash water at the end of cleaning the
14 blending tank?

15 A. Yes.

16 Q. So that it passed a sufficient certain
17 criteria?

18 A. Yes.

19 Q. What criteria was that?

20 A. Oh, I don't know the specifics. They
21 looked for chlorine, for example, but that's not the
22 only thing they looked for. I don't remember all the
23 others.

24 Q. Do you know if they looked for PCBs?

25 A. In 1963, there was no technology that

1 related to the analysis of PCBs other than chlorine
2 determination.

3 Q. No other process had been developed up to
4 that point to do that analysis?

5 A. Correct.

6 Q. Do you know whether they tested for tri or
7 tetrachlorobenzene in this water wash?

8 A. That would be picked up with the chlorine
9 analysis.

10 Q. What is the chlorine analysis? How does
11 that get analyzed?

12 A. Well, you take your sample and -- I'm not
13 going to claim that this is the perfect way to do it,
14 but --

15 Q. I just wondered what equipment was used to
16 do this chlorine analysis that you told me about.

17 A. It's the old wet chemistry. You take
18 silver and add it to the water that you're testing, and
19 the silver combines with the chlorine and comes out as a
20 white sediment, and that sediment is weighed, and the
21 calculation is made from silver chloride the chlorine,
22 and that chlorine is associated with the volume of
23 water, and it's reported as parts per million of
24 chlorine or grams per liter or some such designation.

25 Q. And what was the purpose of that testing?

1 A. That's to show that the tank was within
2 previously designated limits regarding the presence of
3 not only chlorine, but all the other chemicals that are
4 put through the system.

5 Q. Would those tests have to be -- have to
6 result in a certain fashion before the water was flushed
7 into the public system?

8 A. No.

9 Q. Was that water flushed into the public
10 water system?

11 A. Yes.

12 Q. Do you know whether that same form of
13 testing was made at the Anniston, Alabama plant?

14 MR. SABETTA: Objection to form.

15 A. It was not.

16 Q. Is there a river near the Anniston, Alabama
17 plant?

18 A. I need help with the word "near".

19 Q. Within a mile?

20 A. Within a mile? No. It's a little further
21 away than that.

22 Q. How about within five miles?

23 A. Oh, I've never measured it.

24 Q. Is there a river in the vicinity of the
25 Anniston, Alabama plant?

1 A. Yes.

2 Q. What's the name of that river?

3 A. Coosa River, C-O-O-S-A.

4 Q. Now, you mentioned that you were a general
5 superintendent involved with waste disposal also, and
6 this is in the 1963 time period?

7 A. Yes.

8 Q. How long were you a general superintendent
9 involved in that?

10 A. About two years, '63 and most of '64.

11 Q. So that would take us up to 1965 when you
12 became employed in some other capacity?

13 A. Yes.

14 Q. What was the nature of the waste disposal
15 done in this time period, '63 through '65, with respect
16 to PCBs and Pyranol waste?

17 A. It varied with the material being disposed.
18 If it was just sawdust with PCBs on it, it would go to a
19 Monsanto landfill. If it was rags, of course, it would
20 be handled the same way. If it was a presence in water,
21 it would go to the municipal treatment system, the St.
22 Louis municipal treatment system. I don't know of any
23 other form that it would take. There was to my
24 knowledge no incident of just liquid PCBs in a pail or a
25 bucket to be disposed of. That was sent back to be

1 reworked.

2 Q. Did you go out on the floor to see if they
3 disposed of buckets of PCBs?

4 A. Did I go around and see it?

5 Q. Yes.

6 A. When I took my routine fairly frequent
7 walks through the operations, yes, I would have that in
8 mind, along with hundreds of other chemicals.

9 Q. You didn't notice any buckets of PCBs being
10 dumped? Is that what you're saying?

11 A. I never saw that, no.

12 Q. What about incineration during this time
13 period, 1963 through 1965? Was any incineration
14 employed in disposing of PCBs or Pyranol?

15 A. The technology was not available. There
16 was no incineration.

17 Q. When did -- Withdraw that. Did Monsanto
18 ever begin the development of technology for
19 incineration to dispose of PCBs and Pyranols or other
20 chemicals?

21 A. Yes.

22 MR. SABETTA: Objection to form.

23 Q. Yes?

24 A. Yes.

25 Q. When did they do that?

1 A. Started in -- It's difficult to pinpoint
2 the exact timing. The Monsanto Engineering Department
3 was assigned the task in late '69, and, of course, that
4 work continued through early 1970.

5 Q. So, as I understand it, you know of no work
6 done by Monsanto or its engineers or employees with
7 respect to trying to develop a technology of
8 incineration of PCBs up until this late 1969 time
9 period?

10 A. That is true.

11 Q. Did Monsanto employ any outside contractors
12 with respect to incineration of PCBs up till this 1969
13 time period?

14 MR. SABETTA: Objection to the form.

15 A. I don't recall the exact date on which an
16 incinerator manufacturer was contacted. It would have
17 to be within that period of time, late '69 or early
18 1970.

19 Q. I think we've got your employment history
20 up to 1965. With this general superintendent job
21 assignment, what was your next assignment?

22 A. I lost a year in there somewhere. I was
23 assigned to the --

24 Q. I've done that myself.

25 A. -- W. G. Krummrich plant as a General

1 Superintendent of Manufacturing at that plant.

2 Q. Did that plant manufacture PCBs?

3 A. Yes.

4 Q. And I think you already told us that that
5 plant -- Withdraw that. Did that plant blend Pyranol?

6 A. What period of time?

7 Q. Well, I think you told us about 1965 you
8 became the General Superintendent of Manufacturing. How
9 long did you occupy that position?

10 A. About a year.

11 Q. During that time period, '65 through '66,
12 did it blend Pyranol at the Krummrich plant?

13 A. No.

14 Q. Prior to that time period, had it blended
15 Pyranol at the Krummrich plant?

16 A. Not to my knowledge.

17 Q. What about subsequent to that time period?

18 A. Yes. Eventually.

19 Q. Do you know when about?

20 A. About 1975.

21 Q. Did you have anything to do with the plant
22 at that time, 1975, when it was blending Pyranol?

23 A. No.

24 Q. Do you know what particular blend of
25 Pyranol it made?

1 A. No.

2 Q. Do you know what blends of Pyranol the
3 Anniston, Alabama plant made in 1970?

4 A. Did you say were there blends?

5 MR. SABETTA: Do you know what kind of
6 blends?

7 A. No. There were so many, I just don't
8 remember the numbers.

9 Q. What did you do after 1966 for Monsanto?

10 A. My dates are a little advanced.

11 Q. Okay.

12 A. In 1965 I was assigned to the Anniston,
13 Alabama plant as the Plant Manager.

14 Q. At that time, was the Anniston plant
15 blending Pyranol?

16 A. Yes.

17 Q. Was it making PCBs?

18 A. Yes.

19 Q. Was it making other chemicals?

20 A. Yes.

21 Q. About how many other chemicals?

22 A. Gosh! 15, 20.

23 Q. What is Pyranol?

24 A. Pyranol is a mixture of chemicals that is
25 used as a cooling medium in electrical equipment.

1 Q. Do you know whether General Electric
2 company patented that process?

3 MR. SABETTA: Objection to the form.

4 MR. GRONDAHL: Join in the objection.

5 A. I'm not aware of any -- I don't know.

6 Q. Do you know whether General Electric
7 company patented dielectric fluid using Aroclors?

8 MR. SABETTA: Objection to form.

9 MR. GRONDAHL: Objection to form.

10 A. I recall a patent referring to dielectric
11 fluids with PCBs issued to General Electric. I don't
12 recall at this moment the specifics of the patent.

13 Q. Do you know whether Pyranol was a trademark
14 of General Electric Company?

15 A. That's my understanding.

16 Q. Is Aroclors a trademark of Monsanto?

17 A. Yes.

18 Q. How long were you Plant Manager at
19 Anniston?

20 A. Until the end of 1969.

21 Q. What did you do in 1969 or early '70 for
22 that matter?

23 A. I was assigned a new job called Manager,
24 Environmental Control, located in Monsanto's
25 headquarters in St. Louis.

1 Q. Was there a job description written for
2 that job?

3 A. I never saw one.

4 Q. Who assigned you to that job?

5 A. The word "assigned" kind of puzzles me. I
6 never perceived it as being assigned by these
7 individuals, but I was acceptable to the two business
8 directors whose business groups were involved with PCB
9 products.

10 Q. Who were those two business directors?

11 A. James Springgate and Howard Bergen.

12 Q. What do you mean "groups assigned to PCB
13 products"?

14 A. These are I'm going to call them teams of
15 people, including researchers, marketing people,
16 production people involved with an assigned set of
17 products. Product A, product B, product C is yours, and
18 D, E, F is this fellow's. And they then are to
19 supervise the activities of these individual fellows to
20 get the best results for that set of products.

21 Q. What set of products did Mr. Springgate
22 have at that time?

23 A. His group was called in Monsanto as the
24 plasticizers group.

25 Q. Did that group go out of business in 1972?

1 A. No. Not that I'm aware of.

2 Q. Did that group have any other products than
3 plasticizers?

4 A. No.

5 Q. What products did Mr. Bergen's group have?

6 A. Industrial fluids.

7 Q. Could you explain that a little bit more as
8 to what fluids?

9 A. Explain what I mean by industrial fluids
10 you mean?

11 Q. Yes. What products are entailed in
12 industrial fluids?

13 A. Products? Several types. There's the
14 fluids that are used in hydraulic systems to move
15 equipment or move conveyor belts or run air compressors.
16 Then there's the type that's used as a medium for
17 transferring heat from one source to a use point. And
18 then there's, of course, the use in the electrical
19 equipment. There's the use in aircraft to raise and
20 lower the wheels and the flaps and so on, aircraft
21 hydraulic fluid. I'm sure I didn't cover all of them,
22 but that's an example of the type of fluids that they
23 were involved with.

24 Q. Who did Mr. Springgate report to in terms
25 of his superiors? This is back at the time period that

1 you're at.

2 A. As best I remember -- As best I remember,
3 it was John Mason, Assistant General Manager.

4 Q. General Manager of what? Assistant General
5 Manager of what?

6 A. At that time, it was called the Organic
7 Chemicals Division of Monsanto.

8 Q. Do you know who Mr. Mason reported to?

9 A. At that time, it was Howard Minkler,
10 M-I-N-K-L-E-R.

11 Q. What was his title?

12 A. He was the General Manager.

13 Q. Of the company?

14 A. No. Of that division, Organic Chemicals
15 Division.

16 Q. Who did Mr. Bergen report to at that time?

17 A. Mr. Bergen reported to John Mason.

18 Q. Who did Mr. Minkler report to?

19 A. I'm trying to remember. It was a vice
20 president of Monsanto.

21 Q. Was that vice president in charge of any
22 particular area of the company?

23 A. You mean physical area or assigned activity
24 area?

25 Q. His job activity area.

1 A. He was assigned what I'm going to call the
2 chemicals type of activities.

3 Q. Did Monsanto do anything else at that time
4 except for chemicals activities?

5 A. Certainly.

6 Q. Going back to Plant Manager at Anniston,
7 who did you report to at that time?

8 A. When you say "at that time," you mean the
9 whole period or...

10 Q. Well, I think you said it was a four-year
11 period.

12 A. Yes.

13 Q. '65 through '69?

14 A. Yes.

15 Q. That period.

16 A. That period. Initially I reported to
17 Robert Soden, S-O-D-E-N, and then I reported -- He got
18 promoted, and he was replaced with Raymond Stratmeyer,
19 S-T-R-A-T-M-E-Y-E-R.

20 Q. In terms of Pyranol, when you were working
21 as Plant Manager at the Anniston plant, was there a
22 particular place where that chemical was shipped when it
23 was sold to General Electric?

24 MR. SABETTA: Objection to form.

25 A. I'm confused with the question, because

1 when you say "particular place" --

2 Q. Let me ask you some more questions. As I
3 understand it, for example, General Electric made
4 transformers in Rome, Georgia and Pittsfield,
5 Massachusetts and made other electrical equipment at
6 other various plants. I'm interested to know whether it
7 was any particular site that Anniston shipped the
8 Pyranol to in this 1965 through '69 time period.

9 MR. GRONDAHL: Object to the form.

10 MR. SABETTA: Objection to form.

11 MR. McDONOUGH: I would hope so.

12 Q. Can you answer it?

13 A. I think I can. As I understand it, you're
14 asking me to tell you the General Electric plants that
15 received these shipments?

16 Q. If you can.

17 A. I can.

18 Q. Okay.

19 A. Rome, Georgia and Pittsfield,
20 Massachusetts.

21 Q. Okay. Was there a difference in the
22 quantities that went to those plants during those years?

23 MR. SABETTA: Objection.

24 Q. And I'm talking about generally now. Was
25 it shipped half to Pittsfield, half to Rome, and so

1 forth?

2 MR. SABETTA: Objection to form.

3 MR. McDONOUGH: You only have to say it
4 once, John.

5 A. I just don't recall specific numbers. The
6 activity varied.

7 Q. How are you doing?

8 MR. SABETTA: I could use a short break if
9 it's okay.

10 MR. McDONOUGH: Based on your last series
11 of objections, take a break.

12 MR. SABETTA: Okay.

13 (Whereupon, there was a brief recess.)

14 Q. What was your job or what were your job
15 duties as Manager of Environmental Control?

16 A. I was to serve as the individual that tried
17 to keep abreast of all new developments as they related
18 to PCBs and the environment, and it was a -- Really,
19 initially it was a case of letting the left hand know
20 what the right is doing regarding not only within
21 Monsanto, but with its customers, with the university
22 laboratories, with other producers of PCBs, citizen
23 groups, anybody that wanted to know something about
24 PCBs. I was to be aware of that and to try to provide
25 the answers as they developed, and it was up to me to

1 keep abreast of all new developments.

2 Q. Was this position a new position with
3 Monsanto?

4 A. Yes.

5 Q. Do you know who participated in its
6 creation?

7 A. There was a group in '69 of Monsanto
8 individuals who, as best as I can determine, were
9 appointed by Mr. Bergen, Mr. Springgate, and the
10 Corporate Medical Director to address this PCB
11 environmental issue and make recommendations to Monsanto
12 management regarding how to best understand the issue
13 and to respond to it. This group referred to itself as
14 the PCB Ad Hoc Committee.

15 Q. Did it ever get any other names than the
16 PCB Ad Hoc Committee?

17 A. No.

18 Q. Who was the Corporate Medical Director that
19 you referred to?

20 A. Dr. Emmet Kelly.

21 Q. Do you know if Dr. Kelly is still alive?

22 A. He is not.

23 Q. Who else was involved in this group in 1969
24 or '70?

25 A. I'll try to remember them all. I'm sure

1 I'm going to miss somebody. There was Elmer Wheeler,
2 Bill Richard, Paul Hodges. I think Mel Ferrar,
3 F-E-R-R-A-R. He was a member. That's as far as my
4 memory will help me.

5 Q. Are any of these gentlemen still alive?

6 A. Mr. Ferrar is, and I understand Mr. Hodges
7 is. The others are not.

8 Q. Do you yourself have any medical
9 background?

10 A. No.

11 Q. Are you a toxicologist?

12 A. No.

13 Q. Do you have any toxicological background?

14 A. No.

15 Q. Are you an epidemiologist?

16 A. No.

17 Q. Do you have any epidemiological background?

18 A. No.

19 Q. Did you get any information in those
20 various areas when you took on your new assignment?

21 A. Yes.

22 Q. Who gave you information, or how did you
23 get information?

24 A. I would make it a point to talk with
25 individuals within and without Monsanto who I was told

1 had the expertise and were willing to share it with me.

2 Q. Were you given any training program?

3 MR. SABETTA: Objection to the form.

4 A. Not in those fields.

5 Q. What about training for the job of Manager
6 of Environmental Control? Did you get any training?

7 A. Well, I got what I call a tutorial, a
8 one-on-one kind of training.

9 Q. Who gave you this tutorial?

10 A. It depended, of course, on the subject. If
11 it was medically related, it was Dr. Kelly, or Elmer
12 Wheeler. That's only one example.

13 Q. Do you recall meetings with Dr. Kelly and
14 Mr. Wheeler immediately after you assumed your position?

15 A. Yes.

16 Q. Was there a regular series of meetings, or
17 was it informal? How did that go?

18 A. Oh, I don't know what you mean by regular
19 and informal.

20 Q. Well, withdrawn. How many meetings did you
21 have within a month with Dr. Kelly?

22 A. I never kept a record. I would suggest
23 that every working day and some weekends I met with one
24 or the other for periods of time.

25 Q. What was Mr. Wheeler's title?

1 A. At that time, he was the Assistant Medical
2 Director.
3 Q. Was he a medical doctor?
4 A. No.
5 Q. What was his training in?
6 A. Public health.
7 Q. Do you know what his degrees were?
8 A. Master of Public Health.
9 Q. Do you know whether Dr. Kelly had a
10 particular field of specialty?
11 A. I do not.
12 Q. Do you know where Mr. Wheeler is now?
13 A. Deceased.
14 Q. Did you continue to have these meetings
15 with one or the other of them every day and sometimes
16 weekends in the second month after you started your job?
17 A. Not as frequently.
18 Q. Was there a general topic to these meetings
19 in the first month?
20 MR. SABETTA: Objection to the form. You
21 can answer it.
22 A. General topic was what effect, if any, the
23 PCBs that were being reported as being in the
24 environment could cause, some effect somewhere.
25 Q. Were these discussions of human health

1 effects?

2 A. Well, that was the basis, and we picked it
3 up from that after they brought me up to speed on human
4 health.

5 Q. Did they assign you readings?

6 A. Readings?

7 Q. Yes.

8 A. Oh, certainly. Yes.

9 Q. What did they tell you about the effects on
10 human health at that time when they brought you up to
11 speed?

12 A. I don't remember the specifics, but the
13 general impression was one of after decades of the use
14 of these materials with the firm belief that they were
15 innocuous no information had developed to cause any
16 concern regarding illnesses, the toxic effects on
17 humans, as long as they did not overly expose
18 themselves.

19 Q. Whose firm belief was that?

20 MR. SABETTA: Objection to the form.

21 Q. Withdrawn. You mentioned firm belief in
22 your answer. What firm belief or whose firm belief were
23 you referring to?

24 A. Well, I would suggest to you that anybody
25 who even knew what PCBs were had that belief.

1 Q. Can you tell me what you were referring to
2 when you referred to a firm belief in your last answer?

3 A. A firm belief was that PCBs, if used with
4 respect, have not and are not expected to cause serious
5 human health problems.

6 Q. Did Dr. Kelly tell you that?

7 A. Yes.

8 Q. Did Mr. Wheeler tell you that?

9 A. Yes.

10 Q. Did you read any Monsanto documents at that
11 time that said that?

12 A. I believe I did, yes.

13 Q. Do you recall what the titles of the
14 documents were?

15 A. No, I don't.

16 Q. Did it have a title that pertained to PCBs?

17 A. Certainly the documents I read involved
18 reference to PCBs.

19 Q. You don't recall what the titles were of
20 those documents?

21 A. There were so many, sir, that -- Some had
22 product titles; some had use titles.

23 (Reporter marked Plaintiff's Exhibit No.
24 375.)

25 Q. I'm showing you Exhibit 375 for

1 identification, Mr. Papageorge. It reports to be
2 Monsanto's responses to interrogatories on this matter.
3 And I'd ask if you had seen that document before.

4 (Reporter marked Plaintiff's Exhibit No.
5 376.)

6 A. I have scanned the document, and I just do
7 not recall ever having seen this before.

8 Q. All right. If you'll look at question 36
9 for me, at page 29, that says, "Set forth the name and
10 present address of the person most familiar with the
11 following: (a) The manufacture of the product
12 Aroclors; (b) The design of said product; (c) The
13 safety aspects of said product; (d) Advertisement and
14 promotion of said product." And if you look at the
15 response, after the objection, it says that you are the
16 most familiar with the manufacture of the product. Do
17 you see that?

18 A. I see it.

19 Q. Do you agree with that?

20 MR. SABETTA: Objection to the form.

21 Q. I'll withdraw it. Are you the most
22 familiar with the manufacture of Pyranol?

23 MR. SABETTA: Same objection.

24 Q. In the Monsanto Company?

25 A. I don't picture myself as being the most

1 familiar, no, sir.

2 Q. Are you the most familiar with the
3 manufacture of Aroclor 1254 in the Monsanto Company?

4 A. Again, I can think of individuals who can
5 give you much more in the way of specifics regarding the
6 manufacturing process.

7 Q. What about the -- Withdraw that. Can you
8 give me the name of individuals who could give me that
9 information with respect to 1970?

10 A. I'm trying to recall the names of the
11 individuals at the manufacturing plants who supervised
12 the manufacturing process and were familiar with all the
13 details, temperatures, pressures, flows and so on.
14 1970. No specific name comes to mind.

15 Q. What about the chemical characteristics of
16 the product Aroclor 1254 as of 1970? Who would be the
17 most familiar?

18 A. Will you help me with the expression
19 "chemical characteristics"?

20 Q. I was hoping you would help me with that
21 expression. You mentioned things like flows and
22 temperatures and things of that sort in your answer. I
23 wanted to know who might be the most familiar in 1970
24 with the properties of Aroclor 1254 as to them being
25 inert, perhaps, or not oxidizing perhaps or not

1 hydrolyzing perhaps, or things like that.

2 MR. SABETTA: Objection to the form.

3 MR. GRONDAHL: Object to the form.

4 MR. SABETTA: I just observe that my
5 understanding of Mr. McDonough's question encompasses
6 several different areas, chemical characteristics,
7 process characteristics, and properties of the compound,
8 all of which to me are quite different. So I object to
9 the form of the question as it's been put. If you can
10 answer it, go ahead.

11 A. Well, I heard references to temperatures
12 and flow rates, and all of those are manufacturing
13 parameters that the supervisor and his foreman in that
14 department would know because that is their job. It is
15 not something that a person in my position would need to
16 know.

17 Q. But you don't know anybody in the company
18 that would know about properties of Aroclor 1254 as to
19 it being inert?

20 A. Now, the physical and chemical properties,
21 I would personally go to a research person. And, again,
22 I can't at the moment recall an individual because this
23 has been decades ago.

24 Q. Okay. Do you know that Aroclor 1254 is
25 generally considered to be inert?

1 MR. SABETTA: Objection to form.

2 A. I have difficulty with understanding the
3 word "inert".

4 Q. Well, did you ever have an understanding
5 that Monsanto's understanding was that this chemical was
6 going to be like pebbles on the beach?

7 A. Yes. Yes. Yes.

8 Q. In fact, you've used that phrase before;
9 haven't you?

10 A. I have. I invented it.

11 Q. What did you mean by "pebbles on the beach"
12 when you invented that phrase?

13 A. I was referring to the fact of presence and
14 health effects, human health effects.

15 Q. You say when you were referring to the term
16 "pebbles on the beach", you were referring to presence
17 and human health effects?

18 A. Yes.

19 Q. In what fashion were you referring to it?

20 A. Well, the pebble is there on the beach.
21 It's present. And unless you stump your toe or
22 something, it's not going to affect you as a human
23 being.

24 Q. As an organic chemist with a Master's
25 degree, did you understand from the molecular structure

1 of this chemical that it was inert?

2 MR. GRONDAHL: Object to the form.

3 MR. SABETTA: Same objection.

4 A. I am not saying it's inert, uh-uh.

5 Q. What does inert mean?

6 A. To me, it means it's nonreactive and it
7 causes no effect. It's just present.

8 Q. Isn't that what Monsanto thought the
9 chemical was, A-1254, from 1931 up till 1966?

10 MR. SABETTA: Objection to form.

11 A. Again, I have trouble fitting the word
12 "inert" because Monsanto did say, "Don't get it on your
13 skin. It's going to get chapped hands effect. Don't
14 breathe it. It will hurt your breathing." So it's not
15 inert in that definition of the word "inert".

16 Q. Do I understand it's not a pebble on the
17 beach?

18 MR. SABETTA: Objection to form.

19 A. I still think it is. It's there. Just
20 avoid the pebble and go around it.

21 Q. How big is this pebble?

22 MR. SABETTA: Objection to form.

23 MR. GRONDAHL: Objection.

24 A. I was just using that as a figure of
25 speech.

1 Q. Did Monsanto ever test these pebbles by
2 heating them that you know of?

3 MR. SABETTA: Objection to form.

4 MR. GRONDAHL: Objection.

5 A. I need more help with the word "testing by
6 heating".

7 Q. What is unclear with my phrase "testing by
8 heating"?

9 A. I can give you a scenario where you take
10 test animals, heat Aroclor till it becomes a vapor and
11 then you expose these test animals and see what happens.

12 Q. What about taking the Aroclor and applying
13 heat to it and determining what its combustion products
14 or pyrolysis products were?

15 MR. SABETTA: Objection to the form.

16 Q. Did Monsanto do that?

17 A. No.

18 Q. Do you know why not?

19 A. There was no information of any kind to
20 lead anybody in the world, not just Monsanto, to conduct
21 such a study. Why would you do it? There's no evidence
22 that there's a harm being observed.

23 Q. What about people in Monsanto who are most
24 familiar with adverse human health effects or biological
25 effects on animals of Aroclor 1254? Do you know anyone?

1 A. That would have been members of Monsanto's
2 Corporate Medical Department.

3 Q. What about now? Does it still have a
4 Corporate Medical Department?

5 A. They have the department.

6 Q. Where is this Corporate -- Well, withdraw
7 it. Where was this Corporate Medical Department in
8 1969, 1970? Was it in the --

9 A. It was in St. Louis.

10 Q. Was it in the same building that you were
11 in at the time of your assignment?

12 A. No.

13 Q. Was it on the same campus?

14 A. Yes.

15 Q. Did Monsanto have a Research and
16 Development Department at that time in 1969/70?

17 A. Yes.

18 Q. Where was that located?

19 A. On the St. Louis campus.

20 Q. Who was the head of that department in 1965
21 through 1975?

22 A. As best as I recall, it was Monte Throdal,
23 who was the Vice President of Research. M-O-N-T-E
24 T-H-R-O-D-A-L.

25 Q. Is ~~he~~ still alive?

1 A. Yes.

2 Q. Did that department have a library
3 associated with it?

4 A. Yes.

5 Q. How extensive a library? Have you ever
6 seen it?

7 A. I am not qualified to measure extent. It
8 was a -- It was an excellent library as far as I could
9 tell.

10 Q. What about a medical library? Did the
11 Corporate Medical Department have a medical library?

12 A. Yes.

13 Q. How extensive a library was that?

14 A. I have no idea of the number of volumes
15 they had or...

16 Q. With respect to Pyranol or Aroclor 1254,
17 did that medical library gather information on those
18 particular chemicals?

19 A. I'm aware that they gathered information on
20 Aroclor 1254 as a PCB. I am not aware of any library
21 information available for Pyranol per se.

22 Q. Did Pyranol in 1969, 1970, contain other
23 chemicals than Aroclor 1254?

24 A. Yes.

25 Q. Do you know what other chemicals it could

1 contain at that time period?

2 A. I know they contained a mixture of tri and
3 tetrachlorobenzene, and they also contained other
4 ingredients that I don't remember now, but they were
5 intended to, for example, scavenge any free chlorine
6 that might still be in there. Also, as best I recall,
7 there was an attempt to give it a color, a dye
8 ingredient, and I don't propose to tell you that I know
9 all the ingredients in the recipe.

10 Q. Do you know where tri/tetrachlorobenzene
11 came from?

12 A. Yes.

13 Q. Where?

14 A. Hooker Chemical Company.

15 Q. Do you know what the qualities or chemical
16 products of trichlorobenzene were that caused them to be
17 used in this blend?

18 A. I don't know today, no, but there were
19 pretty stringent specifications.

20 Q. Did Monsanto buy that chemical from Hooker
21 Chemical when they blended the Pyranol at their plants?

22 A. Yes.

23 Q. Did you do any testing on that chemical
24 tri/tetrachlorobenzene?

25 A. Yes.

1 Q. What tests did you do?

2 A. I don't remember the details, but samples
3 were taken, and if they passed the criteria that were in
4 place at the time, the shipment would be accepted. If
5 not, it would be returned.

6 Q. Do you know whether the chemical was ever
7 heated by Monsanto and its pyrolysis products tested?

8 A. No.

9 Q. Do you know whether Monsanto ever
10 ascertained that dioxins pyrolyzed from
11 tri/tetrachlorobenzene?

12 MR. SABETTA: At any time?

13 MR. McDONOUGH: At any time.

14 MR. SABETTA: Up to the present.

15 A. I'm not aware of any studies of that kind,
16 but I cannot speak for recent years. I don't know.

17 Q. When did you retire from Monsanto?

18 A. The end of 1986.

19 Q. Can you tell me, by "recent years," can you
20 tell me what are recent to you?

21 A. The '80's and '90's.

22 Q. After Dr. Kelly retired, who became Medical
23 Director of Monsanto?

24 A. Dr. George Roush, R-O-U-S-H.

25 Q. Do you know when that was about?

1 A. I don't recall the exact year. I'm going
2 to suggest about 1974.

3 Q. How long did Dr. Roush remain as Medical
4 Director?

5 A. Again, I don't know the exact date. I was
6 retired by then, so it would have to be after 1986.
7 That's as close as I can get to it.

8 Q. Do you know if Dr. Roush is still alive?

9 A. Yes.

10 Q. Do you know where he lives?

11 A. No, I don't.

12 Q. Do you know if he lives in the St. Louis
13 area?

14 A. Yes, he does.

15 Q. Do you know if he still practices medicine?

16 A. He does not.

17 Q. Do you know how old he is about?

18 A. About 70.

19 Q. Who became the Medical Director after
20 Dr. Roush?

21 A. I don't know.

22 Q. I'm showing you Exhibit 376 for
23 identification, which purports to be Responses and
24 Objections of Monsanto to Plaintiffs' Notice to Produce
25 and ask you to take a look at that for me, if you would,

1 please. I'm going to ask you if you've ever seen the
2 document before, and I'm particularly interested in the
3 response at 19. Have you had a chance to look at that?

4 A. I have scanned it.

5 Q. Have you seen it before?

6 A. I don't recall ever seeing this.

7 Q. Could we take a look at 19, please? Now,
8 in 19, I ask for any memos and correspondence to and
9 from Monsanto Chemical Company from 1930 through 1975
10 regarding health and/or environmental effects and/or
11 toxicity of chlorinated diphenyls, chlorinated
12 biphenyls, Inerteen, Aroclors and Pyranols including,
13 without limiting the foregoing." The response after
14 some objections is Monsanto states that documents
15 responsive to this request will total in excess of 30
16 bankers boxes of documents, and then there's an offer to
17 make them available to the plaintiff. Do you see that?

18 A. Yes.

19 Q. When you started your job in 1970, was
20 there in excess of 30 bankers boxes of documents in the
21 libraries that you were looking at?

22 MR. SABETTA: Object to the form of the
23 question.

24 A. No. I did not personally see 30 boxes of
25 information.

1 Q. How much information did you see in this
2 tutorial program that you've told me about?

3 A. As best I recall, there was two three-ring
4 notebooks about three inches in contents.

5 Q. Did those two three-ring notebooks have a
6 title?

7 A. No.

8 Q. Do you know who prepared them?

9 A. Yes.

10 Q. Who?

11 A. Elmer Wheeler.

12 Q. Do they still exist?

13 A. I don't know.

14 Q. Did they have any summaries associated with
15 them?

16 A. There were summary paragraphs on some of
17 the pages, yes.

18 Q. Could you describe for me what you mean by
19 summary paragraphs on some of the pages?

20 A. I recall paragraphs that would refer to an
21 article or a study by author and date and summarize what
22 was concluded from the study.

23 Q. And that would be in the beginning of the
24 book, the three-ring binder?

25 A. That would be scattered throughout the

1 book. As I remember, they were in the book
2 chronologically depending on when the article first
3 appeared.

4 Q. Do you recall what the first article was?

5 A. Something in the 1930's, but I don't
6 remember the specific article.

7 Q. How about Drinker?

8 A. Drinker was one of them, but I don't know
9 if that was the first article. It was one of the
10 earlier articles, yes.

11 Q. How long did you work in that position?

12 A. Which position, sir?

13 Q. The last position you gave me was Manager
14 of Environmental Control.

15 A. About 1973 my title was changed to I
16 believe it was Manager, Environmental Protection.

17 Q. Did your duties change?

18 A. In a way. They did not change with regard
19 to PCBs.

20 Q. Okay. In what way did they change?

21 A. I was given additional products of Monsanto
22 to monitor and advise on and become familiar with.

23 Q. Did Monsanto have anybody with that title,
24 Manager of Environmental Protection, before you?

25 A. Not to my knowledge.

1 Q. How long did you perform that title?

2 A. I'm not certain of my dates here. '73 may
3 be too late. But, nevertheless, a couple of years for
4 the environmental protection title.

5 Q. Do you know whether the duties of that
6 title were ever put in writing?

7 A. I never saw it in writing.

8 Q. What was your next title?

9 A. Manager of Product Acceptability.

10 Q. Did your duties change with the assumption
11 of that new title?

12 A. They changed only in the types of products
13 I was held responsible for, but I still, as best I
14 recall -- Yes, I still kept the PCB activity.

15 Q. Were your other products that apparently
16 you got involved with products involving issues of
17 environmental concern or concern on biological effect?

18 A. Not necessarily.

19 Q. How did it happen that you got involved in
20 them?

21 MR. SABETTA: Objection to form. You can
22 answer it.

23 A. As I recall, Monsanto had reorganized into
24 separate operating units, and each of those units had a
25 Manager of Product Acceptability, so the products

1 assigned to those units were also assigned to this
2 Manager of Product Acceptability within the major unit.

3 Q. What unit were you assigned to at that
4 time?

5 A. As best I recall, it was Monsanto
6 Industrial Chemicals Company.

7 Q. How long did you function in that job
8 title?

9 A. Until the next reorganization.

10 Q. Which was about when?

11 A. A couple, three years later.

12 Q. Would that be about 1977?

13 A. '76, '77, somewhere in there.

14 Q. What was your title?

15 A. I had the same title of Manager, Product
16 Acceptability, for the Monsanto Intermediate Chemicals
17 Company.

18 Q. Did that job title include PCBs?

19 A. Yes. The PCBs, of course, were assigned to
20 a different company, but the environmental issue was
21 still me, was assigned to me.

22 Q. What different company was PCBs assigned
23 to?

24 A. I'm a little confused at this moment
25 recalling the Industrial Chemicals Unit and the

1 Intermediate Chemicals Company and the timing.

2 Q. Now, I believe you mentioned -- Withdraw
3 that. Had Monsanto discontinued production of PCBs at
4 that time when you took that assignment?

5 A. I think we're still talking about an era
6 before 1977; aren't we?

7 Q. I thought you took this new position in
8 1977. Perhaps not. Maybe I misunderstood. Let me
9 withdraw it and make it less difficult. At some point
10 did Monsanto discontinue manufacturing and selling PCBs?

11 A. Yes.

12 Q. Do you know about when that was?

13 A. The summer of 1977.

14 Q. Did you continue to work with respect to
15 environmental issues on PCBs after Monsanto discontinued
16 their manufacture and sale?

17 A. No. I had been -- It had been reassigned
18 earlier than that.

19 Q. Meaning you had been reassigned earlier
20 than that?

21 A. Yes.

22 Q. Okay. What were you assigned to earlier
23 than the discontinuance of the PCB manufacture?

24 A. I was given, and I don't remember all of
25 them, a whole series of products which were the

1 responsibility of the operating unit, which at this
2 moment I can't recall whether it was Industrial
3 Chemicals or Intermediate Chemicals. But in February of
4 '76, the PCB issue role was transferred to another
5 individual.

6 Q. Who was that?

7 A. J. C. Webber.

8 Q. Is Mr. Webber still alive?

9 A. I think, yes.

10 Q. Does he still live in the St. Louis area?

11 A. As far as I know.

12 Q. Does he still work for the company? Do you
13 know?

14 A. No.

15 Q. Do you know how long Mr. Webber continued
16 in that position?

17 A. Not specifically. I would suggest that he
18 monitored the activities for a couple, three years.

19 Q. Do you know what happened after a couple,
20 three years with respect to that activity?

21 A. I think Mr. Webber sort of broadly covered
22 it, but the activity had diminished to the point where
23 nothing really was going on.

24 Q. Now, as I understand it, you seem to have
25 stopped your involvement with PCBs in about 1976 or

1 thereabouts?

2 A. Yes.

3 Q. And you continued to work for the company
4 until 1986?

5 A. Yes.

6 Q. Can you tell me what you did between 1976
7 and 1986? Just generally. Did you have different
8 titles? What generally were your duties?

9 A. Yes. I was made a Director of
10 Environmental Operations for one of those operating
11 units we discussed earlier, which involved all
12 activities within those operating units that would or
13 could relate to the environment. All the chemicals, all
14 the products, the shipping, trash disposal, the whole
15 bit.

16 Q. Did any of that work entail PCBs?

17 A. PCBs as a presence in the plants, yes, but
18 not with respect to government or customers.

19 Q. Did you meet with any government
20 authorities during this 1976 through 1986 time period
21 with respect to PCBs?

22 A. I met in November of '76 as a committee
23 member of the National Institute of Occupational Safety
24 and Health, N.I.O.S.H., N-I-O-S-H. This committee was
25 --

1 Q. I'll ask you to describe it later if I
2 think it's really relevant. I'm more interested in
3 getting a framework right now, if I can. I understand
4 that I was asking about a roughly ten-year period, '76
5 through '86 in terms of meeting with government agencies
6 or authorities, and you've told me about N.I.O.S.H. in
7 November of 1976. Any others?

8 MR. SABETTA: This relates to PCBs or in
9 general?

10 Q. Yes. Which relates to PCBs, yes.

11 A. I don't recall any other activity of that
12 type.

13 Q. Now, did you have any other job titles with
14 Monsanto before you retired?

15 A. The job titles did not change.

16 Q. In terms of your work in the last ten
17 years, did you deal with any incineration or disposals
18 of PCBs?

19 A. Not directly.

20 Q. Had Monsanto set up a division or part of
21 its operation that incinerated PCBs?

22 A. There was an incinerator installed by
23 Monsanto and operating in the early part of that period,
24 up through '77.

25 Q. Okay. Do you know how long a period that

1 incinerator was operating?

2 A. Yes. From about 1970, about the middle of
3 1970 to the middle of 1977.

4 Q. You know why it stopped operating in 1977?

5 A. Well, the production of PCBs was
6 terminated, and the amount of material being returned
7 had reduced to the point where it was perceived not to
8 be needed any longer because there were commercial units
9 available.

10 Q. Were there commercial incineration units
11 available in 1977?

12 A. Yes.

13 Q. Wasn't there a permitting process necessary
14 for those commercial incineration units?

15 A. I'm not familiar with the details of their
16 operations.

17 Q. Do you know who was in charge of the
18 disposal of PCBs for Monsanto's corporate operations?

19 MR. SABETTA: Objection to form.

20 Q. I'll withdraw it. Was anyone in charge of
21 disposals of PCBs by incineration at Monsanto?

22 A. The Monsanto employee who was responsible
23 for an activity that resulted in PCBs that were no
24 longer usable and must be discarded was expected to
25 dispose of those PCBs in a responsible manner. If this

1 involved sending it to Monsanto's incinerator, all
2 right. If it involved going to a nearby approved
3 commercial incinerator, that's all right, too. Or if it
4 involved perhaps even sending it to Monsanto to refine,
5 to run it through the system and clean it up and make it
6 useful again, that was acceptable. So it was a
7 decision, a judgment call really on the part of the
8 individual held responsible for that so-called waste
9 material.

10 Q. Are you telling me no one was in charge of
11 supervision of the disposal or incineration of waste
12 material?

13 A. There were hundreds responsible. I don't
14 know how to describe it.

15 Q. Who was at the top?

16 A. The president of Monsanto.

17 Q. Was there any job title associated with
18 disposal or destruction of PCBs in the Monsanto system?

19 A. No.

20 Q. Okay. If you take a look at Exhibit 375
21 for me, page six, there's a question as to products sold
22 to General Electric and response by Monsanto for the
23 1970-1977 time period. Would you take a look at that
24 question and answer, please?

25 MR. SABETTA: The question starts on page

1 five and continues on page six.

2 Q. Do you know whether there was a particular
3 blend of Pyranols sold to Rome, Georgia, during the 1970
4 through '71 time period?

5 A. No, I do not.

6 Q. I'm showing you Exhibit 331. It's been
7 marked earlier with another witness. It purports to be
8 a General Electric document on their letterhead dated
9 October 15th, 1995. I'm sorry. 1975. Subject Pyranol
10 formulations, MTPD, Rome, Georgia. It purports to set
11 forth a schedule as to products and years that the
12 products were used. Would you take a look at that,
13 please?

14 MR. GRONDAHL: What's the number on it?

15 MR. SABETTA: 331 is the exhibit number.

16 Q. Now, with respect to 1970, it has an
17 Aroclor 65 percent 1254, 23 percent trichlorobenzene,
18 and 12 percent tetrachlorobenzene. Do you see that?

19 A. I do.

20 Q. Do you know what product designation that
21 was?

22 A. I do not.

23 Q. Now, it also references in year 1993 a
24 product called A13B3B with a footnote saying that that
25 was also used from September '69 through October 1970.

1 Do you see that?

2 A. I do.

3 Q. Now, that product is apparently a 45
4 percent Aroclor 1260 blend with other products; is that
5 correct?

6 A. That's what this says, yes.

7 Q. Are you familiar with these blends?

8 A. No. Today, no.

9 Q. Is that an area outside your field of
10 expertise?

11 A. Yes.

12 (Reporter marked Plaintiff's Exhibit No.
13 377.)

14 Q. I'm showing you an exhibit I've marked 377
15 for identification. It purports to be a memo of data
16 transmitted from General Electric Medium Transformer
17 Department, Rome, Georgia, with a box checked for
18 installation and a date of March 22nd, 1971 on it.
19 Would you take a look at that for me, please? I'm
20 interested in the designation of Pyranol set forth on
21 the inside of that particular exhibit. I'll see if I
22 can help you find it. (Indicating.) What is that
23 designation of Pyranol shown on that exhibit?

24 A. What is it?

25 Q. Yes.

1 A. A13B3B.

2 Q. Do you know what the contents of that
3 particular Pyranol is?

4 A. No, I don't have the recipe in front of me.

5 Q. Do you know whether that designation of
6 Pyranol was being blended by Monsanto in that time
7 period shown in that exhibit, March of 1971?

8 A. I would say, yes, they did it.

9 Q. Would there be a particular plant involved
10 in that?

11 A. Anniston, Alabama.

12 Q. Now, did it come to your attention that at
13 some point there was a change in the formulation so that
14 tetrachlorobenzene was deleted from the formula provided
15 by General Electric?

16 MR. GRONDAHL: Object to the form.

17 A. Well, on occasion, I would get information
18 that would indicate changes in these formulations. I
19 don't remember the exact change and the timing of that
20 change.

21 Q. In terms of the formulations, did Monsanto
22 design those formulations, or did someone else?

23 A. Monsanto did not design.

24 Q. Who designed them?

25 A. That I don't know. All I know is General

1 Electric sent it to us and said, "This is what we want."

2 Q. Did you receive correspondence and
3 communications from General Electric setting forth the
4 quantities of chemicals to be contained in that blend to
5 be made by Monsanto?

6 A. Oh, yes. It's a form that they send us.

7 Q. It came from General Electric?

8 A. Yes.

9 Q. Is that correct?

10 A. Yes.

11 Q. I asked if you had any recollection of the
12 blend from General Electric changing to eliminate
13 tetrachlorobenzene.

14 A. I don't remember that specifically, no.

15 Q. I want to show you Exhibit 373 that's been
16 previously marked for identification. It's entitled
17 "Transformer Pyranol Blends, Pittsfield," and I'd ask
18 you if you would take a look at that for me, please. If
19 you look at the page marked four, it's the second page
20 of the document, it has a heading April '72, "Change
21 from Hexachlor No. 1260 to Pentachlor No. 1254 biphenyl.
22 Change initiated by Monsanto for ecological reasons."
23 Do you see that?

24 A. I do.

25 Q. Do you know anything about that topic?

1 A. Yes.

2 Q. Can you tell us what you know about that?

3 A. Monsanto's information at that point in
4 time was that the higher chlorinated PCBs were those
5 that were being found in the environment. People within
6 Monsanto discussed with individuals at General Electric
7 the possibility of discontinuing the use of Aroclor
8 1260, which was not a high volume Aroclor, for
9 transformer use, and revise their formulations to
10 introduce the use of Aroclor 1254. I personally was
11 involved in discussions with General Electric
12 representatives in this area, and the impression was
13 definitely one of, "It's okay with us." So in April of
14 '72, it was finally implemented, and Aroclor 1260 was no
15 longer manufactured.

16 Q. When you say "Okay with us," you're
17 referring to General Electric?

18 A. With the individuals in General Electric
19 that I was talking to.

20 Q. Who was that?

21 A. Ed Raab.

22 Q. Anyone else that you recall?

23 A. No. Ed Raab was my principal contact, and
24 he was it as far as I was concerned.

25 Q. Do you remember what Mr. Raab's title was?

1 A. I never did know it.

2 Q. It's R-A-A-B?

3 A. Yes.

4 Q. Did you know whether findings had been made
5 as to the presence of Aroclor 1254 in the environment at
6 that time?

7 A. Oh, sure. Yes.

8 Q. Weren't most of the findings indicative
9 that primarily it was 1254 in the environment rather
10 than 1260?

11 MR. SABETTA: Objection to form.

12 MR. GRONDAHL: Object to form.

13 A. The indications, yes, that's correct.

14 Q. Do you have any recollections of
15 discussions with Westinghouse and Westinghouse going to
16 1242 as opposed to 1254?

17 MR. SABETTA: Objection to form.

18 A. I recall discussions with Westinghouse
19 representatives, and, as I recall, they always had an
20 interest in 1242 because they, for reasons unknown to
21 me, were avoiding the use of chlorobenzenes.

22 Q. Could you spell that word for me, please?

23 A. Chlorobenzenes. C-H-L-O-R-O-B-E-N-Z-E-N-E.

24 Q. You don't know why they were avoiding the
25 use of chlorobenzenes?

1 A. I was never told. But with using 1242,
2 they didn't need the diluent in chlorobenzenes.

3 Q. Were there also changes made in terms of
4 the Aroclors that were marketed wherein 1016 was used?

5 MR. SABETTA: Objection to form.

6 MR. GRONDAHL: Objection.

7 A. Oh, yes. Those were -- We're now talking
8 about another PCB used for a different electric purpose.

9 Q. When was that? Let me withdraw that. What
10 electric purpose are you referring to?

11 A. The use in capacitors.

12 Q. Had PCBs been used in capacitors in the
13 past?

14 A. Yes.

15 Q. And what PCBs were used in capacitors in
16 the past going up through 1972?

17 A. Aroclor 1242, Aroclor 1232, and Aroclor
18 1221.

19 Q. At some time was there an Aroclor designed
20 for use in capacitors sold by Monsanto?

21 A. Yes.

22 Q. What Aroclor was that?

23 A. It was called Aroclor 1016.

24 Q. Now, as I understand it, Aroclor 1254
25 connotes a 54 percent chlorine content?

1 A. Yes.

2 Q. And Aroclor 1242 connotes a 42 percent
3 chlorine content?

4 A. Yes.

5 Q. What does 1016 connote?

6 A. It has no relationship to the amount of
7 chlorine present in the product.

8 Q. How much chlorine is present in the
9 product, 1016?

10 A. About 41 percent, 42 percent.

11 Q. Had there been studies done up to that
12 point as to that Aroclor being more biodegradable than
13 1242?

14 A. Yes.

15 Q. What studies had been done?

16 A. Well, Monsanto had its own studies, which
17 indicated that the 1016 would be destroyed or consumed
18 in an activated bacteria sludge just like you find in
19 waste treatment plants throughout the country.

20 Q. Did Monsanto do studies on 1254 as well
21 about the same time?

22 A. Yes.

23 Q. What did they find out with respect to
24 biodegradability of 1254?

25 A. They found that the higher chlorinated PCBs

1 would resist degradation. They were still there after a
2 long period of time.

3 Q. About when were these studies conducted on
4 1016 and 1254?

5 A. Oh, they were ongoing. They were started
6 in 1971 and ongoing in 1972.

7 Q. Were you aware of Monsanto having started
8 the studies of biodegradability of 1254 back in the
9 1930's?

10 A. That's the first I heard of that.

11 Q. Have you heard anything as to burying 1254
12 in Florida and digging it up 30 years later and finding
13 it not biodegraded?

14 A. Yes. I was involved in that.

15 Q. What was your involvement?

16 A. Well, I was following that activity closely
17 with one of our research people.

18 Q. About when was the 1254 excavated?

19 A. Late 1970.

20 Q. All right. And what was the purpose of
21 doing the excavation? Do you know?

22 A. To see if they were still detectable.

23 Q. How did it come about that 1254 was buried
24 in the first place? Do you know?

25 A. There was an experiment conducted in which

1 PCBs were used along with other chemicals to treat wood
2 for use as fence posts. In other words, to permeate the
3 post with the chemicals. And these posts were inserted
4 into the ground down in Florida, and the Monsanto
5 individual who was involved remembered that study, and
6 it occurred to him that perhaps we could go and take
7 samples and see if the PCBs were still detectable.
8 That's how that came about.

9 Q. What was the purpose of burying the fence
10 posts to begin with in terms of doing a study?

11 A. To see how long the fence posts would last
12 with that particular material below ground.

13 Q. Going to the last entry on that exhibit in
14 front of you, 373, it says, "November of '73 changed
15 from tri/tetrachlorobenzene to trichlorobenzene; change
16 initiated by Hooker Chemical Co. because ban on
17 Hexachlorophene put a stop to production of TTCB."
18 Close quote. Do you see that?

19 A. I do.

20 Q. Do you know anything about that change
21 initiated by Hooker?

22 A. I was aware of the change, and I related it
23 to the almost unavailability of the tri/tetra mixture.

24 Q. This says ban on Hexachlorophene; does it
25 not?

1 A. Yes.

2 Q. Were you familiar with a ban on
3 Hexachlorophene at about that time?

4 A. I'm aware of it, yes.

5 Q. What can you tell me about that?

6 A. There was a problem associated with
7 Hexachlorophene. The government got involved and banned
8 it.

9 Q. What was the problem? Do you recall?

10 A. I haven't thought about this for 50 years.

11 Q. Was it dioxin?

12 A. I don't know. I don't know that the word
13 "dioxin" existed then as popular as it was later.

14 Q. What do you know about the existence of the
15 word "dioxin"?

16 MR. SABETTA: Objection, form.

17 Q. Or is it just the popularity of it that
18 you're referring to?

19 MR. SABETTA: Objection to the form.

20 Q. Withdrawn. Are you telling me that you
21 don't know if the word "dioxin" was known in November
22 1973?

23 A. The word was known. The studies were
24 limited. When I first heard about it, it was referred
25 to as Agent X.

1 Q. Who referred to it as Agent X?

2 A. The medical and toxicology community.
3 There's no one person.

4 Q. When did you first hear about it?

5 A. It was during my tutorial with Mr. Wheeler.

6 Q. And what did he tell you?

7 A. He told me there's some stuff out there
8 that is affecting chickens, and he even showed me a
9 photograph of a chicken walking down a corridor with a
10 drooped wing and with a bloated chest.

11 Q. Did he tell you about any studies out there
12 as to dioxins affecting workmen?

13 A. No. There were none to report.

14 Q. Excuse me?

15 A. There were none that he could report on.

16 Q. Is that what he told you?

17 A. Yes.

18 Q. Did Monsanto have a plant at Nitro, West
19 Virginia?

20 A. Yes.

21 Q. Was there an explosion at that plant in
22 1949?

23 A. Yes.

24 Q. And were there complaints by the workmen
25 that they had become ill?

1 A. Yes.

2 Q. Were there studies done by dermatologists
3 relating to the illness through exposure to dioxin?

4 A. Yes.

5 Q. Were those studies done in the '50's?

6 A. Well, your use of the word "studies"
7 differs from mine. A study is a planned program with
8 the protocols and dosages and times of exposure. This
9 was just an evaluation and an attempt by individuals to
10 try to find the source of the problem. So when you said
11 study, that meant something different to me.

12 Q. And these evaluations and attempts by
13 individuals to try to find the source of the problem,
14 were those attempts by Monsanto individuals or by
15 others?

16 A. I know the Monsanto individuals were
17 involved. I don't know about others.

18 Q. Did you say were not or were?

19 A. Monsanto individuals were involved, but I
20 don't know if others were also involved.

21 Q. What Monsanto individuals were involved?

22 A. Oh, gosh. I never knew the people. I
23 don't know.

24 Q. How about Dr. Kelly? Did you know
25 Dr. Kelly?

1 A. But I don't know if he was personally
2 involved. The plant physician may have done it. I
3 don't know.

4 Q. How about Mr. Wheeler? Did you know
5 Mr. Wheeler?

6 A. Yes.

7 Q. Do you know if he was personally involved?

8 A. I don't know.

9 Q. Did you ever see any documents passing to
10 Mr. Wheeler and Dr. Kelly with respect to this Nitro,
11 West Virginia exposure and the question of dioxin?

12 A. I have not.

13 Q. They didn't tell you about that in your
14 tutorial when you took over?

15 A. They told me about the incident, but they
16 didn't show me a document.

17 Q. Did Monsanto manufacture Hexachlorophene?

18 A. Not to my knowledge.

19 Q. Do you know what Monsanto manufactured at
20 Nitro, West Virginia?

21 MR. SABETTA: Objection to form. I think
22 you have to give him a date or some period of time.

23 Q. 1949.

24 A. I don't know.

25 Q. Do you know what they manufactured in 1950

1 at Nitro, West Virginia?

2 A. I don't know.

3 Q. Do you know what the purpose of the
4 tri/tetrachlorobenzene was in the Pyranol?

5 A. I can share with you my understanding.

6 Q. Is this an understanding told to you or
7 something that you researched on your own? Let me
8 withdraw that. What was the basis of your understanding
9 before I ask whether I want to hear it?

10 A. It has to do with the physical and chemical
11 properties of the chemicals involved.

12 Q. Wasn't this an area that you weren't
13 familiar with earlier? Did I understand you?

14 A. I'm confused.

15 MR. SABETTA: Just a second. The last
16 question that Mr. McDonough put to you was different
17 than the one you answered, I believe. He asked you what
18 the source of your knowledge was about the reasons for
19 using tri or tetrachlorobenzene in Pyranol. What were
20 the sources of your information about that? That's what
21 I think he asked you.

22 Q. I'll ask a new question because I'm lost.
23 What was your understanding as to the purpose of the
24 tri/tetrachlorobenzene in the Pyranol?

25 A. For reasons unknown to me, General Electric

1 preferred the use of Aroclor 1254 and 1260 in their
2 transformer fluids. Those PCBs are rather viscous. To
3 become more fluid, they had to blend this chlorinated
4 benzene mixture at the same time they wanted to retain
5 the fire resistance of the total mixture, and then there
6 was a cost consideration involved where the material
7 from Hooker was pound to pound cheaper than the PCB, so
8 it was an economic as well as a fire resistant, as well
9 as a fluidity question to be answered.

10 Q. What is the source of your information in
11 that regard?

12 A. I can't pinpoint any particular person. To
13 me, it was just sort of general knowledge.

14 Q. Well, you mentioned economics as being one
15 of the factors and viscosity being another factor. If
16 the material PCBs was too viscous to be used in the
17 transformer, how did economics have to do with that?

18 MR. SABETTA: Objection to the form. I
19 don't understand the question. If you do, you can
20 answer it.

21 A. Well, the competition was willing to use a
22 different PCB that did not require dilution with a more
23 fluid material.

24 Q. And that competition would be Westinghouse?

25 A. That's one of them.

1 Q. Was there other competition besides
2 Westinghouse that used Aroclor other than 1254 or 1260
3 at that time?

4 A. Yes.

5 Q. Can you tell me who that was?

6 A. I'm certain I'm not going to remember all,
7 but I recall an Allis-Chalmers activity. At the moment
8 I can't recall anymore.

9 Q. Do you know of any other transformer
10 manufacturers at about that time that were using 1254
11 other than General Electric?

12 A. There were others, but I'm at a loss to try
13 and recall the names of these entities. I just can't
14 remember them.

15 Q. Had Monsanto required an indemnity
16 agreement by the transformer manufacturers at that point
17 in time, 1973, before they would sell them --

18 A. Yes.

19 Q. -- 1254 or any Aroclor?

20 A. Yes.

21 Q. Do you know about when that was that they
22 started? I'm sorry. Do you know at about what time
23 that was that Monsanto started requiring the indemnity
24 agreement?

25 A. Yes.

1 Q. When?

2 A. Early 1972.

3 Q. Did you participate in discussions with
4 respect to that indemnity agreement?

5 A. No.

6 Q. Do you know who did for Monsanto?

7 A. Yes.

8 Q. Who?

9 A. Mr. Bergen and Mr. Mason, his boss. Those
10 two I know for sure. I don't know any others.

11 Q. How about the lawyers? In-house.

12 A. Oh, yeah. The lawyers were involved.

13 Q. Like pebbles on the beach?

14 MR. McDONOUGH: This might be a good time
15 to break. If he's not tired, I am.

16 MR. SABETTA: All right.

17 MR. McDONOUGH: An hour.

18 MR. SABETTA: All right. It's ten till
19 1:00. Try to get back at ten to 2:00.

20 (Luncheon recess.)

21 (Reporter marked Plaintiff's Exhibit No.
22 378 and 379.)

23 Q. Mr. Papageorge, I'm showing you Exhibit 378
24 for identification. It purports to be a document from
25 United States Patent Office on dielectric composition by

1 a Frank M. Clark, Pittsfield, Massachusetts, and ask if
2 you've ever seen that document before.

3 A. This document does look familiar. I've
4 seen it before.

5 Q. Is that the General Electric patent on
6 dielectric fluids containing PCBs?

7 MR. SABETTA: Objection to form.

8 MR. GRONDAHL: Object to form.

9 A. PCBs and other chlorinated materials.

10 Q. Yes. As I understand it, that's the
11 General Electric patent on dielectric fluids containing
12 PCBs and other chlorinated materials?

13 A. Correct.

14 MR. GRONDAHL: Object to the form.

15 Q. Do you know whether General Electric
16 patented dielectric fluids before Monsanto purchased
17 Swann Chemical?

18 A. That's my understanding.

19 Q. Is it your understanding that Monsanto
20 purchased Swann Chemical for purposes of providing PCBs
21 for General Electric's dielectric fluid?

22 A. That is not my understanding.

23 Q. Do you have any understanding in that
24 regard to why Swann Chemical was purchased?

25 A. I do not.

1 Q. I'm showing you Exhibit 379 for
2 identification, a document entitled "The Proper Handling
3 of Aroclors and Their Mixtures in the Electrical
4 Industry" with a Monsanto Chemical Company address and a
5 P. G. Benignus, P. G. B-E-N-I-G-N-U-S, revised January
6 1980 date on the cover, and ask you if you've ever seen
7 that document before. I'm only going to ask you about
8 one entry, so I don't think you have to look at the
9 whole thing.

10 MR. SABETTA: I think you said the date was
11 1980. It's 1960. January 1960.

12 MR. McDONOUGH: I'm sorry. Thank you. I
13 lose decades, much less years.

14 A. This looks familiar.

15 Q. Who is Mr. Benignus? Do you know?

16 A. Yes. He's a Monsanto employee who at the
17 time of this report was involved with Monsanto's
18 marketing group located at the home office to supply
19 information to the field marketing people about
20 electrical use of Monsanto products.

21 Q. Is Mr. Benignus still alive? Do you know?

22 A. The last I heard, he was.

23 Q. Do you know if he still lives in the St.
24 Louis area?

25 A. That's my understanding.

1 Q. Do you know if he still works for the
2 company?

3 A. No. He's been retired.

4 Q. Do you know about how old he would be?

5 A. Well, he retired at 65 in 1974, so...

6 Q. Later on when we get time we'll work that
7 out. That marketing group, did it have a particular
8 name other than marketing group?

9 A. This is the marketing group within the
10 functional fluids group.

11 Q. Who was the head of functional fluids in
12 the 1970 time period?

13 A. Howard Bergen.

14 Q. Who was the head of it in 1960?

15 A. 1960. I can see the individual's face, but
16 his name escapes me. I can't recall his last name. His
17 first name is Constantine something.

18 Q. Referring to the page marked page one of
19 Exhibit 379 at the bottom of the page, above the
20 footnote it says, quote, "The electrical industry's use
21 of these fluids has been largely in accordance with the
22 General Electric's Company's patents and developments."
23 Do you see that?

24 A. Yes.

25 Q. Was it your understanding that that's

1 accurate?

2 MR. GRONDAHL: Object to the form.

3 A. Yes.

4 Q. That's all I have on that document.

5 (Reporter marked Plaintiff's Exhibits 380
6 and 381.)

7 Q. I'm showing you Exhibit 380 for
8 identification. It purports to be a document entitled
9 "The Journal of Industrial Hygiene and Toxicology" with
10 an article "The Problem of Possible Systemic Effects
11 From Certain Chlorinated Hydrocarbons," dated September
12 1937, with the first listed author Cecil, C-E-C-I-L, K.
13 Drinker, D-R-I-N-K-E-R. Have you ever seen that article
14 before?

15 A. It looks similar to something I saw in
16 early 1970.

17 Q. I'm showing you Exhibit 381 for
18 identification. It purports to be entitled "Report to
19 the Monsanto Chemical Company," Cecil K. Drinker, M.D.,
20 September 15th, 1938, and ask if you've ever seen that
21 document before?

22 A. This document which I have scanned appears
23 to be one I had seen before.

24 Q. When you said with reference to Exhibit
25 380, the earlier report, that you had seen a document

1 similar, were you referring to 381 as the similar
2 document?

3 A. No. In my recollection, they are two
4 distinct and separate documents.

5 Q. Do you know whether these documents were
6 contained in these three-ring binders that you reviewed
7 when you took your position in 1970 and did your
8 tutorial with Dr. Kelly and Mr. Wheeler?

9 A. As best as I recall, yes.

10 Q. Do you know if they were abstracted by
11 Monsanto in that three-ring binder?

12 A. I don't recall abstraction of these Drinker
13 articles, no.

14 Q. Did you read those articles or look through
15 them in 1970?

16 A. Yes.

17 Q. Where did they come from? Do you know?

18 A. I just automatically assumed they came out
19 of the medical library.

20 Q. Do you know whether the medical library had
21 those articles in it at about the time they were
22 published or written?

23 A. I'm sure of that, yes.

24 Q. Do you know generally that Dr. Drinker
25 voiced some concerns with vapors of Aroclors or

1 biphenyls?

2 A. Yes.

3 Q. What concerns did he reference?

4 A. I forget exactly, but it's a typical
5 concern of almost all chemicals when the vapors exceed
6 high levels, which is different for each chemical, and
7 the time of exposure to that high level, you will see
8 some effects on the human being.

9 Q. And did Dr. Drinker find back in 1937 that
10 there were effects on animals with respect to exposures
11 to biphenyl vapors?

12 MR. SABETTA: Objection to the form.

13 A. Biphenyl -- I don't remember the
14 unchlorinated material.

15 Q. Well, maybe I misspoke. Did he find
16 effects on animals as a result of exposure to vapors of
17 polychlorinated biphenyls?

18 A. Yes.

19 Q. Do you know whether or not Monsanto did
20 anything in terms of its process of production or
21 marketing with respect to chlorinated biphenyls as a
22 result of Drinker's studies?

23 A. That certainly appeared in their product
24 bulletins and pamphlets, and it appeared on the product
25 label with the reference to avoid inhalation.

1 Q. When did it appear on product pamphlets or
2 bulletins?

3 A. I don't have an exact date. I would
4 suggest it appeared before World War II.

5 Q. When did it -- I'm sorry.

6 A. Early '40's, somewhere in there.

7 Q. When did it appear on labels or information
8 given to customers?

9 A. I don't remember the -- Well, the bulletins
10 were given to customers. I don't personally recall the
11 dates in which it appeared on product labels.

12 Q. Do you know whether that occurred in the
13 early '70's as opposed to before the war?

14 A. Oh, I would -- No. It was certainly in
15 place in the '50's and so on. My best recollection is
16 that it was there before World War II.

17 Q. And do you recall generally what the
18 instruction or direction or warning was?

19 MR. SABETTA: Objection to form.

20 Q. Withdrawn. Do you recall generally what
21 the instruction was?

22 A. Generally, it was avoid prolonged
23 inhalation or some such words.

24 Q. Do you know what prolonged inhalation
25 meant?

1 A. I don't have any time to quote in terms of
2 describing a period. It was understood by all of those
3 involved that it had to do with the appearance of
4 symptoms.

5 Q. Does that mean you were to avoid exposure
6 to inhalation after you had symptoms?

7 MR. SABETTA: Objection to the form.

8 MR. GRONDAHL: Object to the form.

9 A. No. The intent was to avoid exposure to
10 vapors, and if you expected to be in that environment a
11 while put on your respirator, and if you notice that
12 your throat was sore and you were coughing, go get that
13 respirator or stay out of the area.

14 Q. Do you know whether Monsanto provided
15 respirators for its own employees that manufactured
16 Aroclors?

17 A. Yes. Yes.

18 Q. When did they start doing that?

19 A. In the '30's.

20 Q. Did they stop doing that after the war?

21 A. No.

22 Q. Did they provide special equipment to their
23 own employees prior to the war?

24 MR. SABETTA: Objection to the form.

25 Q. Withdrawn. Did they provide clothing to

1 their employees before the war, employees who dealt with
2 PCBs?

3 A. I don't know when the issue of clothing
4 began.

5 Q. Did you say anything -- Withdraw it. Do
6 you know whether Monsanto said anything in its labels or
7 bulletins about wearing respiratory protection?

8 A. I recall reading some of the product
9 literature that included words to that effect.

10 Q. Do you know what the time period of that
11 product literature was?

12 A. It ranged from the '30's all the way to the
13 '70's.

14 Q. And my question was do you know when it was
15 that this product literature referenced respiratory
16 protection?

17 A. No, I don't remember that.

18 Q. Do you know whether it was in the '70's as
19 opposed to the '30's?

20 A. It was long before the '70's. That was
21 standard information by the '70's.

22 Q. Do you know what this literature is called
23 other than labels and bulletins?

24 A. Well, other words were used, such as
25 product literature, product pamphlets.

1 Q. Was there anybody in the Monsanto structure
2 that was in charge of this labeling or supplying of
3 bulletins to customers?

4 MR. SABETTA: Objection to the form. I
5 think you have to give him a time. You're talking about
6 a 40-year period here.

7 Q. Let's take the time period 1960 to 1970.

8 A. The marketing representative located in St.
9 Louis assigned to a specific use would periodically have
10 the available literature reviewed, and he would have the
11 appropriate individuals in Monsanto comment, revise as
12 necessary the different portions. For example, the
13 medical people would be involved, the research people,
14 the engineering people, and so on. And once he got all
15 the comments in, he would arrange with the group in
16 Monsanto that was responsible for assisting in the
17 publication to put together the pamphlet with the
18 necessary photographic information, pictures and logos
19 and the like, and have it printed, so many copies. So
20 it kind of changed hands as it progressed through the
21 system.

22 Q. I was asking who that individual might be
23 in 1960 through 1970. Do you know?

24 A. For dielectric fluids?

25 Q. For the labels and the bulletins that would

1 have been discussing about the dielectric fluids for
2 PCBs.

3 A. Mr. Benignus was the initiator of any
4 activity of this type.

5 Q. Do you know how long Mr. Benignus was that
6 individual?

7 A. Oh, he was -- Again, the exact dates are
8 difficult to recall, but it's from the '50's through
9 1974.

10 Q. Did Mr. Benignus retire in 1974?

11 A. Yes.

12 (Reporter marked Plaintiff's Exhibits 382
13 through 386.)

14 Q. I put a book in front of you,
15 Mr. Papageorge, and I'd ask you to open it to the tab
16 two, if you would. Have you got tab two in front of
17 you?

18 A. 382, yes, sir.

19 Q. Thank you. That purports to be a letter of
20 February 6th, 1950 from Louis Spolyar, S-P-O-L-Y-A-R,
21 M.D., Director, Division of Industrial Hygiene, Indiana
22 State Board of Health, to Toxicology Department,
23 Monsanto. Have you seen that before?

24 A. I don't recall it.

25 Q. Now, in the first paragraph, Dr. Spolyar

1 says, "One of our Indiana industries is using your
2 Aroclor 1248 (tetrachlorodiphenyl) as a heat transfer
3 media (up to 400 degrees F)," meaning Fahrenheit, in the
4 extrusion of Tenite, T-E-N-I-T-E, 2 plastic.
5 Considerable vapor of Aroclor is present in the workroom
6 due to leaks in the 'closed' system. Several workers
7 have reportedly become ill due to the inhalation of
8 these vapors." Were you familiar with that situation?

9 A. Am I familiar with that situation?

10 Q. Yes.

11 A. No. This is the first I've seen of this.

12 Q. Was that covered in your tutorial by
13 Dr. Kelly or Mr. Wheeler?

14 A. I don't recall it being so, no.

15 Q. Do you know if Monsanto had a Toxicology
16 Department?

17 MR. SABETTA: At what time?

18 Q. Let's start February 6th, 1950.

19 A. Not a department as such, but the function
20 was carried out by the Medical Department.

21 Q. So would it be your understanding that if a
22 letter was directed to the Toxicology Department, would
23 it have been delivered to the Medical Department?

24 A. Yes.

25 Q. Do you know if there was ever a response to

1 this particular document?

2 A. I do not.

3 Q. On the second paragraph, Dr. Spolyar says,
4 "This plant called us as to any knowledge relative to
5 the toxicity of this product. We did not have any data
6 that could be transmitted to them. The so-called
7 illness was vague in that we could not learn from the
8 plant what the exact complaints were." Do you know
9 whether any data or information had been transmitted by
10 Monsanto to anyone to that date, 1950, as to toxicity of
11 Aroclor or PCB oil?

12 A. Oh, yes.

13 Q. And who had it been transmitted to?

14 A. Oh, gosh! I don't know. Many, many
15 people. Customers and state authorities and so on would
16 get those.

17 Q. Apparently Dr. Spolyar hadn't gotten any as
18 the Director of the Division of Industrial Hygiene at
19 the Indiana State Board of Health?

20 A. Apparently not.

21 Q. How do you know that Monsanto sent
22 information to state agencies or federal government up
23 through 1950?

24 A. That was the practice of the Medical
25 Department to do so, and I don't see why they would fail

1 to do so.

2 Q. Who told you it was the practice of the
3 Medical Department?

4 A. Mr. Wheeler, Dr. Kelly.

5 Q. And what was this practice that they told
6 you about up through 1950?

7 A. Whenever they had new data or they had a
8 new customer or a new inquiry, they would share what
9 they knew about the product that they might be
10 interested in.

11 Q. Would the sharing of that information go to
12 the ultimate recipient of the product?

13 MR. SABETTA: Objection to form.

14 A. It went to a representative as perceived by
15 Monsanto of that entity that received the product.

16 Q. Well, if we look at Aroclor 1254, that was
17 sold for use in transformers, among other things; is
18 that correct? 1254 was sold for use in transformers
19 among other things?

20 A. Yes.

21 Q. Now, as I understand your answer, you would
22 provide information to the purchaser of the 1254; is
23 that correct?

24 A. Yes.

25 Q. And what would the purchaser of the 1254 do

1 with the chemical with respect to its transformers?

2 MR. SABETTA: Objection to form. Do you
3 understand the question?

4 A. Not quite. What would the purchaser do?

5 Q. I was trying to make it easier. Did you
6 understand that General Electric and Westinghouse sold
7 transformers to others?

8 A. Yes.

9 Q. And did you understand that these
10 transformers contained Aroclors in them?

11 A. Yes.

12 Q. Did Monsanto do anything to notify whoever
13 the transformers were sold to of problems associated
14 with vapors?

15 A. Monsanto would never know who that customer
16 was.

17 Q. Would the answer be no?

18 A. That's correct.

19 Q. Did Monsanto ever ask who those customers
20 were?

21 MR. SABETTA: Objection to form.

22 A. I don't know that.

23 Q. Turn to the next tab. We've marked it as
24 Exhibit 383. Have you got that in front of you?

25 A. I do.

1 Q. 383 purports to be a letter from Dr. Kelly
2 to Dr. Newman in Newport, England, February 12th, 1954.
3 Have you ever seen that letter, before?

4 A. I remember this letter, yes.

5 Q. When did you see that?

6 A. During my tutorial in 1970.

7 Q. Now, the first paragraph of that letter --
8 Let me withdraw that. Was that in this three-ring
9 notebook or two three-ring notebooks that you looked at?

10 A. Yes.

11 Q. The first sentence says, "We do not know
12 what the maximum allowable concentration of Aroclor is.
13 One milligram per cubic meter has been set up. We have
14 run animals for about 60 days at seven times this and
15 found some liver damage. We are now running this at a
16 lower level." Do you see that?

17 A. I do.

18 Q. Do you know who set up this one milligram
19 per cubic meter as referred to in the document?

20 A. I don't know the individual.

21 Q. Well, do you know whether it was Monsanto
22 or another agency or company?

23 A. Monsanto.

24 Q. Now, this refers apparently to some animal
25 testing done by Monsanto; is that correct?

1 A. It is done for Monsanto.

2 Q. Had Monsanto done or had done animal
3 testing up to that point?

4 A. Yes.

5 Q. How do you know that?

6 A. I recall seeing reports reporting the
7 results of some studies done back in the '30's and '40's
8 as best I remember.

9 Q. Do you know who did those studies in terms
10 of an outside agency?

11 A. I don't remember the laboratory that did
12 the work.

13 Q. How many studies are you familiar with in
14 the '30's and '40's?

15 A. It seems they had performed for them
16 studies referred to as acute toxicity studies on test
17 animals for Aroclor 1242, 1248, 1254 and 1260. That's
18 all my memory will help me with.

19 Q. Does that mean one study or four studies
20 with respect to each chemical?

21 A. Four different studies.

22 Q. Your memory hasn't come back yet on the
23 agency or laboratory that might have done the testing?

24 A. I should know. It evades me. I can't
25 remember it.

1 Q. Now, Dr. Kelly references "some liver
2 damage". Do you know what liver damage was reported in
3 these studies?

4 A. As best I remember, it was described to me
5 as liver enlargement.

6 Q. Do you know whether there were any
7 pathological tests performed on liver sections?

8 A. I do not.

9 Q. Who described it to you as liver
10 enlargement?

11 A. Elmer Wheeler.

12 Q. Now, do you know what lower level they were
13 going to now run the studies at?

14 A. I believe it was a half a milligram per
15 cubic meter.

16 Q. Do you have a recollection of a half a
17 milligram per cubic meter?

18 A. Yes.

19 Q. Okay. And do you recall what the results
20 of that study was?

21 A. They found no damage of any kind.

22 Q. And who is "they"?

23 A. This laboratory, I'm trying to recall.

24 Q. Was it the same laboratory?

25 A. Yes.

1 Q. And the best date you can fix for this is
2 the '30's or '40's?

3 MR. SABETTA: I think we're talking --

4 A. This is the '50's.

5 MR. SABETTA: -- testing in the '50's.

6 Q. The best date you can fix is the '50's?

7 A. Yes.

8 Q. Who's Dr. Newman? Do you know? Or who was
9 Dr. Newman?

10 A. Dr. Newman was the physician, head of the
11 Medical Department of Monsanto's European office located
12 in England.

13 Q. Did that Monsanto installation also produce
14 PCBs?

15 A. Yes.

16 Q. Did it produce Pyranol?

17 A. No.

18 Q. If you look at the last paragraph, in the
19 last sentence, it says, "As soon as I get a report on
20 the work at Kettering," K-E-T-T-E-R-I-N-G, "I will let
21 you know." Do you see that?

22 A. Yes.

23 Q. Do you know what the reference to Kettering
24 is?

25 A. Yes. That is a testing laboratory.

1 Q. Is that the testing laboratory that you
2 believe these tests were done on 1242, 1248, 1254 and
3 1260?

4 A. That's what this last sentence tells me,
5 yes.

6 Q. Your answer is based on how you read this;
7 is that correct?

8 A. Yes.

9 Q. Where is Kettering?

10 A. Ohio. Cincinnati, Ohio.

11 Q. Do you know the name of any particular
12 tester that was involved in these chemicals?

13 A. No, I don't.

14 Q. Do you know whether Kettering was also
15 doing testing with reference to the 1949 Nitro, West
16 Virginia explosion?

17 A. No, I don't know much about that explosion.

18 Q. Do you know whether there was a different
19 individual in Monsanto in the 1960's and 1970's that
20 dealt with dioxins as opposed to PCBs?

21 MR. SABETTA: Objection to the form.

22 Q. I'll withdraw it. Do you know if there was
23 an individual in Monsanto in the 1960's and 1970's that
24 dealt with dioxin?

25 MR. SABETTA: Same objection.

1 A. Well, when you say "dealt with," I have
2 some difficulties distinguishing between obtaining a
3 medical knowledge or developing analytical procedures.
4 There were two sets -- two groups of people that
5 addressed each of those.

6 Q. Would it be a fair statement that your job
7 involved dealing with PCBs?

8 A. Yes.

9 Q. Was there anybody in Monsanto in the '60's
10 or '70's that you know of that dealt with dioxins in the
11 same fashion that you dealt with PCBs?

12 A. No.

13 Q. Was there anybody in the '60's or '70's
14 that dealt with dibenzofurans in the same fashion as you
15 dealt with PCBs?

16 A. No.

17 Q. You mentioned medical problems and
18 analytical problems. Is that what you said?

19 A. Those are two that come to mind, yes.

20 Q. And do I understand that it was somebody
21 that dealt with medical problems associated with dioxins
22 at Monsanto in the '60's and '70's?

23 A. Yes.

24 Q. Who would that be?

25 A. Elmer Wheeler, Jack Garrett, Fred Johansen,

1 George Levinskas. In other words, the medical team all
2 played a part in this.

3 Q. Do you know whether Jack Garrett is still
4 alive?

5 A. I understand he is.

6 Q. Do you know whether he's located in the St.
7 Louis area?

8 A. That's my understanding.

9 Q. Do you know whether Frank Johansen is still
10 alive?

11 A. Yes.

12 Q. Do you know where he's located?

13 A. No, I don't.

14 Q. Do you know whether George Leviticus (sic.)
15 is still --

16 A. Lavinskas, L-A-V-I-N-S-K-A-S.

17 Q. Do you know whether George Lavinskas is
18 still alive?

19 A. Yes.

20 Q. Is he in the St. Louis area?

21 A. Yes.

22 Q. Do any of them still work for Monsanto?

23 A. I don't know about Mr. Johansen.

24 Mr. Garrett and Mr. Levinskas are retired from Monsanto.

25 Q. Do you know what training each of these

1 individuals had, Mr. Levitikas or Lavinkus?

2 A. Levinskas?

3 Q. Yes.

4 A. He has a doctorate in toxicology.

5 Q. Do you know whether he was working for
6 Monsanto in the '60's?

7 A. No, he was not.

8 Q. Do you know about when he started working
9 for Monsanto?

10 A. About 1971, '72.

11 Q. Did he replace another toxicologist?

12 A. That's rather hard to define because the
13 individual who was following PCB studies died at the
14 same time that the department was expanded, hiring
15 people. So when Mr. Levinskas showed up, you couldn't
16 tell whether he was replacing someone or just part of
17 the growth of the department.

18 Q. You said the individual following PCB
19 studies died. Who are you referring to?

20 A. I cannot remember his name. I just can't
21 remember it.

22 Q. It was my understanding that you gave me
23 these gentlemen's names of people who were working in
24 dioxins. Was I incorrect in my understanding?

25 MR. SABETTA: Objection to the form.

1 A. I at this moment am wrestling with the
2 concept what does working in dioxin really mean. Is it
3 keeping tuned in? Is it talking to the toxicology
4 community, and so on?

5 Q. Did the same people that worked in
6 following PCBs work in following dioxins?

7 A. Pretty much so.

8 Q. And what was Mr. Johansen's training in?

9 A. A doctorate of toxicology.

10 Q. Mr. Garrett, do you know what his training
11 was in?

12 A. Mr. Garrett had, as best I recall, a
13 Master's degree in chemistry, working in the field of
14 industrial hygiene.

15 Q. Do you know whether these same gentlemen
16 were involved in following dibenzofurans?

17 A. Yeah. They were keeping tuned in.

18 Q. Was there anyone else in the company in the
19 '60's and '70's that was following dioxins or following
20 dibenzofurans than these gentlemen you've given me the
21 names of?

22 MR. SABETTA: Objection to form.

23 A. Well, there were several of us following
24 those two chemical groups, but each from a different
25 perspective. I was following personally from an overall

1 viewpoint in terms of where were they, what do they do,
2 how do you know you have them? That kind of attitude or
3 that approach. There were others who were interested
4 enough to kind of keep tuned in and talk to the
5 customers, see if any of our customers were doing any
6 studies.

7 Q. Who were these people keeping tuned in by
8 talking to customers?

9 A. They were primarily marketing people who
10 made calls at the customers' locations.

11 Q. Do you know any names?

12 A. Oh, I just can't remember all of them.

13 Q. Was GE one of these customers that they
14 were making calls on?

15 A. Oh, certainly, yeah.

16 Q. What was the answer from GE?

17 MR. SABETTA: Objection to form.

18 MR. GRONDAHL: Objection.

19 Q. I think you told me that these marketing
20 representatives were calling on customers to see whether
21 the customers were doing anything --

22 A. Yes.

23 Q. -- with respect to dioxins or
24 dibenzofurans. Is that what you told me?

25 A. Yes.

1 Q. Did you get a response from General
2 Electric?

3 MR. GRONDAHL: Object to the form.

4 MR. SABETTA: Objection to form.

5 A. I did not hear, not only from General
6 Electric, anybody regarding studies being made and the
7 results of those studies.

8 Q. Did Monsanto do any studies with respect to
9 dioxins and dibenzofurans?

10 MR. SABETTA: Objection to form.

11 A. Well, they did a lot of work on the
12 analytical procedure.

13 Q. Other than doing a lot of analytical work
14 -- Other than doing a lot of work on the analytical
15 procedure, did Monsanto do any studies on dioxins?

16 A. No.

17 Q. Other than doing a lot of analytical work,
18 did Monsanto do any studies on dibenzofurans?

19 A. No.

20 Q. What do you mean by analytical work?

21 A. It involves the development of a procedure
22 of taking a sample of material and running through a
23 series of steps through instruments that will report or
24 display a certain reaction, a graph or a bar or a color
25 or what-have-you, which the chemist will then interpret

1 in terms of what is the material and how much is
2 present.

3 Q. Where was this work done?

4 A. For Monsanto, most of it was done in the
5 St. Louis main offices of the Analytical Research
6 Laboratory.

7 Q. Do you know whether that research
8 laboratory has its own library?

9 A. It does not.

10 Q. Do you know what library they would rely on
11 if they needed to find some information?

12 A. Yes.

13 Q. What library?

14 A. The Monsanto Research Department's library.

15 Q. Do I understand it that Monsanto was
16 attempting to find out whether there were dioxins
17 present in its products?

18 A. Yes. There was an effort to answer that
19 question, yes.

20 Q. And do you know when that started?

21 A. I would suggest about '71. Late '71, early
22 '72.

23 Q. Do you know whether it started in the
24 '60's?

25 MR. SABETTA: Objection to form.

1 A. It did not.

2 Q. How did you find out it started in late '71
3 or early '72?

4 A. I was in close contact with the head of
5 that group, and I would contact him to see what
6 progress, if any, had been made and where they stood and
7 when they expected results, that kind of conversation
8 would take place.

9 Q. Who was the head of the group?

10 A. Dr. Robert Keller.

11 Q. Do you know what product Dr. Keller's group
12 was testing?

13 A. They were checking chlorinated hydrocarbons
14 of all kinds.

15 Q. Including polychlorinated diphenyls and
16 biphenyls?

17 A. Yes.

18 Q. Were the results of that effort ever
19 published?

20 A. You mean for peer reviewed articles and so
21 on?

22 Q. No. I mean in the literature, newspapers,
23 magazines, journals, peer review, not peer reviewed.

24 A. None of that.

25 Q. Do you know what the results were?

1 MR. SABETTA: Objection to form.

2 A. In general, the results were that we didn't
3 find it. We can't find it. It's not there.

4 Q. At some time -- Withdraw that. You can't
5 find it in what?

6 A. In the whole list of products that they
7 were looking at.

8 Q. Did you ever test Pyranol to see if you
9 could find it?

10 A. Not as a mixture, no.

11 Q. Isn't it true that if you had tested the
12 tri/tetrachlorobenzene you would have found dioxin?

13 MR. SABETTA: Objection to form.

14 MR. GRONDAHL: Object to the form.

15 A. Oh, I don't know that that's true, no way.
16 There's nothing that I am aware of that would lead me to
17 that conclusion.

18 Q. Do you know we're here about this fire on
19 February 5th, 1981 in the Binghamton State Office
20 Building?

21 A. Yes, sir.

22 Q. Do you know that dioxins were found after
23 the fire?

24 A. After the fire, yes.

25 Q. Where do you think they came from?

1 MR. SABETTA: Objection to the form.

2 MR. GRONDAHL: Object to the form.

3 A. I don't have enough information to make a
4 wise conclusion.

5 Q. Do you know that dibenzofurans were found
6 after the fire?

7 A. That's what I heard.

8 Q. Where did they come from?

9 A. I don't know that one either.

10 Q. Did Monsanto test for dibenzofurans in its
11 products?

12 MR. SABETTA: Objection to form.

13 A. Which products?

14 Q. You don't know whether it tested or not for
15 dibenzofurans in its products?

16 A. Which products?

17 MR. SABETTA: Just a second. Let me get in
18 my objection. Okay. There's no race to complete this
19 exercise. Objection to form.

20 Q. I have to tell you which product before you
21 can answer that question.

22 MR. SABETTA: Objection to form.

23 Q. Is that true, Mr. Papageorge?

24 A. Well, from what little I know of the
25 scenario at Binghamton, there were many other things

1 other than transformer fluid.

2 Q. We're talking about Monsanto testing its
3 products for dibenzofurans, that's what we're talking
4 about, and I want to know whether Monsanto ever tested
5 its products for dibenzofurans.

6 MR. SABETTA: Do you know whether Monsanto
7 tested any of its products at any time for the presence
8 of dibenzofurans? That's what I understand the scope of
9 Mr. McDonough's question to be.

10 A. Any product, yes.

11 Q. And did it test PCBs?

12 A. Yes.

13 Q. And when did it first test PCBs for
14 dibenzofurans?

15 A. 1970's.

16 Q. Is that part of the same test group that
17 was testing for dioxin, or is it a different group?

18 A. Same analytical group.

19 Q. And did it test Aroclor 1254?

20 A. Yes.

21 Q. And did it get any results?

22 A. By that, you mean did it get positive
23 results?

24 Q. No. What were the test results?

25 MR. SABETTA: Objection to form. As I

1 understand, the tests went on over a period of time. I
2 don't think you can ask him about test results without
3 specifying some time period, because there's no reason
4 to believe that the test results were the same
5 throughout the period.

6 MR. McDONOUGH: Counsel, the witness said
7 they did testing in the 1970's.

8 MR. SABETTA: Right.

9 MR. McDONOUGH: I can't help that. I asked
10 him what the test results -- Are you saying he can't
11 answer that?

12 MR. SABETTA: I think you have to zero in
13 on a specific time or series of tests because I know
14 from my own studies that the test results varied.

15 MR. McDONOUGH: I think the witness can
16 tell me that if he's having trouble with the question.

17 MR. SABETTA: Well, I object to the form of
18 the question. Can you read me the question?

19 Q. I'll ask another question. Let's not waste
20 anymore time. Did you testify that Monsanto tested
21 Aroclor 1254 to determine whether it contained
22 dibenzofurans in the 1970's?

23 A. Yes.

24 Q. When in the 1970's did Monsanto do that?

25 A. It started, gosh, very early in the year.

1 Q. And do you recall whether Monsanto ever got
2 test results that their Aroclor 1254 contained
3 dibenzofurans?

4 A. Eventually, yes.

5 Q. And when was that?

6 A. 1976.

7 Q. Did any of those tests in the 1970's
8 include applying heat to Aroclor 1254?

9 A. Not knowing the analytical procedure, I
10 don't know if heat is part of the process, so I can't
11 answer that.

12 Q. Do you know anything as to the analytical
13 procedure that was employed by Monsanto to test for
14 dibenzofurans?

15 A. Did I know what? Did I know anything else?

16 Q. Anything about it.

17 A. Not in the technical sense, no.

18 Q. Did you tell me you didn't know whether
19 they tested the Aroclor 1254 by applying heat or not?

20 A. Why not?

21 Q. Why not?

22 A. I don't understand.

23 Q. Do you know whether Monsanto tested Aroclor
24 1254 by applying heat?

25 MR. SABETTA: I think he's already answered

1 that. I object to the form of the question.

2 Q. Can you answer it?

3 A. I do not know.

4 Q. Did Monsanto have any other laboratory
5 facilities in the 1960's or '70's other than this
6 laboratory run by Dr. Keller that you've told me about
7 doing analytical work on Monsanto's products?

8 A. Yes.

9 Q. Where were those laboratories? Well, let
10 me withdraw that question. Did they have any other
11 laboratories testing to determine whether Monsanto's
12 products produced dioxins or dibenzofurans other than
13 Dr. Keller's laboratory?

14 A. Not to my knowledge.

15 Q. If you'll look at tab four for me, it's
16 marked as Exhibit 384. That purports to be some pages
17 out of a document entitled "Process for the Production
18 of Aroclors, Pyranols, Etc., at the Anniston and at the
19 Wm. J. Krummrich Plant, April 1955, E. Mather." Have
20 you got that in front of you?

21 A. Yes.

22 Q. Have you seen that document before or the
23 entire document from which that is taken?

24 A. I believe I recognize this article,
25 although it doesn't appear to be a complete document.

1 Q. Did you know an E. Mather?

2 A. Yes. Uh-huh.

3 Q. Was he a predecessor of yours at the
4 Anniston plant?

5 A. I don't associate him with the Anniston
6 plant, but --

7 Q. Do you know what his job title and function
8 was about that time?

9 A. He was a research individual.

10 Q. If you look at the page -- first page in
11 from the cover, it's marked Roman numeral XI-1, Hazards,
12 referencing the second paragraph, it says, "There was
13 some trouble of this kind among the production workers
14 at Anniston in the early days of the development of the
15 Aroclors."

16 A. I see that.

17 Q. Do you know what that's with reference to?

18 A. They are referring to a situation in which
19 a highly chlorinated biphenyl was produced and some of
20 the workers got some sort of skin problem. It was
21 described to me as chloracne.

22 Q. Who described it to you that way?

23 A. Elmer Wheeler. And it was attributed to
24 the use of impure benzene in the manufacture of the
25 PCBs.

1 Q. Do you know of any study or attempt to
2 study whether the benzene used at Anniston at that time
3 was impure?

4 A. I'm not aware of any such studies.

5 Q. Do you know whether this outbreak of
6 chloracne was associated with vapors from the Aroclors?

7 A. It's my understanding that it resulted from
8 the dust of this particular PCB. This is a solid PCB
9 ground into a flour-like dust that settled all over the
10 equipment and on the workers and so on.

11 Q. The first paragraph says, "There are many
12 literature references to harmful effects of the type of
13 'chloracne' resulting from exposure to chlorinated
14 diphenyls, especially in cases where people working with
15 small electrical components have been exposed to the
16 fumes of hot, highly chlorinated Aroclors. Chloracne is
17 sometimes accompanied by gastric troubles, and there are
18 literature references to liver troubles." Do you see
19 that?

20 A. Yes.

21 Q. Isn't that the trouble that was experienced
22 at Anniston in the early days?

23 A. Yes.

24 Q. And wasn't that trouble with reference to
25 being exposed to vapors?

1 MR. SABETTA: Objection to form.

2 A. Well, certainly there are two types of
3 exposures here. The paragraph you just read does refer
4 to fumes, but the second paragraph follows an incident
5 where it's my understanding they were -- You'll see the
6 word "highly chlorinated Aroclors". That refers to the
7 Aroclor 1270 that was made at that time.

8 Q. How do you know it refers to 1270?

9 A. That's what I was informed was the product.

10 Q. Isn't 1254 considered highly chlorinated?

11 MR. SABETTA: Objection to form.

12 MR. GRONDAHL: Objection to form.

13 A. It all depends what you're comparing it to.

14 Q. Well, as you subsequently worked in PCBs in
15 the 1970's and thereafter, didn't everyone consider 1254
16 highly chlorinated --

17 MR. SABETTA: Objection to form.

18 MR. GRONDAHL: Object to form.

19 Q. -- as compared to the other Aroclors?

20 A. That's what I meant when I said it depends
21 on what you compare it to. In the '70's, 1260 and 1254,
22 when compared to 1242, 1232, and so on, they were
23 perceived to be the highly chlorinated. But back in
24 this period of time that we're reviewing here, when they
25 made 1272 and 1270, those were understood to be highly

1 chlorinated as compared to a 54 or even a 60.

2 Q. If you look at page Roman numeral XI-3,
3 it's an article "On the Toxicity of the Aroclors". Now,
4 that article refers to another recently-published
5 article that has recommended the substitution of one of
6 the Aroclors as the melting-point bath liquid in
7 preference to the customary sulphuric acid. As stated
8 in that article, Aroclors are a group of chlorinated
9 diphenyls produced by the Monsanto Chemical Company.
10 Then it says, "There is need, therefore, to give
11 warning."

12 A. Okay.

13 Q. Do you know what that references?

14 MR. SABETTA: Object to form.

15 A. Not yet. I have to read more of the
16 article.

17 MR. SABETTA: Is there a question pending?

18 MR. McDONOUGH: Yes.

19 MR. SABETTA: Please read it.

20 (Whereupon, the reporter read "Do you know
21 what that references?")

22 MR. SABETTA: Do you understand the
23 question? Objection to the form. Do you understand the
24 question?

25 Q. I withdraw it. If you'll look at the last

1 page of the exhibit, which is page Roman numeral XIV-1,
2 "History of the Process in Monsanto," I'd ask you to
3 read it to yourself, and then I just want to know
4 whether you believe it's an accurate history.

5 A. I have read it.

6 Q. Is it accurate?

7 A. I'm sorry?

8 Q. Is it accurate?

9 A. As far as I know, yes.

10 Q. Referring back to page XI-4, a little bit
11 down the page, it's entitled "Health and Safety". It's
12 Bates number 3784. It states under "Health and Safety,"
13 "At Anniston, no special protective clothing is provided
14 for the diphenyl and Aroclors operators. A daily change
15 of clothing was provided in the past but this practice
16 ceased before the war. Gauntlet leather gloves and face
17 shields are, of course, available as required by the
18 plant." Do you see that?

19 A. Yes.

20 Q. Did you testify when you were at Anniston
21 they had special protective clothing?

22 A. Yes.

23 Q. Do you know when they started getting them
24 after the war?

25 A. It was after the war. When I arrived in

1 '65, it was a well-established practice.

2 Q. Do you know who established the practice?

3 A. I do not.

4 Q. Do you know why it was established?

5 A. I have an understanding.

6 Q. What's your understanding?

7 A. It was a matter that was raised during
8 union contract negotiations.

9 Q. This article apparently refers to the
10 employees at Anniston having to shower on their own time
11 whereas at Krummrich they tried to shower on company
12 time.

13 A. That was part of the discussion.

14 Q. So it your understanding that the special
15 clothing was a product of negotiations with the union?

16 MR. SABETTA: Objection to form.

17 A. Yes.

18 Q. What about showers on company time? Was
19 that a practice when you were at Anniston?

20 A. Yes.

21 Q. Do you know how that practice came about?

22 A. That was part of the union negotiations
23 between World War II and 1965.

24 Q. Do you know whether at Anniston the
25 Aroclors building was ever designated as a toxic

1 department?

2 A. Not to my knowledge.

3 Q. If you go down about two-thirds of the way
4 down this page, it says, "At St. Louis, Plant B, the
5 Aroclors building is rated a toxic department." And it
6 goes on to talk about operators being provided with a
7 complete set of clothing and that sort of thing. Do you
8 see that?

9 A. Yes.

10 Q. What does a designation as a toxic
11 department mean?

12 A. It means that the employees of that
13 department so designated get this shower time, clothing
14 change, shoe change, all of these benefits, because not
15 all operations were designated as such.

16 Q. Do you know if Anniston was designated as a
17 toxic department at some time?

18 MR. SABETTA: Objection to form.

19 A. The term "toxic department" at Anniston was
20 not used for operations like PCB.

21 MR. McDONOUGH: Could I have that answer
22 back, please?

23 (Whereupon, the reporter read back as
24 requested.)

25 Q. If you look at the last paragraph on that

1 page, it says, "Employees in toxic departments are given
2 an annual medical examination and a lung x-ray every
3 three years." Do you see that?

4 A. I do.

5 Q. Do you know whether the Anniston employees
6 got an annual medical exam and a lung x-ray every three
7 years?

8 A. They did when I was there.

9 Q. Was there any classification of Anniston
10 that caused that medical examination and lung x-ray to
11 be given?

12 A. Not to my knowledge.

13 Q. Well, here it says if you're a toxic
14 department you get the medical examination and the lung
15 x-ray. Doesn't that seem to say that?

16 MR. SABETTA: Objection to form.

17 A. Well, yes. But you have to keep in mind
18 that this is dated 1947 describing --

19 Q. '55?

20 A. -- conditions observed before '47.

21 Q. '55, I believe is why I quibble.

22 A. Well, I'm looking at page XI-3.

23 Q. Uh-huh. Is that contained in a document
24 called 384 with a title "Process for the Production of
25 Aroclors, Pyranols, etc." with a date of 1955?

1 A. I don't see that.

2 MR. SABETTA: He's referring to the first
3 page, the cover page, I believe, of this entire
4 document, which is an incomplete version I guess of a
5 document that we produced in the litigation. The first
6 page is numbered 3397, and the second page jumps to
7 3781, so it's obviously an extract of some sort. Do you
8 see the date on the first page?

9 A. I see that, but I also see the other dates
10 to which the material showing up underneath is -- I
11 associate those other dates with the material below it.

12 Q. Why did the employees at Anniston get
13 medical examinations and lung x-rays while you were
14 there?

15 A. Why was it?

16 Q. Yeah. Was it company policy? Was it union
17 contract?

18 A. There was a change in company policy.
19 Dr. Kelly recommended that this be adopted as a matter
20 of practice at all the plants, and Anniston agreed to it
21 and did it.

22 Q. When did that happen?

23 A. As I said earlier, the offer of wash time,
24 shower time, replacement clothing and all was in
25 practice or in place when I arrived, and I'm under the

1 understanding that the introduction of the annual
2 physical with the x-rays was instituted at about the
3 same time, but I personally don't know the exact timing,
4 the dates.

5 Q. Aside from exact timing and dates, do you
6 have any idea when that happened? Even decade I'll
7 take.

8 MR. SABETTA: For the Anniston plant only?

9 Q. Yes.

10 A. 1950's.

11 Q. Do you know what the basis of Dr. Kelly's
12 recommendation for the change in policy was?

13 A. I do not.

14 Q. If you look at the next tab, has that
15 document been marked 385 for identification?

16 MR. SABETTA: Yes.

17 Q. That purports to be a letter from Dr. Kelly
18 to Dr. J. W. Barrett, two R's, two T's, September 20th,
19 1955, re your memo September 8 to Mr. Nason, N-A-S-O-N,
20 Aroclor toxicity. Do you see that?

21 A. I do.

22 Q. Have you ever seen that before?

23 A. It does look familiar.

24 Q. Was that in your two three-ring binders?

25 A. I would say yes.

1 Q. Was that document ever sent to your
2 customers?

3 A. I'm sorry?

4 Q. Was that document ever sent to your
5 customers, meaning Monsanto's?

6 A. No. To Monsanto's customers?

7 Q. Yes.

8 A. No.

9 Q. The second paragraph says, "You comment
10 upon the difference in toxicity between Aroclor 1254 and
11 1242. This is not particularly surprising because in
12 the earlier work it was found that toxicity increased
13 with chlorination." Do you see that?

14 A. Yes.

15 Q. Do you know what earlier work Dr. Kelly is
16 referring to?

17 A. He's talking about these acute toxicity
18 studies we talked about earlier where the four types of
19 Aroclors were tested with test animals.

20 Q. From the Kettering Laboratory?

21 A. That was one of the laboratories involved,
22 yes.

23 Q. Was there more than one?

24 A. Through the years, there were --

25 Q. I'm just asking about this particular memo

1 here, as to what he's referring to.

2 A. So '55 would be the Kettering report, yes.

3 Q. Now, Dr. Kelly goes on to discuss various
4 levels of vapors, and then in the next-to-last paragraph
5 says, "I don't know how you would get any particular
6 advantage in doing more work. What is it that you want
7 to prove? I believe your work should be directed
8 towards finding out what the concentrations are of
9 Aroclor during different operations whether it is
10 industrial or painting. The reports you have seen from
11 Kettering Laboratory are the result of approximately
12 \$15,000 to \$20,000 expenditure by MCC." Do you see
13 that?

14 A. I do.

15 Q. Have you ever seen this memo, September
16 8th?

17 A. I think I remember the memo that
18 Dr. Barrett had sent.

19 Q. Was Dr. Barrett asking about doing more
20 testing?

21 A. He did raise the point of why don't we do
22 more, and Dr. Kelly is responding to that particular
23 thought.

24 MR. McDONOUGH: I'll have a request for
25 documents at the end of the deposition, Mr. Sabetta, I

1 don't want to interrupt every time.

2 Q. Who is Dr. Barrett?

3 A. He was a Monsanto employee, a member of
4 Monsanto's European group. He was located in London.
5 He was a medical doctor, but he was also very active in
6 research, chemical research activities.

7 Q. Did he work with Dr. Newman?

8 A. I believe he reported to Dr. Newman, but
9 I'm not certain.

10 Q. The last paragraph says, "MCC's position
11 can be summarized in this fashion. We know Aroclors are
12 toxic but the actual limit has not been precisely
13 defined. It does not make too much difference, it seems
14 to me, because our main worry is what will happen if an
15 individual develops any type of liver disease and gives
16 a history of Aroclor exposure. I'm sure the juries
17 would not pay a great deal of attention to MAC's."
18 That's capital MAC's. Do you see that?

19 A. Yes.

20 Q. Do you know what Dr. Kelly is referring to
21 when he says the actual limit referring to toxicity has
22 not been precisely defined?

23 A. I don't know how to respond to that. It's
24 just what the sentence says.

25 Q. Okay. If you turn to the next page,

1 Dr. Kelly discusses the applications of the Aroclor use
2 and then says, "No amount of toxicity testing will
3 obviate this last dilemma and therefore I do not believe
4 any testing would be justified. Let's see what our
5 discussions with Dr. Newman and yourself bring out." Do
6 you see that?

7 A. I do.

8 Q. Do you know if there was any more toxicity
9 testing on Aroclors after this September 1955 date?

10 A. There was.

11 Q. Do you know if it was acute testing?

12 A. Yes.

13 Q. Do you know if chronic testing was done?

14 A. Yes.

15 Q. When was the next acute testing done?

16 A. I would suggest the middle '60's or so.

17 Q. Do you recall who did that testing?

18 A. As close as my memory will allow me to get
19 is I'm under the recollection that it was a laboratory
20 located in the St. Louis area. That's as close as I can
21 get to it at the moment.

22 Q. Would that be IBT?

23 A. No. They are not in St. Louis.

24 Q. Do you know whether this was one series of
25 acute tests or more than one?

1 A. Help me with "series". You mean --

2 Q. Withdraw it. Are we talking about one
3 acute test?

4 A. We're talking about acute testing of at
5 least four types of PCBs or so by Monsanto.

6 Q. Do you know how the acute testing was done?
7 Was it animal testing?

8 A. It's a typical acute testing as described
9 by the toxicology professionals, a 30-day exposure at
10 which a given number of the test animals will
11 deliberately be exposed to the point of death so you can
12 establish the upper limit for that animal.

13 Q. Do you know what animals were used in these
14 tests?

15 A. Rats.

16 Q. Any particular kind of rat?

17 A. Oh, gosh! I don't know them all by
18 species. All I know is it's the white laboratory rat.

19 Q. After that testing, was there more acute
20 testing done by Monsanto?

21 A. More acute?

22 Q. Additional acute testing.

23 A. Additional acute. Not of the same type.

24 Q. What do you mean not of the same type?

25 A. Well, because the word "acute" shows up in

1 the subacute studies. They were also done.

2 Q. Were chronic studies done at some point?

3 A. Yes.

4 Q. When?

5 A. From '69 through '71.

6 Q. And do you know who did those?

7 A. Yes.

8 Q. Who?

9 A. Industrial Bio-Test Laboratories.

10 Q. Now, you mentioned Monsanto did subacute
11 studies?

12 A. Yes.

13 Q. What do you mean by subacute studies?

14 A. That's a 90-day study which later leads to
15 the chronic studies.

16 Q. Do you know about when they were done?

17 A. Early '69.

18 Q. Were they being done at the same time as
19 the chronic studies?

20 A. No. The chronic studies followed the
21 subacute.

22 Q. Do you know who did the subacute studies?

23 A. Industrial Bio-Test Laboratories.

24 Q. If you look at tab six, have we marked that
25 386 for identification?

1 A. Yes.

2 Q. That purports to be a memo dated November
3 14th, 1955 from Jack Garrett to Mr. H. B. Patrick at
4 Krummrich plant, subject Department 246 (Aroclors), date
5 November 14th, 1955. Have you seen that before?

6 A. Yes.

7 Q. That document states it is the opinion of
8 the Medical Department that the eating of lunches should
9 not be allowed in this department for a number of
10 reasons, and then it goes on with some reasons. Do you
11 see that?

12 A. I do.

13 Q. Item 3 says, "It has long been the opinion
14 of the Medical Department that eating in process
15 departments was a potentially hazardous procedure that
16 could lead to serious difficulties. While the Aroclors
17 are not particularly hazardous from our own experience,
18 this is a difficult problem to define because early
19 literature work claimed that chlorinated biphenyls were
20 quite toxic by ingestion or inhalation." Do you know
21 what early work Mr. Garrett is referring to?

22 A. I do not.

23 Q. Do you know whether this document was in
24 these binders that you were given in 1970?

25 A. I believe it was, yes.

1 Q. The last sentence says, quote, "In any case
2 where a workman claimed physical harm from any
3 contaminated food, it would be extremely difficult on
4 the basis of past literature reports to counter such
5 claims." Do you see that?

6 A. Yes.

7 Q. Do you agree with that?

8 A. Yes.

9 Q. Now, in your work at Monsanto, did you ever
10 hear any discussions with respect to exposures of
11 workmen with respect to an explosion at BASF in Germany?

12 A. I do not remember that.

13 Q. Do you recall any discussions of concerns
14 about dioxins being emitted during that explosion which
15 was in the 1956 time period?

16 A. I don't remember that. I have no
17 recollection.

18 Q. Do you recall any discussions with
19 Dr. Kelly or Mr. Wheeler about claims of chloracne based
20 on exposure in those explosions?

21 A. That's news to me.

22 Q. There weren't any memos on it in these
23 three-ring binders that you described for me; were
24 there?

25 A. Not to my recollection.

1 Q. Do you know the name Boehringer,
2 B-O-E-H-R-I-N-G-E-R?

3 A. I do not.

4 Q. Do you know anything as to letters being
5 sent out in 1957 to all American manufacturers,
6 including Monsanto, identifying dioxin as a contaminant
7 in 245T?

8 A. No. I'm not familiar with that.

9 Q. Do you know whether 245T was made at Nitro,
10 West Virginia by Monsanto?

11 A. I'm not very certain, but it rings a faint
12 bell.

13 Q. Do you know whether 245T is a herbicide?

14 A. Yes, I know that.

15 Q. Do you know whether it was used for the
16 same purposes as Agent Orange?

17 MR. SABETTA: Objection to form.

18 A. Well, all I know is that they are both weed
19 killers. I do not know the specific application and
20 what vegetation they are used on.

21 MR. McDONOUGH: Let's take a five-minute
22 break, ten-minute break, whatever.

23 (Reporter marked Plaintiff's Exhibits 387
24 through 399.)

25 Q. I'm showing you 387 for identification.

1 A. Yes.

2 Q. Mr. Papageorge, it's a document entitled
3 "Polychlorinated Biphenyls (PCB's), A Report on Uses,
4 Environmental and Health Effects and Disposal". Have
5 you got that in front of you?

6 A. I do.

7 Q. Have you seen that document before?

8 A. Yes.

9 Q. Did you prepare it?

10 A. I was involved in its preparation, but this
11 is really a composite of contributions from several
12 people.

13 Q. Okay. Do you know about when the document
14 was prepared?

15 A. Around 1972, '73.

16 Q. Well, since the graphs seem to go to 1977,
17 some of the information seems to go to 1977, and I see a
18 reference to a seminar in October of 1979, I think that
19 dating is probably off if you think it's '72.

20 MR. McDONOUGH: Off the record.

21 (Whereupon, there was an off-the-record
22 discussion)

23 Q. If you look at the index, it says "Section
24 1. History of Monsanto Production and Sales of
25 Chlorinated Biphenyls". Do you see that?

1 A. I do.

2 Q. Do you know who prepared that portion of
3 the document?

4 A. Well, I see some information in that
5 section of the document in which I did participate in
6 the preparation. That's the pages that have the FUR
7 003911 and 3912, up through the year '76 -- I'm sorry --
8 '75, I had that information prepared for me by
9 Monsanto's accounting department. I do not know who
10 requested the data that takes it through 1977. That
11 also applies then to these graphs that follow.

12 Q. Graphs were prepared under your supervision
13 up through 1975 and then subsequent to that under
14 somebody else's supervision?

15 A. That's my understanding of what I'm looking
16 at here. Because I remember those graphs were put
17 together while I was still actively involved.

18 Q. Now, under Section 2 of the index, back at
19 the beginning, it says "Information on Health Effects".
20 Do you know who prepared that information?

21 A. Not a specific person, but within Monsanto,
22 it would have to be the Medical Department.

23 Q. Would that have been under Dr. Roush at
24 that time?

25 A. Let me see if I can get a... Well, since

1 it does cover on into the end of '77, Dr. Roush would
2 have been in place in the position of Corporate Medical
3 Director, so whoever prepared this was to me obviously
4 reporting to Dr. Roush's organization.

5 Q. Did you prepare any parts of this section
6 dealing with health effects?

7 A. No.

8 Q. Under the index Section 3, "Monsanto's
9 Actions Resulting from Health Data," do you know who
10 prepared that section?

11 A. No, I don't.

12 Q. Section 4 is "Communicating with
13 Customers". Do you know who prepared that section?

14 A. I do not.

15 Q. Section 5, "PCB Disposal," do you know who
16 prepared that?

17 A. I do not.

18 Q. Okay. If you'll look at tab nine for me,
19 please, we've marked that Exhibit 388 for
20 identification. It purports to be, the first sheet, a
21 letter from D. Wood, Monsanto Europe, to G. R. Buchanan,
22 St. Louis, 1st December 1966.

23 A. I see that.

24 Q. Who's G. R. Buchanan?

25 A. Mr. Buchanan was a marketing representative

1 in St. Louis, and he was involved with the sale of PCBs
2 into the plasticizer applications.

3 Q. Have you seen this document before?

4 A. I don't remember it.

5 Q. I was referring to this first page.

6 A. I'm sorry. Do what with the first page?

7 Q. I was referring to the first page only of
8 388. Have you seen that before?

9 MR. SABETTA: What's the Bates number on
10 it?

11 MR. McDONOUGH: 3944.

12 A. Okay. No. That's the one I had not seen
13 before.

14 Q. Now, that purports be copied to Dr. Emmet
15 Kelly in St. Louis.

16 A. Yes.

17 Q. D.V.N. Hardy in London, R.A. Steenrod,
18 S-T-E-E-N-R-O-D, St. Louis, and A. Arpino, A-R-P-I-N-O,
19 Brussels. Who is Mr. Steenrod?

20 A. Mr. Steenrod was a member of the marketing
21 department with plasticizers located in St. Louis.

22 Q. That particular document, that first page
23 of 388, doesn't refer to plasticizers; does it?

24 A. It does not.

25 Q. It refers to Aröclor?

1 A. It does.

2 Q. Do you know who D. Wood is or was?

3 A. He was the Monsanto marketing
4 representative in Europe located -- His office was in
5 Brussels, Belgium, and he was involved with the
6 marketing of PCBs for what we called the plasticizer
7 applications.

8 Q. Did Monsanto have any plants in Europe that
9 manufactured Aroclors?

10 A. Yes.

11 Q. Where were the plants in Europe?

12 A. Newport, Wales.

13 Q. Do you know what Aroclors they manufactured
14 there?

15 A. They, in essence, made the same groupings
16 that were made in the U.S.

17 Q. Did they have their own research and
18 laboratory there?

19 A. Yes.

20 Q. Did they have their own Medical Department
21 there?

22 A. Yes.

23 Q. Do you know if they maintained a library
24 there in the Medical Department?

25 A. Yes.

1 Q. Would that be the same facility where
2 Dr. Newman worked?

3 A. Yes.

4 Q. And Dr. Hardy?

5 A. Yes.

6 Q. This copy to D.V.N. Hardy, London, do you
7 know who that is?

8 A. He's a marketing person, Monsanto employee,
9 working out of the London office.

10 Q. Now, the next page of that Exhibit 388
11 purports to be a letter of November 28th, 1966 from a
12 Rising, R-I-S-I-N-G, and Strand, S-T-R-A-N-D. It
13 appears to be signed by an Ola, but I can't quite tell
14 from the copy. Is your copy better than mine?

15 A. I believe you're right.

16 Q. Would that be the Ola Palm that the
17 December 1st, 1966 letter refers to?

18 A. December 1st? Yes. Ola Pond, yes.

19 Q. Did Monsanto have facilities in Sweden?

20 A. No.

21 Q. Have you ever seen this letter, November
22 28th, 1966 before?

23 A. Yes.

24 Q. When did you see that?

25 A. During my tutorial.

1 Q. Was that part of your notebooks?

2 A. Yes.

3 Q. That references some testing that was done
4 in Sweden; is that correct?

5 A. Yes.

6 Q. Now, do you know about when it was that you
7 saw the letter? Was that in 1970 when you started
8 there?

9 A. About January '70, yes, sir. This is one
10 of the earliest documents I was shown.

11 Q. Do you know who showed it to you?

12 A. Elmer Wheeler.

13 Q. Did he discuss it with you?

14 A. Yes.

15 Q. Did he indicate whether Monsanto had done
16 anything in reference to this correspondence?

17 A. Yes.

18 Q. What did he tell you?

19 A. Well, initially David Wood located in
20 Brussels went to the University of Stockholm to
21 personally talk with the investigators who made the
22 report about finding a strange material in their samples
23 that was interfering with their analysis for DDT, and to
24 establish some sort of communications for reporting
25 further results and to get from those researchers a copy

1 of the procedures they followed to make their analyses.

2 Q. Mr. Willard told you that Mr. Wood did
3 that?

4 A. Yes.

5 Q. Were the procedures given to Monsanto at
6 about that time?

7 A. Yes.

8 Q. Did you ever see those procedures?

9 A. Yes, I did.

10 Q. Did Monsanto have similar procedures in its
11 laboratories at about that time?

12 A. No. They were -- No, they didn't.

13 Q. What was the difference between any
14 procedures you had in the Monsanto labs and the
15 procedures here in Sweden?

16 A. The primary difference is the availability
17 of the latest in analytical instruments. It's a
18 specially-ordered instrument that had to be in place,
19 and that created the difference in capabilities between
20 the two labs.

21 Q. What was the name of the instrument?

22 A. I've forgotten now, but it's a gas liquid
23 chromatogram and spectrophotometer.

24 Q. Do you -- I'm sorry.

25 A. That's it.

1 Q. Do you recall who the manufacturer was?

2 A. No, I don't.

3 Q. Did Monsanto obtain one?

4 A. Yes.

5 Q. When?

6 A. As I remember, it took about a year for
7 delivery, and it was ordered in '67, so about 1968.

8 Q. Was that delivered to any particular
9 laboratory at Monsanto?

10 A. Yes. To Dr. Keller's group.

11 Q. Did he begin to perform analysis at that
12 time?

13 A. Oh, certainly, but he performed analyses
14 with the old style instruments before the new instrument
15 came along.

16 Q. What did he perform analysis on?

17 A. PCBs.

18 Q. What was the purpose of his analysis?

19 A. To be able to detect the presence of PCBs
20 in all types of samples at low levels.

21 Q. So, as I understand it, he took water,
22 earth, things of that sort, and then tested them to see
23 if he could determine if PCBs were present in them?

24 A. Yes. And in order to do that, he
25 deliberately contaminated them and then ran them through

1 the instrument to see if his numbers matched the input.

2 Q. Did they?

3 A. I'm sorry?

4 Q. Did his numbers match the input?

5 A. Not initially because they were still
6 learning, but with the analysis of the difference in
7 numbers, they were able to, in essence, close the gap,
8 and they got better and better with time.

9 Q. Did he do any analysis on material that he
10 hadn't contaminated deliberately with PCBs?

11 A. At what time?

12 Q. 1968, right after you got the equipment you
13 were referring to at Monsanto.

14 A. Yes. They did go out and get some soil
15 samples around the plants, soil near the operation and
16 so on.

17 Q. And did they find that these soils had PCBs
18 in them?

19 A. Yes.

20 Q. And did you know when that first was found?

21 A. Late '68 is the best I can recall.

22 Q. Now, was that prior to obtaining the better
23 equipment?

24 A. I think about the time the new equipment
25 came in place they were able to feel more confident of

1 the numbers.

2 Q. What did the new equipment add to the
3 analysis from Monsanto's point of view?

4 A. It produced a graph that was consistent
5 each time they ran the sample, and by graph I'm talking
6 about the peaks and valleys of a chart which point out
7 the types of PCBs and the amounts.

8 Q. Did the new equipment quantify whereas the
9 old equipment did not quantify?

10 A. Well, it tried to, but once in a while it
11 would blend the peaks or skip and make a valley when it
12 shouldn't have. So it had its limitations.

13 Q. Was it possible to get some quantification
14 from the old equipment?

15 A. Yes. But they had difficulty duplicating.
16 They never felt comfortable with whatever number they
17 came up with.

18 Q. Did you ever have any discussions with
19 Dr. Keller about his results of these analyses that he
20 was performing in about 1968?

21 A. Yes.

22 Q. Was he surprised that there were PCBs in
23 the environment?

24 A. Oh, yes.

25 Q. Why?

1 A. Primarily because of the presence in things
2 or samples that were not associated with industrial
3 applications, and PCBs from Monsanto's viewpoint were
4 looked upon as industrial chemicals. They are not the
5 kind you find in a pine forest, for example. How did it
6 get there? Those are the questions that these answers
7 were bringing up.

8 Q. Did Dr. Keller express surprise that you
9 found them in the soils around the Monsanto plants that
10 manufactured these chemicals?

11 A. No. He expected to find them there, and he
12 expected to find them in the same condition as they
13 would be right out of the manufacturing system.

14 Q. And why was that?

15 A. Because of the understanding that these
16 were nonreactive. They stayed the same no matter what
17 happened.

18 Q. They were inert or expected to be inert?

19 A. They were expected to be inert, inactive.

20 Q. They were expected to be pebbles on the
21 beach?

22 A. Yes.

23 Q. So as I understand your answer,
24 Dr. Keller's surprise was with respect to the extent
25 that the PCBs had migrated from the factories?

1 A. That was one of the surprises.

2 Q. What other surprises did he have?

3 A. The other surprises, as you proceeded
4 further from the plant, the composition of that PCB
5 would change, indicating that something was affecting
6 the lower chlorinated PCBs.

7 Q. Do you know if Dr. Keller attempted to do
8 any testing with either the old equipment or the new
9 equipment in 1968 with respect to dioxins or
10 dibenzofurans being present?

11 A. Not at that time.

12 Q. Did he do any testing on Pyranol in 1968 in
13 terms of presence of dioxins or dibenzofurans?

14 A. No.

15 Q. Did Dr. Keller produce reports with respect
16 to his test, his tests?

17 A. Certainly.

18 Q. These earlier tests that you've told me
19 about about the acute animal studies and the chronic
20 animal studies, was that usual that Monsanto would test
21 industrial chemicals in that manner?

22 MR. SABETTA: Objection to form.

23 A. This is the first example that Monsanto and
24 I personally heard of an industrial chemical being
25 tested in a manner similar to the tests given to

1 materials approved for food grade or pharmaceutical use,
2 so it was a first.

3 Q. As I understand it, the Department of
4 Agriculture makes you test for chemicals that are used
5 in foods?

6 A. The Food and Drug Administration is the one
7 that monitors and approves the use in foods. The
8 Department of Agriculture makes certain that what I'm
9 going to call the farm produced meat and so on meets
10 acceptable standards.

11 Q. Who tests for pharmacological chemicals?

12 A. Food and Drug Administration.

13 Q. So as I understand it, there's no
14 requirement, there was no government requirement for
15 testing Aroclors in this fashion that you did for acute
16 and chronic studies; is that correct?

17 A. That is correct.

18 Q. And this is the first chemical that
19 Monsanto has tested in that fashion?

20 A. That anyone has tested in that fashion.

21 Q. Why did you test it in that fashion?

22 A. To answer the question of if it's out there
23 what harm, if any, can it do.

24 Q. And I think you told me that some of the
25 acute testing took place in the 1950's; is that correct?

1 A. Yes.

2 Q. Did Monsanto know that it was out there in
3 the 1950's?

4 A. It didn't know, but it assumed that if any
5 did get out into the environment -- And the thing really
6 was associated with industrial sites. If it did get out
7 there, there was nothing to indicate any harm would be
8 done.

9 Q. That's why I'm asking what the basis for
10 doing the testing was in the 1950's, the animal testing.

11 A. Something came up to trigger the retesting.
12 Oh, as I remember, the -- I'm trying to remember the
13 name of the group. The American Institute of Government
14 Industrial Hygienists, AIGIH or IH, they were looking
15 for levels of exposure that they would include in their
16 published list of industrial chemicals, and Monsanto
17 conducted those tests to come up with the numbers that
18 were eventually adopted by the AIGIH.

19 Q. Was the lead investigator on those Treon?

20 A. Yes. That's the name I associate with it.

21 Q. And did Monsanto retain Treon as a
22 consultant?

23 A. I don't know the official relationship. I
24 do know that there was a continual dialogue. I don't
25 know if he was an official consultant.

1 Q. Let's get rid of the word "consultant". Do
2 you know if Monsanto sponsored the studies?

3 A. Yes. The studies that we saw earlier with
4 Kettering.

5 Q. Yes.

6 A. That was Monsanto's activity.

7 Q. Okay. Were the Treon studies -- Are they
8 the same as Kettering?

9 A. I'm under the impression they were the same
10 as the Kettering.

11 Q. Did Monsanto pay for those studies?

12 A. That's my understanding.

13 Q. Can you tell me why?

14 A. This is a Monsanto product. Anything to do
15 with these products would immediately be associated with
16 Monsanto, so how could we expect others to do the
17 studying?

18 Q. But up until this point, as I understand
19 your opinion, they are like pebbles on the beach. I'm
20 trying to get at why Monsanto would do all of this
21 testing if they were like pebbles on the beach.

22 MR. SABETTA: Objection, asked and
23 answered.

24 A. Well, the intent was to get data to help
25 the worker that is exposed to these chemicals at

1 Monsanto plants and the customers' plants, which is
2 different than the environmental effect that might be
3 out there.

4 Q. Haven't you said on many occasions
5 throughout the paper that you prepared for Monsanto that
6 there were no occasions where the workers were exposed
7 other than -- or suffered other than once that you knew
8 of?

9 MR. SABETTA: Objection to form:

10 A. I guess that's true, but that's under
11 industrial conditions with respirators on the shelf to
12 grab, a change of shoes, a change of clothing, a lot
13 different than the average person on the street.

14 Q. What workers were you talking about? The
15 Monsanto workers or --

16 A. Any workers that are handling PCBs.

17 Q. If you turn to the next tab, please, we've
18 marked that 389 for identification. It purports to be a
19 letter, January 16th, 1968, from the United States
20 Department of the Interior, Fish and Wildlife Service.
21 Richard A. Wilson, to Monsanto Chemical Company. Have
22 you seen that before?

23 A. Yes.

24 Q. Was that in your notebook?

25 A. Yes.

1 Q. Do you know whether Monsanto sent samples
2 of Aroclors to the United States Department of the
3 Interior as requested?

4 A. Yes.

5 Q. Who sent them?

6 A. The samples were sent out of Monsanto from
7 Dr. Keller's group. I don't know the specific
8 individual who put them in the box and mailed them.

9 Q. Do you know if they were specially prepared
10 samples?

11 A. No. They come off the shelf.

12 Q. How do you know that?

13 A. That's the way it's done, the practice.

14 Q. Had Monsanto been requested for chemicals
15 before for testing by some government agency?

16 A. Oh, yeah. Many times.

17 Q. Was it Monsanto's practice to give the
18 agency a standard sample from a regular run of the
19 industrial chemical?

20 A. Yes.

21 Q. Did Monsanto have any practice of blending
22 chemicals together prior to sending them to a government
23 agency?

24 A. Oh, no. That would be -- No. That
25 wouldn't be condoned. It has to be associated with a

1 batch number, a lot number, and a date, and where was it
2 manufactured and who packaged it. There is a little
3 history that goes with it that's got to be kept and
4 respected.

5 Q. You can't think of any scientific basis for
6 why a company would submit a blend of a chemical to a
7 government agency that it asked for a chemical for
8 sampling?

9 MR. SABETTA: Objection to form.

10 A. I personally would find that disturbing at
11 best. I'd like to know that this material I have is
12 associated with a process that started on a date and
13 these things happened and was put into this bottle on a
14 given date.

15 Q. Could we turn to the next tab we've marked
16 Exhibit 390, something entitled "Minutes of Meeting of
17 the Corporate Development Committee, April 22nd, 1968,"
18 which purports to be an abbreviated redacted version of
19 minutes. Have you ever seen that before?

20 A. I don't recall seeing this.

21 Q. Do you know who the Corporate Development
22 Committee is or was at that time period?

23 A. In this particular exhibit, they are listed
24 on the front page. They are members. They include the
25 top official in Monsanto and some of his senior vice

1 presidents and an individual who's designated as a
2 secretary to keep notes.

3 Q. Was there anybody in that group of eight
4 names listed on the first part of Exhibit 390 members of
5 Mr. Springgate's or Mr. Bergen's groups?

6 A. No. These people are several levels above
7 them.

8 Q. Are they above Mr. Minkler's level?

9 A. Oh, yes.

10 Q. Do you know what the purpose of the
11 Corporate Development Committee is other than corporate
12 development?

13 A. They are to serve as the group that guides
14 the corporation in some of its key activities.

15 Q. If you turn to the second page of Exhibit
16 390, in the first paragraph it says Dr., and I'll spell
17 it, A-N-A-G-N-O-S-T-O-P-O-U-L-O-S, "reviewed the
18 functional fluids group. Phosphate esters and Aroclor
19 are the two major products in this group. The product
20 group expects to be above the 1968 budget in terms of
21 ROI and on the objective line for net income." Do you
22 see that?

23 A. Yes.

24 Q. Do you know who that doctor referred to is?

25 A. Yes. He is the individual that preceded

1 Mr. Bergen. Constantine that I tried to remember
2 earlier. He was the business group director of the
3 functional industrial fluids group.

4 Q. Would that allow you to place a date on
5 when Mr. Bergen started in that position?

6 A. Yes. That would zero in more and more on
7 1969.

8 Q. Was Mr. Bergen there when you got to your
9 position in January 1970?

10 A. Yes.

11 Q. Do you know what ROI refers to?

12 A. Return on investment.

13 Q. Do you know what "on the objective line for
14 net income" means?

15 A. I can only share with you my interpretation
16 of that. It's a line that was plotted to designate the
17 objective of the business group.

18 Q. If you look at the last paragraph on that
19 page, it says, "In the case of Aroclor the key issue
20 becomes how to significantly increase the sales growth
21 while maintaining the domestic supply position and
22 profitability. It is believed that transformers and
23 heating systems provide the major opportunities. A
24 target of ten percent of the transformer market by 1972
25 has been set. In the case of Therminol we have about a

1 \$1 M business in 1968 and a target of \$10--20 M business
2 by 1972. In this area, a total systems approach is
3 being used; supply the fluids, design the system and
4 supply the hardware." Do you note that?

5 A. Yes.

6 Q. Do you know what M refers to?

7 A. M with a bar on top is million.

8 Q. What is M without a bar on top?

9 A. Thousand.

10 Q. What's the billion dollar mark that
11 Monsanto uses in its documents? Have you seen it?

12 A. In its documents?

13 Q. Yeah.

14 A. All I recall is the M with the bar over it.

15 Q. What's Therminol?

16 A. Therminol is the registered trademark of
17 fluids used in heat transfer systems.

18 Q. Does that particular fluid contain
19 Aroclors?

20 A. Some of them.

21 Q. Did there come a time when Aroclors were
22 not sold for that particular purpose?

23 A. Yes.

24 Q. About when was that?

25 A. About '72. 1972.

1 Q. All right. If you look at tab 13 for me,
2 please, we've marked as Exhibit 391 a two-page document
3 dated December 30th, 1968, W. R. Richard to W. A. Kuhn,
4 K-U-H-N on Aroclor -- Wildlife. Have you got that in
5 front of you?

6 A. I do.

7 Q. Have you ever seen that before?

8 A. Yes.

9 Q. Now, this was -- Withdraw that. Do you
10 know who W. R. Richard was?

11 A. Yes.

12 Q. Who was he?

13 A. He was the individual in charge of research
14 in the industrial fluids business group.

15 Q. Was he part of Dr. Keller's testing group?

16 A. No. No. Dr. Keller is analytical
17 chemistry.

18 Q. What's Mr. Richard?

19 A. It's a broader field of finding chemicals
20 or developing new chemicals and finding applications for
21 these new chemicals.

22 Q. Is he superior to Dr. Keller in terms of --

23 A. I think they are --

24 MR. SABETTA: Let him finish the question.

25 Q. In terms of the structure there in research

1 and development?

2 A. I think they are peers within the overall
3 organization.

4 Q. I don't know if I asked you. Have you seen
5 this document before?

6 A. Yes.

7 Q. Now, it notes in the fourth paragraph down,
8 "We are taking three steps to protect ourself. Scott
9 Tucker and R. Keller are to repeat some of the
10 analytical identification work feeding Aroclor to
11 chickens and seeing if Aroclor is really present as
12 'shown' by the literature. I hope we have been falsely
13 accused but maybe Aroclor is present." Do you see that?

14 A. I do.

15 Q. Is that R. Keller Dr. Keller that we've
16 been referring to?

17 A. Yes.

18 Q. Did Dr. Keller participate in feeding
19 chickens?

20 A. No.

21 Q. Were there some chicken studies done about
22 then?

23 A. They were started.

24 Q. Who was doing that?

25 A. Industrial Bio-Test Laboratories.

1 Q. Do you know what it refers to when it says
2 "seeing if Aroclor is really present as 'shown' by the
3 literature"? Do you know what the author is referring
4 to?

5 A. Based on the information available at that
6 time, it has to refer to the University of Stockholm
7 studies.

8 Q. So does that indicate they were going to
9 test the chicken eggs to see if there was presence of
10 Aroclors?

11 A. You mean the University of Stockholm
12 studies?

13 Q. No. The Monsanto studies, the chicken
14 feeding that R. Keller and Scott Tucker were supposed to
15 do.

16 A. Yeah. They were supposed to arrange for
17 some chickens to be fed and their tissue analyzed to see
18 if it stayed within their bodies.

19 Q. Were those tests done?

20 A. Eventually, yes.

21 Q. How eventually?

22 A. Late '71, as best I recall.

23 Q. And did Industrial Bio-Test do those?

24 A. They did the whole study and saved samples
25 and sent them to Dr. Keller and Dr. Tucker to analyze.

1 Q. And did the results show whether Monsanto
2 had been falsely accused?

3 MR. SABETTA: Objection to form.

4 A. No. The PCBs were found.

5 Q. In the last paragraph, it says, "E. Wheeler
6 is having feeding tests done on animals to establish a
7 'safe' level for Aroclor feeding. If we can find a
8 'safe' level, Calandra's lab will do two year
9 experiments on animals including effects on succeeding
10 generations. This will help a bit, but the wildlife
11 people won't be stopped by this kind of evidence." Do
12 you see that?

13 A. Yes.

14 Q. What is the reference to Calandra's lab?

15 A. Dr. Calandra was the principal individual
16 with Industrial Bio-Test Laboratories.

17 Q. Was he subsequently indicted along with
18 three other Industrial Bio-Test employees for falsifying
19 test results for federal government analysis?

20 MR. SABETTA: Objection to form.

21 A. All I recall, and I got this from public
22 press, that Dr. Calandra was accused of some illegal
23 wrongdoing, and that's as much as I know.

24 Q. Do you know whether Monsanto ever went back
25 over the Industrial Bio-Test test results and did an

1 analysis as to whether they were accurate or falsified?

2 MR. SABETTA: Objection to form.

3 A. Which products?

4 Q. Do you understand that Dr. Calandra and the
5 other Industrial Bio-Test individuals were indicted with
6 respect to Monsanto products that were not Aroclors?

7 MR. SABETTA: Objection.

8 A. That's my understanding.

9 Q. All right. Did Monsanto go back and test
10 the Industrial Bio-Test work that had been done to
11 determine if it was accurate with respect to those
12 products?

13 MR. SABETTA: Objection to form. Which
14 products are you referring to? The Aroclors or the
15 non-Aroclors?

16 Q. The products that they got indicted on.

17 A. I don't know.

18 Q. After Monsanto found out that Dr. Calandra
19 and the others had been indicted with respect to certain
20 products and test reports on certain products, did they
21 ever do a review or analysis on the results that
22 Industrial Bio-Test had been giving them on Aroclors?

23 A. Yes.

24 Q. Who did that?

25 A. Elmer Wheeler, Dr. Levinskas and Fred

1 Johansen.

2 Q. Was that review done in writing?

3 MR. SABETTA: Objection to form.

4 Q. I'll withdraw it. Were there any documents
5 produced as a result of that review?

6 A. I don't remember any personally. That
7 doesn't mean -- I just don't remember it.

8 Q. How do you know that it was done?

9 A. Well, I was informed that they were looking
10 over the study, and this was after, as best I recall,
11 after I was removed from the PCB issue.

12 Q. You mentioned a study in your answer. Was
13 there one particular study they were looking at?

14 A. No. The studies.

15 Q. If you turn the page on Exhibit 391, up at
16 the top of the second page, it says, "The third step is
17 to minimize exposure of Aroclor to reduce air and water
18 pollution, to restrict Aroclor to uses which can be
19 controlled. This is the only way I see to survive." Do
20 you see that?

21 A. I do.

22 Q. Do you know what that refers to?

23 MR. SABETTA: Objection to form.

24 Q. Withdraw it. Did Monsanto restrict Aroclor
25 to uses which can be controlled?

1 A. Yes.

2 Q. Do you know when they did that?

3 A. The first restriction became effective on
4 August 30, 1970.

5 Q. And do you know what product was entailed
6 in that restriction?

7 A. These were the PCBs used in what Monsanto
8 referred to as open uses.

9 Q. Can you tell me what those open uses were?

10 A. I can give a few examples. Like lacquers,
11 varnishes, caulking, the painted stripes on the
12 highways. Any application that was not inside a sealed
13 system.

14 Q. Did you restrict plasticizers at that
15 point?

16 A. I thought that's what I said, yeah.

17 Q. Well, I didn't hear it. How are people
18 exposed to painted stripes on the highway?

19 A. Well, this refers to environmental
20 contamination.

21 Q. How is that environmental contamination
22 going to take place? Paint was going to wash off?

23 A. Eventually it does wear off and gets
24 distributed.

25 Q. Do you know what percentage of Monsanto's

1 PCB business was entailed in that August 30th, 1970
2 restriction?

3 A. I think you'll find it in the previous
4 document here. I don't remember the number.

5 Q. What uses were not restricted as of that
6 August 30th, 1970 time period?

7 A. The uses not restricted were the dielectric
8 applications, the industrial hydraulic fluids, and the
9 heat transfer systems.

10 Q. Can you give me an example of a heat
11 transfer system use of PCBs that you're referring to?

12 A. I'll try. Let's suppose you have a process
13 that involves, say, the cooking of varnish, and by
14 putting a gas or oil flame under the pot that this
15 varnish is in, you run the risk of overflowing and
16 subsequent fire. In order to avoid that risk, you use a
17 heat transfer fluid in a closed system where the fluid
18 is heated in one building to a high temperature, and the
19 hot fluid is pumped into that second building where the
20 varnish is located, and with coils inside or outside of
21 that tank you heat the varnish. So any spillage that
22 occurs there won't catch fire. There is no flame.

23 Q. Do you know generally what temperatures
24 those heat transfer units operated at?

25 A. Generally about 400 Fahrenheit.

1 Q. How does that convert to centigrade?
2 A. Centigrade? Roughly half.
3 Q. Do you know if Monsanto was aware of the
4 Yusho incident in 1968?
5 A. In 1968? No, it was not aware of it.
6 Q. What do you base your answer on?
7 A. Because not even the government knew about
8 it until early '69 or so.
9 Q. The government doesn't know a lot of
10 things.
11 A. I understand that.
12 Q. Did Yusho occur in 1968?
13 A. That's my understanding, yes.
14 Q. Did Monsanto have sales in Japan in 1968?
15 A. No.
16 Q. Did they have employees in Japan in 1968?
17 A. Yes.
18 Q. What were they doing with respect to
19 Monsanto's work?
20 A. I don't understand the question.
21 Q. Well, I think you told me there were
22 employees of Monsanto in 1968 in Japan.
23 A. Yes.
24 Q. What were they doing?
25 A. Selling Monsanto products.

1 Q. Did that include Aroclors?

2 A. Not at that time.

3 Q. Why do you say not at that time?

4 A. A plant was finally built in Japan in a
5 joint venture, and Aroclors, Monsanto's trademark, were
6 marketed briefly.

7 Q. Was that a joint venture with Monsanto and
8 someone else?

9 A. Yes.

10 Q. Who was the someone else?

11 A. Mitsubishi.

12 Q. What period of time were Aroclors marketed
13 briefly?

14 A. '69. Say late '69, early '70.

15 Q. Was that less than a year that they were
16 marketed in Japan?

17 A. Yes.

18 Q. What happened with respect to that
19 particular plant production of Aroclors?

20 MR. SABETTA: Objection to form.

21 Q. Withdrawn. Why was it only marketed for a
22 year in Japan?

23 A. It was decided that in the face of these
24 reports that were coming in regarding the environment
25 and the plan within Monsanto to start phasing out that

1 it was prudent not to market PCBs in Japan any longer.

2 Q. Did the Japanese government pass a ban on
3 marketing and manufacture of PCBs?

4 A. No.

5 Q. They did not?

6 A. I'm sorry?

7 Q. They did not?

8 A. They did not.

9 Q. Are PCBs still sold in Japan?

10 A. The last I knew, yes.

11 Q. Who sells them? Do you know?

12 A. Kanega Fuchi.

13 Q. Does Monsanto still sell them in Japan?

14 A. Sell what?

15 Q. PCBs.

16 A. Monsanto doesn't make any PCBs.

17 Q. What did -- After the discontinuance of the
18 marketing of PCBs by Monsanto in Japan, what did that
19 plant do?

20 A. I do not know.

21 Q. Do you know when Monsanto found out about
22 the Yusho incident?

23 MR. SABETTA: Objection to form.

24 Q. Withdrawn. Did Monsanto find out about the
25 Yusho incident?

1 A. Yes. Eventually they did.

2 Q. And when was that?

3 MR. SABETTA: Objection to form.

4 A. I personally don't know when they found
5 out.

6 Q. When you started work in your job in
7 January of 1970, did Dr. Kelly and Mr. Wheeler know
8 about Yusho?

9 A. Yes.

10 Q. What did they tell you about it?

11 A. They reported to me about the incident and
12 what they knew about it at the time.

13 Q. Did they tell you how long they had known
14 about the incident?

15 A. No. That never came up in their
16 discussion.

17 Q. Did you get any articles or journals or
18 literature or materials on Yusho in your notebooks?

19 A. I recall seeing a column article, but I
20 don't recall whether it was in that notebook or brought
21 to my attention later on in 1970.

22 MR. McDONOUGH: Could I have that answer
23 back, please?

24 (Whereupon, the reporter read back witness'
25 answer.)

1 Q. When you say "column article," are you
2 referring to a newspaper article?

3 MR. SABETTA: Just let him finish the
4 question before you answer.

5 A. It's similar to a newspaper column, but
6 that same kind of column appears in trade journals.

7 Q. What did Dr. Kelly and Mr. Wheeler tell you
8 about Yusho when you had your tutorial with them in
9 January 1970?

10 A. They mentioned that rice bran oil was
11 consumed by people in a certain locale. The individuals
12 who consumed it had some health problems, and they were
13 determined to have consumed an oil contaminated with
14 PCBs, and the PCBs got into the oil because of a leak in
15 the system where a PCB used as a heat transfer fluid
16 leaked into the oil that was later sold.

17 Q. Did they tell you in this tutorial in
18 January of 1990 that there was any involvement of
19 dibenzofurans with respect to that Yusho incident?

20 A. No. There was no inkling as to what could
21 be causing the health effects that were noted at that
22 time.

23 MR. SABETTA: If you have other questions
24 on this subject, I'll let you ask them, but I was going
25 to suggest maybe it would be a good time to break for

1 the day because I don't want to push him too long on the
2 first day. If you want to finish up --

3 MR. McDONOUGH: What time is it?

4 MR. SABETTA: It's a little after 5:00.

5 Q. Why don't I finish with this exhibit
6 anyway. Do you feel okay?

7 A. Yes.

8 Q. I've only got about five more questions.
9 Who is this Mr. Kuhn referred to in this 391?

10 A. He was the Monsanto employee, a member of
11 the industrial fluid business group that was responsible
12 for manufacturing of the chemicals sold by that business
13 group.

14 Q. Was Mr. Richard Mr. Kuhn's boss at that
15 time?

16 A. No. They are peers.

17 Q. The next paragraph on page two says, "I
18 believe we should make sure that our plants have minimum
19 air or stream pollution. I believe Anniston is
20 vulnerable and that off-gas HCl and Aroclors should be
21 100 percent controlled. Krummrich may also need help."
22 Do you know what he's referring to there?

23 A. Not really.

24 Q. Do you know if Mr. Richard is a lawyer?

25 A. No. He's a research director.

1 Q. The next paragraph -- I'm sorry.

2 A. Go ahead.

3 Q. The next paragraph says, "I believe we
4 should demonstrate that Aroclor can be incinerated to
5 harmless products for disposal." Do you see that?

6 A. I do.

7 Q. Do you know whether Aroclor was ever
8 demonstrated to be incinerated to harmless products?

9 A. Yes.

10 Q. Do you know when that was?

11 A. That was done in March of 1970.

12 Q. And do you know what particular employee of
13 Monsanto was involved in that project to determine if it
14 could be incinerated to harmless products?

15 A. Well, I was involved. Scott Tucker, the
16 analytical chemist, was involved. And I'm trying to
17 think of the individual from Monsanto's corporate
18 engineering department who was responsible for the
19 design and selection of the equipment.

20 Q. How was it determined that the material
21 could be incinerated to harmless products?

22 A. There were some preliminary studies made in
23 the laboratory, small amounts at which temperatures
24 could be controlled and measured, and the gases that
25 were released from this incineration could be captured

1 and analyzed. That information was passed on to the
2 designer of the incinerator, and he had a test unit
3 built that was demonstrated to be capable of doing what
4 was performed in the laboratory.

5 Q. Do you know if Dr. Keller's analytical
6 group participated in that particular demonstration?

7 A. Scott Tucker represented that group,
8 Dr. Tucker.

9 Q. In the last paragraph it says in the
10 next-to-last sentence -- Well, I'll read the whole
11 paragraph. "We probably have six months to one year
12 while they fight out the DDT case. I want to use this
13 time to minimize our exposure. We will need your help
14 in setting TSD targets." Do you see that?

15 A. Yes.

16 Q. Do you know what TSD targets means?

17 A. That is a department back at the plants,
18 and the letters stand for Technical Services Department.

19 Q. Do you know if TSD targets were set?

20 A. Oh, yes.

21 Q. Who set them?

22 A. Well, the level of exposure to employees
23 was set by this American Congress of Governmental
24 Industrial Hygienists. Now, all of this doesn't happen
25 overnight. This evolved. The amount in water was set

1 at ten parts per billion, which was the level that
2 Dr. Tucker and Dr. Keller felt was measurable and
3 reproducible. That kind of thing happened.

4 Q. There was a Technical Service Department as
5 I understand it at Monsanto at this time?

6 A. At each plant. At the Anniston plant, at
7 the Krummrich plant.

8 Q. And the head of that Technical Service
9 Department was at each one of those plants?

10 A. Yes.

11 Q. Who was at the Anniston plant that headed
12 it at that time?

13 A. I can see his face, but I can't remember
14 his name.

15 Q. Well, let's save his face until tomorrow.

16 (Deposition was adjourned to be continued
17 to April 28, 1999 at 9:30 a.m.)
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25

NOTARIAL CERTIFICATE

STATE OF MISSOURI)
CITY OF ST. LOUIS)

-I, FAITH A. OLLIGES, a Registered Professional Reporter and a duly commissioned Notary Public within and for the State of Missouri, do hereby certify that there came before me at the offices of Husch & Eppenberger, 100 North Broadway, St. Louis, Missouri,

WILLIAM B. PAPAGEORGE, P.E.,

who was by me first duly sworn to testify to the truth and nothing but the truth of all knowledge touching and concerning the matters in controversy in this cause; that the witness was thereupon examined under oath and said examination was reduced to writing; that the signature of the witness was not waived by agreement of all parties, and this transcript is a true and correct record of the testimony given by the witness.

I further certify that I am neither attorney nor counsel for nor related nor employed by any of the parties to the action in which this deposition is taken; further, that I am not a relative or employee of any attorney or counsel employed by the parties hereto or financially interested in this action.

IN WITNESS WHEREOF, I have hereunto set my hand and seal on May 3, 1999.

My commission expires March 21, 2001.

Notary Public

STATE OF NEW YORK
SUPREME COURT: COUNTY OF BROOME

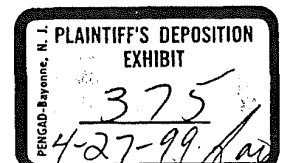
JAMES L. and BARBARA A. FURCH, RICHARD F. and)
KATHRYN S. GARDNER, GERALD E. and LINDA O'NEILL,)
WILLIAM G. and HELEN STAUB, JAMES F. and)
KATHLEEN SNYDER, GEORGE S. and BARBARA L.)
ROGALAVICH, JACK L. and DOLORES P. MEDOVICH,)
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JOHN F. and ALBERTA CASEY, JAMES A. and)
ROSEMARY COLGAN, PAUL B. HORNICK, JOHN P. and)
MARY ELLEN WHALEN, CHARLES E. DEARBORN, GERALD F.)
and CAROL MULLINS, JAMES B. and DONNA MAHAR,)
BRIAN P. and MICHELLE O'LOUGHLIN, DONALD C. and)
KIM EDWARDS, RONALD L. and BARBARA McMAHON,)
BERNARD A. and SHARON MASSAR, WILLIAM F. and)
MARY ANNE KOZEL, ANTHONY J. and EDITH WINKLER,)
TIMOTHY E. and DOROTHY M. KOLOSKI, RICHARD J.)
and RITA ANN KINNEY, RONALD E. and CAROLYN A.)
HOWE, CLIFFORD C. and NADINE COLGAN, THOMAS M.)
BUTCHKO, DONALD T. and JACQUELINE FOLEY, MARIO A.)
and MARIE E. PIROZZI, ROGER E. and GAIL JULIAN,)
Plaintiffs,)

-vs-

GENERAL ELECTRIC COMPANY, NEW YORK STATE ELECTRIC)
& GAS CORPORATION, MONSANTO COMPANY, THE DOW)
CHEMICAL COMPANY, BEC ELECTRIC CO., INC., JOHN B.)
CUMMINGS and GEORGE H. PASH, JR., d/b/a CUMMINGS)
AND PASH, PHILLIPS L. ST. JOHN, HOWARD O. WARD,)
EDWIN C. GENT, AND STEPHEN JONES, III, d/b/a ST.)
JOHN ASSOCIATES, ST. JOHN ASSOCIATES-ENGINEERS,)
and VINCENT J. SMITH, INC.,)
Defendants.)

ACTION #1

Index No.
137082



EDWARD MOSHER, MADALYN MOSHER, THOMAS KRESS,
SUSAN KRESS, CHARLES SIMONS, ROSE SIMONS,
JAMES E. NEISS, BETTY NEISS, and GARY M. O'NEILL,

Plaintiffs,

-vs-

GENERAL ELECTRIC COMPANY, NEW YORK STATE ELECTRIC
& GAS CORPORATION, MONSANTO COMPANY, THE DOW
CHEMICAL COMPANY, BEC ELECTRIC CO., INC., JOHN B.
CUMMINGS and GEORGE H. PASH, JR., d/b/a CUMMINGS
AND PASH, PHILLIPS L. ST. JOHN, HOWARD O. WARD,
EDWIN C. GENT, AND STEPHEN JONES, III, d/b/a ST.
JOHN ASSOCIATES, ST. JOHN ASSOCIATES-ENGINEERS,
and VINCENT J. SMITH, INC.,

Defendants.

ACTION #2

Index No.
137081

DEFENDANT MONSANTO COMPANY'S RESPONSE
TO PLAINTIFFS' INTERROGATORIES

COMES NOW the defendant, Monsanto Company (hereinafter
"Monsanto"), and for its response to plaintiffs' interrogatories,
says as follows:

GENERAL OBJECTIONS AND LIMITATIONS

1. Monsanto objects to any and all interrogatories to the
extent that they seek privileged communications or attorney work
product protected from disclosure under CPLR, §§ 3101 and 4503 of
the State of New York.

2. Monsanto objects to any and all interrogatories to the
extent that they seek confidential, financial or business informa-
tion without the protection of an acceptable form of stipulation
and protective order adequate to preserve the confidentiality of
such information.

MEMO OF
DATA TRANSMITTAL

GENERAL ELECTRIC
C O M P A N Y

Refer to G.E. Req'n No.
In Correspondence

March 22, 1971

MEDIUM TRANSFORMER DEPARTMENT
ROME, GEORGIA

(DATE)

CUSTOMER

General Electric Supply Company

STATION OR PROJECT NO.

CUSTOMER ORDER

CUSTOMER REQ.

G.E. CONTRACT

G.E. REQUISITION

7150-027268DX

306-36351

PRINTS ARE:

☐

FOR APPROVAL

☒

FOR INSTALLATION

☐

FOR REFERENCE

☐

APPROVAL REQUIRED BY

(DATE)

RETURN OF "FOR APPROVAL" PRINTS SHOULD BE ADDRESSED TO THE
GENERAL ELECTRIC OFFICE WITH WHOM YOUR ORDER IS PLACED.

—NOT TO THE FACTORY—

Drawings are intended to be in accordance with applicable purchase order specifications. Comments are solicited concerning any departures in this respect. Features not covered by purchase order specifications portray General Electric Company standard design practice. The shipping date for this equipment is based on obtaining approval by the above specified date, and any delay in approval may extend the shipping schedule. Any requested changes from the purchase order specifications, resulting in additional engineering and/or manufacturing costs, will entail an increase in price and the extension of the shipping schedule.

Prints to:

10- Bec Electric Company, P.O. Box 41, Eastwood Station, Syracuse, New York 13206

1- Carl Larrabee, Syracuse Office

1- I&SE, Syracuse Office

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3- Bill Olashaw, DAD, Plainville Works

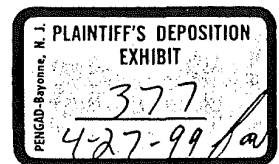
0A/FA-T-60-3750/4687(65)-12470-480Y/277 Transformer (Indoor)

Outline 104D9219, Sh. 1 & 2, Rev. 3 Supersedes 104D9219, Sh. 1 & 2, Rev. 2 Previously
Mailed

Conn. Diagram 149B9105BA

Nameplate 175B7682

GEB00464



JOB NUMBER: 53A852577

PAINT : PEARL GRAY ANSI-61

OUTLINE TO: MARKETING SHIPPING LARGE ENG. SMALL ENG. MS TO PRODUCTION

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PRINTS ARE NOT TO SCALE, are loaned subject to return
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REPRODUCTION UNIT

WATER_PCB-SD0000070975

Oct. 29, 1935.

F. M. CLARK
DIELECTRIC COMPOSITION
Filed Jan. 16, 1934

2,019,338

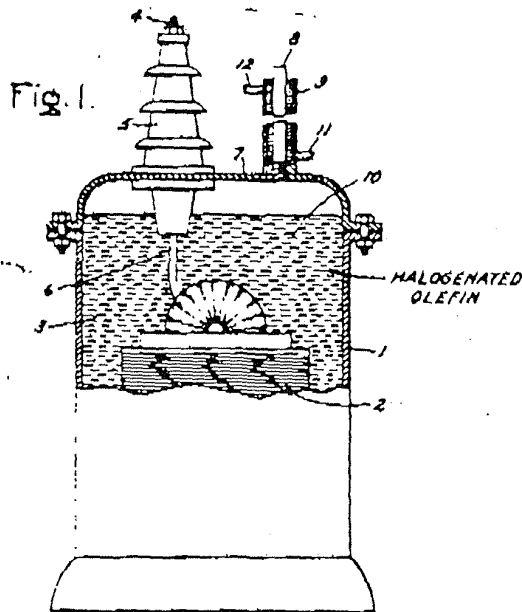
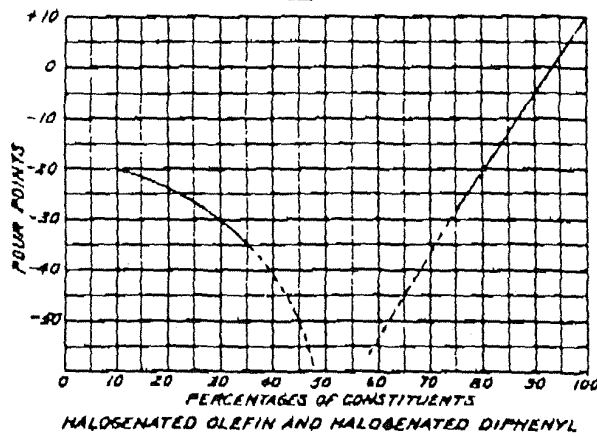
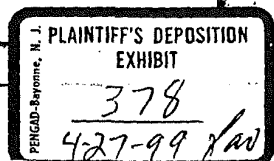


Fig. 2.



Inventor:
Frank M. Clark,
by *Harry E. Dunham*
His Attorney.

GEB00078



UNITED STATES PATENT OFFICE

2,019,373

DIELECTRIC COMPOSITION

Frank M. Clark, Pittsfield, Mass., assignor to
General Electric Company, a corporation of
New York

Application January 16, 1934, Serial No. 794,852

3 Claims. (Cl. 252-1)

The present invention relates to halogenated organic compositions comprising wholly or in part unsaturated compounds of the olefin type, such compositions being suitable for use as dielectric materials in electrical devices, such as transformers, capacitors, switches, and the like.

As described in my prior United States Patents 1,931,373 and 1,931,455, both issued October 17, 1933, it is advantageous to employ in electrical devices a dielectric material comprising one or more liquid halogenated hydrocarbons containing a sufficiently high proportion of halogen to insure non-inflammability of such gases as might be evolved by decomposition of a dielectric by an arc or otherwise. Heretofore only halogenated aromatic hydrocarbons have proved to be sufficiently stable for this purpose.

I have discovered that the chemical instability heretofore experienced with dielectric materials comprising aliphatic halogenated compounds is associated with the chemical saturation of the carbon atom to which the halogen is chemically attached, or, in other words, that chemically saturated carbon atoms possess an electronic condition which results in increased reactivity of the combined halogen under the conditions existing in an electrical device. I have also discovered that, if the halogen atoms instead of being attached to a chemically saturated carbon are attached to chemically unsaturated carbons, then in such case the halogenated compound is stable as a dielectric material under the normal operating conditions of electrical devices.

I have found that the chemical stability resulting when the halogen atom is attached to a chemically unsaturated carbon appears to be closely related to the electronic condition of the carbon atom of halogenated benzene compounds characterized by similar chemical stability.

Aliphatic compounds which I have found to possess unlooked-for chemical stability are the halogenated derivatives of the olefins, such, for example, as the chlorinated ethylenes or propylenes containing the chlorine atom or atoms attached to the unsaturated carbon or carbons, and also cyclic or aromatic derivatives of such compounds with or without halogen substituted in the aromatic nucleus in addition to the halogen on the olefinic carbons. The introduction of the aromatic group does not affect the chemical stability of the chlorine atoms chemically united to the unsaturated carbons. Chlorinated styrolens and chlorinated divinyl benzene containing the chlorine atoms either attached to the unsaturated carbons of the aromatic group or the

olefin group are further illustrations of chemically stable halogenated olefin derivatives. If a material is desired which not only is non-inflammable in itself but which under decomposition for any reason shall evolve only non-inflammable gases, it is necessary to introduce sufficient halogen into the molecule that it contains an amount of halogen at least chemically equivalent to the amount of hydrogen present.

Dielectric compositions included in the present invention also comprise mixtures of one or more halogenated olefins and one or more halogenated aromatic hydrocarbons, such, for example, as mixtures of a chlorinated olefin and chlorinated diphenyl or chlorinated benzene, or both.

The accompanying drawing shows in Fig. 1 in side elevation and partly in section a transformer containing a halogenated olefin dielectric composition and Fig. 2 is a graph showing the depression of point or congealing temperature resulting when a halogenated cyclic compound is mixed with a halogenated olefin.

The term "olefin" has been used herein to describe the compounds of a class which I have found to possess chemical stability, including both (1) the aliphatic compounds having the general formula C_nH_{2n} containing unsaturated carbons and (2) substituted aliphatic compounds having the general formula $C_nH_{2n-1}Ar$, containing unsaturated carbons in the molecule in which an aromatic group, (Ar) (or groups, Ar₂) have been substituted for hydrogen. The aromatic group may be a phenyl group, or a condensed group, such as the naphthalene group, or a polyphenyl group such as the diphenyl group. The term "halogenated olefin" is to be understood as limited to those compounds in which the halogen atom is attached to an unsaturated carbon either of the olefin group itself or of an aromatic nucleus.

The liquid halogenated olefins possess also a viscosity which easily adapts these materials to dielectric purposes, especially in apparatus such as transformers, where low viscosity is demanded for thermal reasons. Trichlor- or tetrachlor-ethylene are examples of halogenated liquid olefins suitable for dielectric use. These materials are inert and without corrosive action to metals present in electrical devices. These materials have a viscosity of about 30 seconds Saybolt universal and show little change in viscosity over a range of temperatures. The electrical characteristics of these materials are good. The dielectric strength, tested in a .1" disc electrode gap, gives a value higher than 30 kilovolts. The di-

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electric constant of approximately 3.3 and the power factor of less than 1% at 1000 cycles, 25° C., coupled with a characteristic resistivity of about 1×10^{12} ohms per centimeter cube at 500 volts D. C., makes these materials particularly well-adapted for general dielectric application in transformers, circuit breakers, capacitors, cables, and the like.

The transformer shown in Fig. 1 constitutes one example of an electrical device in which a liquid dielectric embodying my invention may be used with advantageous results. As well known, a transformer comprises a tank 1 containing a magnetic core 2 and electrical windings 3. For the sake of simplicity only a single terminal 4, provided with an insulator 5 has been shown, this terminal being connected to one of the windings by a conductor 6. Mounted on the cover 7, together with the terminal is condenser 8, provided with a jacket 9 through which a cooling fluid may be circulated to condense vapors evolved from the body of dielectric material 10. Inlet and outlet ducts 11, 12 are provided for the cooling fluid which conveniently may consist of water. To render the drawing simple and to indicate that its height may be varied the condenser has been shown as broken. It is to be understood that the condenser has been indicated conventionally as representative of any one of various types of condensers either air-cooled or liquid-cooled.

Halogenated olefins have a relatively low boiling point or in other words a high volatility. For example, dichlor ethylene, $C_2H_2Cl_2$, is a liquid which boils at about 55° C., trichlor ethylene, C_2HCl_3 , is a liquid which boils at about 87 to 88° C., alpha trichlor propylene, $C_3H_2Cl_3$, is a liquid which boils at about 115° C., and tetrachlor ethylene is a liquid which boils at about 120° C. Vapors evolved from such compounds during the operation of a transformer or other electric device are condensed to the liquid state in the condenser 8 and returned to the main body of the cooling medium.

The necessity of using a condenser may be eliminated by the use of a substituted halogenated olefin, the molecule of which contains an aromatic nucleus. Thus although synthetic dichlor ethylene boils at 55° C., the introduction of the benzene nucleus results in dichlor styrolene, or styrene, $(C_6H_5.CCl:CHCl)$ a product which boils at 221° C. For many electrical purposes the use of a halogenated olefin containing a substituted aromatic nucleus therefore will be more advantageous.

Many of the halogenated olefins possess a relatively high congealing point which tends to restrict their use for dielectric purposes. As already indicated, a lower congealing temperature (pour point) may be secured by compounding the halogenated olefin with a halogenated aromatic compound of the type represented by a halogenated benzene, a halogenated polyphenyl, such as halogenated diphenyl, or the halogenated derivatives of diphenyl ketone, diphenyl methane, diphenyl benzene, or diphenyl oxide or with halogenated naphthalene, a halogenated compound containing condensed nuclei. For most purposes chlorine compounds are to be preferred over compounds containing bromine or other halogens.

As an illustration of the characteristics of such blended compositions, I cite the case of tetrachlor ethylene compound or mixed with pentachlor diphenyl as an example of a chlorinated polyphenyl. In Fig. 2 is indicated the extraordinary and unexpected decrease in pour point of liquid

compositions resulting in such case. The pour points or congealing temperatures are plotted here as ordinates and the percentages of halogenated diphenyl as abscissae. In the specific case here taken, the diphenyl compound is the technical pentachlor diphenyl which itself is a viscous material having a pour point of about +10° C. The pour points were determined by the standard methods adopted by the American Society for Testing Materials. As pentachlor diphenyl is present in increasing amounts in the mixture (accompanied by a corresponding decrease of tetrachlor ethylene), the pour point of the mixture drops to a value lower than -50° C. This extremely low pour point is found in a mixture made up of equal parts by weight of tetrachlor ethylene and pentachlor diphenyl. As indicated by dotted lines the exact pour point of the 50:50 mixture was not determined experimentally because of the difficulty of working at such low temperatures.

The viscosity of such a mixture is not materially different from the viscosity of the pure tetrachlor ethylene alone, being 30 seconds Saybolt universal at 37.8° C. Under the same testing conditions tetrachlor ethylene has a viscosity of 28 seconds Saybolt. Pentachlor diphenyl has a very high viscosity. At the commonly used testing temperature at 37.8° C. the viscosity of pentachlor diphenyl is 1200 seconds Saybolt universal.

Such mixed halogenated products constitute a material particularly well adapted for use in apparatus exposed to low temperature conditions. Other mixtures of chlorinated olefins and chlorinated cyclic compounds are characterized by extraordinary low congealing temperatures. The pour point of a mixture of 25% by weight or more of trichlor ethylene and 75% or less of pentachlor diphenyl is lower than -80° C. The viscosity of the 50:50 mixture is about 34 seconds Saybolt universal.

While I have illustrated my invention with particular reference to chlorine as a particular halogen in products embodying my invention, products containing other halogens are not precluded and such products are to be considered as being included in the present invention.

The term "olefin" is used herein to designate ordinary forms of such compounds as distinguished from solid resinous olefin polymerization products such as described in Clark and Kutz U. S. Patent 1,998,309 of March 16, 1935.

Halogenated olefin products in many cases can be advantageously compounded with an oil, either a hydrocarbon oil, for example, a petroleum oil; or a glyceride oil, for example, castor oil. In some industrial fields, an admixture of a halogenated product, such, for example, as trichlor, or tetrachlor ethylene, renders an oil better suited for its purposes while at the same time rendering it less inflammable. For most purposes the oil should be in a preponderant proportion by volume in the mixture. Although I have herein referred mainly to dielectric and cooling uses of compositions embodying my invention, other uses, such as use for lubrication, are not to be excluded.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A dielectric composition containing a halogenated olefin, in which halogen is attached only to unsaturated carbon, and a halogenated aromatic hydrocarbon as substantial ingredients.

2. A dielectric composition, a substantial pro-

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portion of which consists of trichlor ethylene and chlorinated diphenyl).

3. A dielectric composition containing tetrachlor ethylene and a chlor polyphenyl as substantial ingredients.

4. A dielectric composition containing substantial amounts of tetrachlor ethylene and pentachlor diphenyl.

5. A composition of matter containing substantial proportions of a halogenated olefin compound containing an aromatic group and a substantial proportion of halogenated cyclic hydrocarbon compound.

6. A composition of matter containing a substantial proportion of halogenated styrolene and a substantial proportion of halogenated polyphenyl compound.

7. A composition of matter containing as substantial ingredients chlor olefin and chlor polyphenyl.

8. A liquid composition suitable for insulating use in electrical apparatus comprising as substantial ingredients liquid chlor ethylene and chlor polyphenyl.

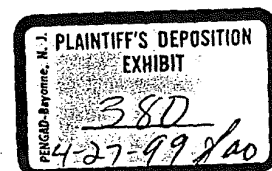
FRANK M. CLARK.

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THE JOURNAL OF INDUSTRIAL HYGIENE. (AND TOXICOLOGY)

VOLUME 19
JANUARY, 1937—DECEMBER, 1937

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THE JOURNAL OF INDUSTRIAL HYGIENE AND TOXICOLOGY

VOLUME 19

SEPTEMBER, 1937

NUMBER 7

THE PROBLEM OF POSSIBLE SYSTEMIC EFFECTS FROM CERTAIN CHLORINATED HYDROCARBONS*

CECIL K. DRINKER, MADELEINE FIELD WARREN AND GRANVILLE A.
BENNETT

*Department of Physiology, Harvard School of Public Health and Department of Pathology,
Harvard Medical School, Boston, Mass.*

THE use of chlorinated naphthalenes and compounds of allied pharmacological possibilities is extremely wide, and with the steady growth of the use of electricity is certain to expand much farther. For years it has been known that many of these compounds cause a troublesome acne, and there is a large literature upon this phase of the subject. Our investigations have not been concerned with chloracne but with the possibility of systemic effects following ingestion or inhalation of such products. In the spring of 1936, the Halowax Corporation, a division of the Bakelite Corporation, called our attention to three fatal cases of jaundice in workmen using chlorinated naphthalenes and chlorinated diphenyl, and requested that the subject be investigated as

rapidly and thoroughly as possible.† In brief these cases were as follows:

Patient 1. Male, age 21. The previous medical history of this man was in no way significant except for the fact that he had an attack of jaundice about 6 weeks prior to his fatal illness. Late in December, 1936, he became badly constipated and had much abdominal pain and distention. When admitted to the hospital he was slightly jaundiced and was evidently very ill. He was somewhat anemic and his skin, particularly upon the arms, face, chest and back, showed many pustules. He died after a brief period in the hospital, and at autopsy was found to

† The Halowax Company makes many products besides chlorinated naphthalenes, and it has come to our knowledge that all of these products are indiscriminately called "halowaxes" by purchasers and users, and are lumped together as possible causes of acne and even of systemic disease. Since "halowax" is merely a trade designation, care should be taken to describe compounds by their chemical names and thus avoid condemnations which are both troublesome and misleading.

* Received for publication June 30, 1937.

have a cirrhosis of the liver with acute yellow atrophy superimposed upon it. This man had been exposed to low concentrations of vapors arising from a mixture of tetra and pentachloronaphthalenes, together with approximately 10 per cent of a refined chlorinated diphenyl. While both he and others engaged in the same work had chloracne, there were no other disturbances of health in fellow workmen, nor was there any precipitating cause for the acute yellow atrophy such as treatment with arsphenamine or exposure to dangerous concentrations of carbon tetrachloride.

Patient 2. This was a young man who died in February, 1936, after an acute illness characterized by jaundice. He had been exposed to fumes arising from a mixture of penta and hexachloronaphthalenes. There is no record of chloracne. The patient worked with a large number of other people of whom but one (Patient 3), a close friend, had significant illness.

Patient 3. Another young man employed with Patient 2. He became jaundiced in March, 1936, and died after an illness of 2 weeks. A careful autopsy resulted in a diagnosis of acute yellow atrophy of the liver. Here again no history could be obtained as to a precipitating cause, and there was no record of preceding attacks of jaundice.

In addition to these three very recent fatalities, we have learned of four other possible cases, none of them fatal. All of these have had jaundice and the entire group consists of isolated individuals who have been picked out of large groups having the same exposure. In but one instance, Patient 1, is there record of antecedent disturbance of health, and the general health of fellow workers has been good.

Such cases have not been reported in the medical literature and only occasionally can one find reference to systemic effects of any sort. For example, Courtois-Suffit (1934) reports on work done by Touraine and his associates (1934) who examined 60 workers

who had been exposed to trichloronaphthalene. Of these 13 were found to have mild digestive complaints, anorexia, nausea and vertigo, but Courtois-Suffit remarks finally, "Absorption is certainly possible and we have for proof of it some of the digestive and general complaints which have been due to it. But they appear to be of little consequence considering the mildness of the digestive troubles and the absence of respiratory phenomena."

In Touraine's cases the exposure was to a trichloronaphthalene, whereas the American cases of acute yellow atrophy were exposed to compounds of higher chlorination. Our own experiments indicate that trichloronaphthalenes require enormous dosage, far beyond anything encountered in industry, in order to produce liver damage. Tel'eky (1927) reported a number of cases of chloracne in persons exposed to chlorinated naphthalenes with a chlorine content ranging from 14 to 53 per cent. He found that the lower the chlorine content the less the acne. Mittelstädt (1935) examined a number of cases of chloracne due to trichloronaphthalene and reported a number of vague general complaints but nothing in the nature of serious disease. Regarding his animal experimentation, Lehmann (1919) reported that animals fed chlorinated naphthalenes refused to eat after a time and that, whether poisoned by inhalation or by feeding, at death showed "peculiar" lesions in the liver. Flinn and Jarvik (1936) gave subcutaneous injections of enormous doses of chlorinated naphthalenes dissolved in paraffin oil to rabbits. The compounds used were as follows:

1. A mixture of tri and tetrachloronaphthalene.
2. A mixture of tetra and pentachloronaphthalene.
3. A mixture of penta and hexachloronaphthalene.

In addition, sublimates from (2) and (3) were collected in oil and injected subcutaneously.

None of the animals receiving (1) or the sublimate from (2) died, and even after 2 months were quite normal when autopsied. The first death in the animals receiving (3) occurred on the 12th day and the last died on the 26th day. Those receiving the sublimate from (3) were even more severely affected. Autopsy in these animals revealed striking changes in the liver, not, as described, entirely characteristic of acute yellow atrophy but sufficiently suggestive to cause the authors to conclude that "certain chlorinated naphthalenes or impurities contained in them are capable of producing yellow atrophy of the liver in the rabbit."

At the beginning of their paper, Flinn and Jarvik (1936) mention the fact that there have been three cases of acute yellow atrophy of the liver in men working with chlorinated naphthalenes but give no details in regard to them. These cases are undoubtedly the same as those described in the beginning of this paper.

One may summarize the meagre literature upon systemic effects from these substances as follows:

1. With the exception of the mention of acute yellow atrophy by Flinn and Jarvik (1936) there are no reports or even suggestions of serious effects upon human beings.
2. There is evidence (Teleky, 1927) that the degree of chlorination is sig-

nificant in relation to the production of acne. In the work of Flinn and Jarvik (1936) the compounds producing serious liver injury were the most highly chlorinated of those tested, though the chlorine contents as given by analysis vary surprisingly little.

3. There are no published figures upon the amounts of various chlorinated naphthalenes in the air which will produce injury of any sort, and while the work of Lehmann (1919) and of Flinn and Jarvik (1936) point to the liver as a possible site of injury this indication rests upon such extreme dosage as to fail to apply directly to human exposure.

EXPERIMENTAL WORK

In appraising the possible toxicity of any substance met in industry it is first necessary to determine the principal route of absorption. In the case of the compounds under consideration there can be no doubt that inhalation is their chief means of entering the body. They are used hot in a great variety of operations and volatilize in varied degree. They are often applied in solution in such volatile solvents as carbon tetrachloride and toluene. The amounts reaching the air under such circumstances are hardly detectable. It will however be shown that carbon tetrachloride adds to the toxicity of the chlorinated naphthalenes and allied compounds, and if there is possibility of inhaling these compounds in other parts of the factory then inhalation of carbon tetrachloride adds a decided hazard. Under such circumstances solvents such as toluene should be used.

Observation in a number of plants causes us to feel that even though

workmen may be extremely dirty and careless, comparatively little of these waxes is eaten. They are tenacious substances, insoluble in water, and if they get on the hands they stick there and are not transferred to the food.

Skin absorption is the third possible means of entering the body. It may occur but at best must be slight when compared to the steady inhalation of finely divided or gaseous material in the air.

They thrive upon a diet very similar to man, and in the case of these chlorinated compounds it is possible that diet may be very significant. Finally, their normal characteristics have been described so well as to make the detection of abnormalities both easy and certain.

Method of exposure.—The inhalation experiments were carried out in four large air-tight wooden boxes, each capable of holding ten rat cages, size



FIG. 1. Front view and inflow end of two boxes with rat cages in place and doors open.

Inhalation experiments are then the most important sources of information, but to them we have added a certain number of observations upon ingestion and subcutaneous injection of various compounds.

Inhalation Experiments

Animals.—White rats have been employed throughout. They permit the use of a large number of animals in a relatively small inhalation installa-

tion. They thrive upon a diet very similar to man, and in the case of these chlorinated compounds it is possible that diet may be very significant. Finally, their normal characteristics have been described so well as to make the detection of abnormalities both easy and certain.

At the center of one end of each box—the inflow end—air was introduced through a pipe 7 inches in diameter (figure 2). Each box was equipped with an individual variable-speed electric blower which blew the air through several feet of 7-inch pipe before enter-

ing the meter was the flow could be from a deflector pipe into sure a stream of

At the outflow end was exhausted with a large ce

About the 7-inch of the produced in cially de (figure 4), diameter hold the were made that exte top of the this fitted length. 7 into a large tightly into pipe on the flask in tu heater ma below the top. Rub side arm w voir and a through tl motion an Into each fl centigrade kept in pla time above which it pa Approx chlorinated

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ing the end of the box. An orifice meter was placed in the pipe line, and the flow of air in cubic feet per minute could be adjusted and read off directly from a calibration curve. A vane deflector placed at the entrance of the pipe into the box was adjusted to assure a uniform distribution of the stream of air to the two tiers of cages.

At the opposite end of the box—the outflow end—the air from each box was exhausted through a 7-inch pipe fitted with a damper and connected to a large central exhaust fan (figure 3).

About 4 inches from the entrance of the 7-inch pipe into the box, the fumes of the substances listed were introduced into the inflowing air. Specially designed pyrex glass flasks (figure 4), 7½ inches long and with a diameter of 1½ inches, were used to hold the heated waxes. These flasks were made with a side arm and tube that extended to the bottom. The top of the flask was ground, and into this fitted a short tube 1½ inches in length. This short tube was inserted into a large rubber stopper that fitted tightly into a hole cut out of the 7-inch pipe on the under side (figure 2). The flask in turn was placed in an electric heater made to cover it completely below the side arm and ground glass top. Rubber tubing connected the side arm with a compressed air reservoir and a gentle stream of air blown through the melted wax kept it in motion and assured uniform heating. Into each flask was inserted a long stem centigrade thermometer which was kept in place and could be read at any time above the 7-inch pipe through which it passed (figure 2).

Approximately 30 gm. of pulverized chlorinated naphthalenes or 20 gm. of

chlorinated diphenyl were placed in the bottom of each flask and melted in the electric heater. Fresh samples were used every other day, but it was often found necessary to add 20 gm. of new material even after one run since so much had sublimed. Whatever the case, the collected sublimate was



FIG. 2. Electric heater for maintaining chlorinated compounds at a constant temperature in place at inflow end of box.

always removed from the upper part of the flask and a clean top used each day. No sample was ever used for more than two runs.

The flask plus the contents was carefully weighed at the beginning of the run and at the end, and the loss in weight used to calculate the average

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amount in a cubic meter of air per minute as determined by a series of

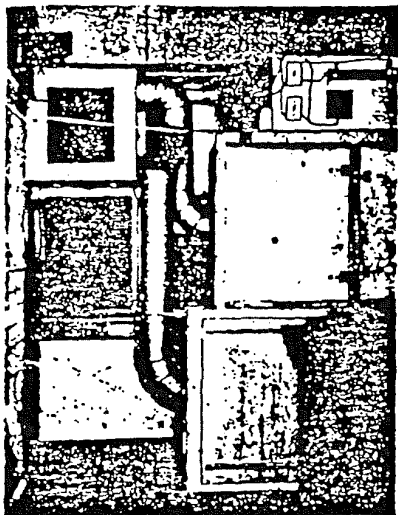


FIG. 3. Outflow end of two boxes showing connections to exhaust system.

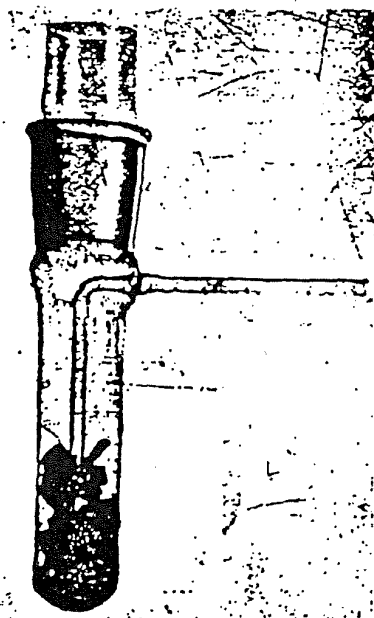


FIG. 4. Pyrex glass flask

flowmeter readings. The figures obtained were not absolute because of slight variations in the air flowing through the boxes and because of deposition of material on the thermometers and on the inside surfaces of the box, but they checked well with direct determinations through air samples.

Approximately 1 hour was allowed for the wax in the flasks to melt and come to a constant temperature. At that time the box doors were tightly closed, air bubbled through the flasks, and the blowers turned on. This was the beginning of the exposure period. By means of rheostats on the fans and dampers in the outflow pipes, the amount of air flowing through the boxes was adjusted and an attempt was made to keep the four boxes as uniform as possible—usually between 165 and 175 c.f.m.

In the first group of experiments the following substances were tested:

1. A mixture of trichloronaphthalenes plus a trace of tetrachloronaphthalene. Chlorine content 49.9 per cent.
2. A mixture of penta and hexachloronaphthalenes. Chlorine content 62.6 per cent.
3. A mixture of 90 per cent penta and hexachloronaphthalenes plus 10 per cent refined chlorinated diphenyl. Chlorine content 63.0 per cent.
4. Chlorinated diphenyl. Chlorine content 65.0 per cent.

The compounds were selected as representing a certain range in chlorination and also because of their industrial importance. In each instance 80 animals were exposed, 10 rats being placed in each cage. They were fed Purina

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Dog Chow
eggs, milk

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CONDITIONS M

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Penta and hexa

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Chlorinated dip

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for examination

The average
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Each morning
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4:00 p.m. the
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Dog Chow supplemented by lettuce, eggs, milk and cod liver oil.

This first group of experiments was begun on July 1, 1936 and the last exposure to number 2 (penta and hexachloronaphthalenes) was on November 16th. The exposure to the other three compounds ceased upon November 18th. On October 15th representative animals were taken out of exposure from groups 1, 2, and 4 and were killed after 2 months on December 15th, in order to see whether this clear

wax concentrations were somewhat higher at the inflow end of the boxes. Preliminary runs showed that once properly adjusted, wax concentrations in the air remained very uniform from day to day, but to insure absolute safety readings of temperature, air-flow, etc. were made every night between 10:00 and 12:00 p.m. as well as on starting and stopping. At different times during the course of the experiment tests for free chloride were made but were uniformly negative and

TABLE I
CONDITIONS MAINTAINED IN INHALATION EXPERIMENT FROM JULY 1 TO NOVEMBER 16 AND 18

MATERIAL	CHLORINE CONTENT	TEMP. °C.	AV. CONCENTRATION OF AIR IN BOX		TOTAL EX- POSURE hours	AV. DAILY EX- POSURE hours
			mg./cu. m.	range		
Trichloronaphthalenes plus traces of tetrachloronaphthalene.....	49.9	150-160	1.31	High 2.60 Low 0.10	1896	16
Penta and hexachloronaphthalenes....	62.6	160-170	1.16	High 2.19 Low 0.51	1894	16
80% penta and hexachloronaphtha- lenes plus 10% chlorinated diphenyl.	63.0	165-175	1.37	High 3.17 Low 0.64	1896	16
Chlorinated diphenyl.....	65.0	165-175	0.57	High 1.19 Low 0.23	1896	16

period would bring about recovery in the affected livers. Animals from group 3 were similarly removed from exposure on October 4th and killed for examination on December 4th.

The average length of exposure was 16 hours daily for 6 days a week. Each morning at about 9:00 exposure ceased, and between this time and 1:00 p.m. the rats were cleaned, fed, weighed, etc. In order to secure uniformity of exposure the cages were rotated on a regular schedule, since

showed that under the temperatures used no decomposition occurred.

Table 1 shows the temperatures at which the various substances were held, the average concentrations per cubic meter of air, and the average exposures from July 1 to November 16 and 18.

The concentration of chlorinated naphthalenes and chlorinated diphenyl in the air of workrooms.—Table 1 shows that animals have been exposed to varied concentrations of the substances under

test. The concentrations employed may be regarded as fairly representative of industrial experience. Prior to the initiation of inhalation experiments a number of estimates of chlorinated hydrocarbons in the air of different factories were made and the

in question is passed over heated platinum in an electrically heated quartz tube and the effluent gas scrubbed in a column of glass beads moistened with sodium carbonate containing a trace of sodium sulfite. The beads are then washed down and the chloride deter-

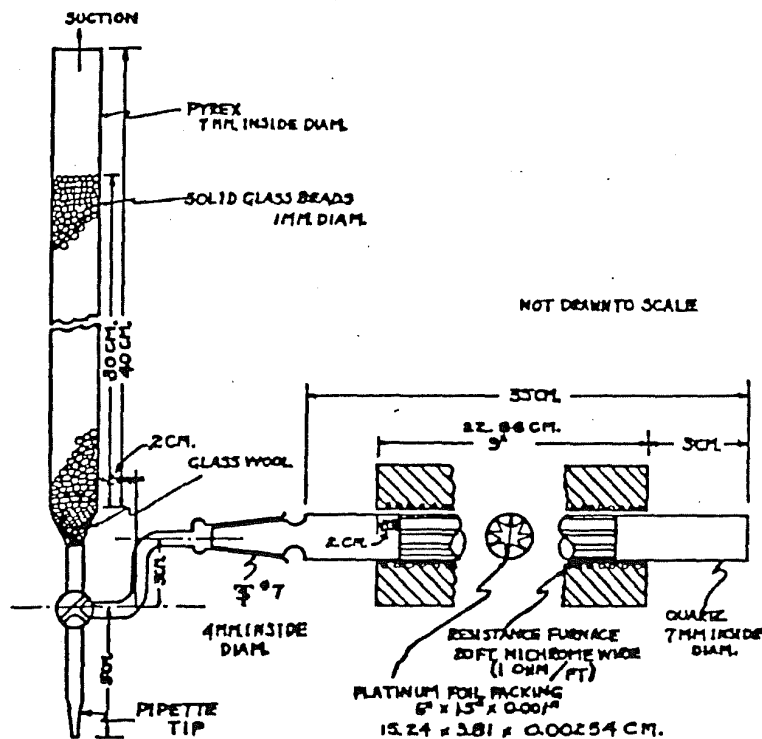


FIG. 5. Dimensioned sketch of combustion tube and absorption apparatus.

concentrations chosen for inhalation experiments depended on these examinations. The technic of analysis and the apparatus employed were the work of Frederick R. Millhiser and William F. Hemperly.

The method and apparatus used for determining concentrations of chlorinated hydrocarbons in air were adapted from well-known procedures. The air

mined nephelometrically as silver chloride.

Tebbens (1937) has recently described a method and apparatus which should be equally satisfactory for this work. In figure 5 we show a dimensioned sketch of the combustion tube and absorption apparatus as used by us in both our laboratory and field problems. The absorption tube is

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somewhat easier to wash down than is Tebbens's but the essentials of the two devices are the same.*

In both cases conversion of the chlorinated hydrocarbons to hydrochloric acid and subsequent absorption as sodium carbonate should be complete. In our case concentrations in air are apt to be very low—the objective is less than 1 mgm. per cu. m. Consequently the amount of silver chloride actually formed in the final reaction is so small that it can not be determined either gravimetrically or by titration. For this reason we have been forced to use the nephelometric procedure which is sensitive to concentrations as low as 0.1 mgm. per cu. m. of air.

It is doubtful if the sampling rate should exceed 1 liter per minute as conversion of the chlorinated compound to hydrochloric acid and its subsequent absorption are not efficient unless the velocity of the gas stream is low. Another precaution to be noted is that the method is not selective—any chlorinated substance will be determined. Furthermore it does not distinguish between solid particles and gases but determines them all alike and the results must, of course, be computed in terms of total chlorine.

At the present time we possess information as to the amounts of chlorinated naphthalenes in the air of 30 different plants, and in a number of instances the measurements have been repeated several times. Frequently the amounts have been greater than those used in our experiments, but it must be remembered that the rats

* The combustion and absorption apparatus suited to field sampling is now made by Wilson Products, Inc., Reading, Pa. The equipment includes flowmeter and suction pump with a carrying case.

have been exposed for 16 hours to an atmosphere constantly impregnated with the substance under test, whereas human exposure is usually a variable quantity, intense for a short time and then negligible. It is our opinion at the present time that the concentrations of chlorinated hydrocarbons used in our experiments would be dangerous for workers in the case of compounds above trichloronaphthalene in chlorination. Fortunately it is easy to ventilate processes of manufacture which require these substances and to reduce air contamination practically to the vanishing point. Such treatment of the problem at once removes both the possibility of systemic poisoning and the annoyances that arise from cases of acne.

Results of Inhalation Experiments.

1. Animals exposed to a mixture of trichloronaphthalenes plus small amounts of tetrachloronaphthalene. Living animals were apparently entirely normal. Autopsies performed near the end of exposure seemed to show slight swelling of the liver, and microscopic examination occasionally showed swollen and hypergranular liver cells. The changes were, however, never more than slight.

2. Animals exposed to a mixture of penta and hexachloronaphthalenes. No abnormalities were observed in the living animals. Rats were killed and autopsied every 6 weeks. In the first animals sacrificed liver changes were observed. These were swelling of cells, slight granulation and hyalinization. In September and October these conditions were somewhat more advanced, and in November the process became stationary. There were highly

granular cells, hyaline inclusions and mitotic figures, but no more than 2 months previously.

3. Animals exposed to a mixture of 90 per cent penta and hexachloronaphthalenes plus 10 per cent refined chlorinated diphenyl. No abnormalities were seen in the living animals. After 6 weeks the livers showed changes similar to those in the animals exposed to penta and hexachloronaphthalenes. These advanced in grade during August and September and then became stationary.

4. Animals exposed to chlorinated diphenyl. No abnormalities were seen in the living rats. After 6 weeks' exposure there was slight liver damage which advanced during the next 2 months. The changes consisted in slight to moderate swelling of the liver cells, an increased granularity and many mitotic figures. Hyalinization was always present as a result of inhalation of chlorinated diphenyl.

Summary of the first inhalation experiment.—In these experiments careful observation of appearance, body weight, activity, blood, and urine showed no abnormalities of any sort. Yet after 6 weeks' exposure all the compounds with chlorination above trichloronaphthalene caused minor degrees of liver damage, and no changes whatsoever in other organs. There was no acute yellow atrophy or anything suggesting it except that a slight degree of liver damage was always present and was quite clear in the liver sections examined microscopically. This damage had no detectable effect on the health of the animals. They held their weight, ate and behaved normally, being in every respect similar to the many people who have been

exposed to these compounds without illness of any sort.

The functional appraisal of the liver damage caused by certain chlorinated naphthalenes and by chlorinated diphenyl.—There are no tests of liver function useful in such minor degrees of liver damage as were produced in these experiments. Indeed the animals resisted the injury so perfectly as to display no abnormalities except upon histological examination of the liver. The situation was perhaps similar to that met in industry, where, barring acne, the health of workers in these compounds has been good with the exception of the fact that in isolated instances jaundice has occurred which upon at least three occasions has gone on to acute yellow atrophy.

During recent years this disease has been seen following administration of carbon tetrachloride, arsphenamine and cinchophen. In the case of carbon tetrachloride it is known that a low calcium diet and alcohol favor the production of liver damage. For the acute yellow atrophy that occasionally complicates use of the other two drugs no cause can be assigned. One cannot produce acute yellow atrophy with arsphenamine, but somehow or other this now and then does happen to patients under antisyphilitic treatment.

It occurred to us that something of the same sort might be involved in this problem. The human cases have been scattered and few. They have been isolated instances out of large groups of healthy employees who have had equal degrees of exposure. It was our idea that perhaps many of these people got liver changes such as existed in our rats, changes not recognizable through

any means of nation. If, such changes, disturbance, not a very c which any of this relatively over to acute

Knowing the had liver the slight to cause we decided to substances kn struction. Ca alcohol were mation that l chloride plus per kilogram v normal white r to 0.75 cc. ca 0.75 cc. of eth This mixture tube to the fo mals and with following tabu

Expt. fed 0.75 cc tetrachlorid

1. Trichloronap-
chloronaphthalene.
10, 1935. 10 rats
2. Penta and he
at 9:30 a.m., No
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1 died Nov. 1
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8. 80 per cent
toluene and 10 pe
fed at 10:00 a.m.

any means other than autopsy examination. If, upon the substratum of such changes, they got an acute liver disturbance, acute catarrhal jaundice, not a very common disease but one which any of us may experience, would this relatively innocuous disease go over to acute yellow atrophy?

Knowing that our inhalation rats had liver changes, but changes too slight to cause recognizable symptoms, we decided to test their resistance to substances known to cause liver destruction. Carbon tetrachloride and alcohol were selected. Having information that 1.0 cc. of carbon tetrachloride plus 1.0 cc. of ethyl alcohol per kilogram would kill 14 per cent of normal white rats, we reduced the dose to 0.75 cc. carbon tetrachloride and 0.75 cc. of ethyl alcohol.

This mixture was given by stomach tube to the following groups of animals and with the results found in the following tabulation.

Rats fed 0.75 cc. per kgm. each of carbon tetrachloride and ethyl alcohol by stomach tube

1. *Trichloronaphthalene plus trace of tetrachloronaphthalene.* Fed at 9:00 a.m., Nov. 10, 1936. 10 rats. No deaths.
2. *Penta and hexachloronaphthalenes.* Fed at 9:30 a.m., Nov. 10, 1936. 10 rats.
 - 2 died Nov. 11th between 4:30 and 10:30 p.m.
 - 1 died Nov. 12th at 3:30 p.m.
 - 1 died Nov. 12th at 4:30 p.m.
 - 1 died Nov. 13th between 9:30 and 11:30 a.m.
 - 1 died Nov. 15th between night of Nov. 14th and 12:30 p.m. Nov. 15th. 2 died Nov. 16th between 10:15 p.m. Nov. 15th and 9:00 a.m. Nov. 16th (stiff).
3. *10 per cent penta and hexachloronaphthalenes and 10 per cent chlorinated diphenyl.* Fed at 10:00 a.m., Nov. 10, 1936. 10 rats.

- 1 died Nov. 10th between 5:00 and 10:30 p.m.
- 5 died Nov. 11th between 4:30 and 10:30 p.m.
- 1 died Nov. 11th between 4:30 p.m. and 9:00 a.m. Nov. 12th.
- 2 died Nov. 12th about 1:00 a.m.
- 1 died Nov. 13th between 5:00 and 10:00 p.m.
- 4. *Chlorinated diphenyl.* Fed at 10:00 a.m., Nov. 10, 1936. 10 rats.
 - 1 killed Nov. 10th at 10:30 p.m. (almost dead).
 - 2 died Nov. 11th between 4:30 and 10:30 p.m.
 - 1 died Nov. 12th before 8:30 a.m. (stiff).
 - 1 died Nov. 13th between 9:30 and 11:00 a.m.
 - 1 died Nov. 16th between 10:15 p.m. Nov. 15th and 9:00 a.m. Nov. 16th (stiff).
- Controls:* Fed at 9:30 a.m., Nov. 12, 1936. 10 rats. 1 killed Nov. 13th for normal liver.

This tabulation summarizes into the facts that:

1. No normal rats were killed by carbon tetrachloride and ethyl alcohol.
2. No trichloronaphthalene exposed rats were killed, and this finding agrees with our inability to find lesions of moment in the livers of the animals that inhaled this substance.
3. The penta and hexachlorinated naphthalene, the mixture of these with 10 per cent chlorinated diphenyl, and finally the latter substance alone seem to have produced conditions lowering the resistance to an agent capable of producing serious liver disease.
4. The sole lesion produced by this test of liver function was acute yellow atrophy usually accompanied by jaundice.

This test of liver function was accomplished with a substance which itself is an organic chloride and curiously enough it is the only substance we were able to find that was effective.

In animals with the minor degree of liver injury which has been described we were unable to produce acute yellow atrophy or any variety of liver effect with arsphenamine, cincophen, butyl chloride, ethylene chloride and tetrachlorethylene, but carbon tetrachloride was uniformly effective in disclosing the existence of liver damage.

Recovery from liver damage following removal from exposure.—Animals exposed to trichloronaphthalenes plus traces of tetrachloronaphthalene being practically normal on removal from exposure need no consideration. In the case of the penta and hexachlor-

signs of liver injury will be many months in returning to normal.

The effect of high concentrations of trichloronaphthalenes with traces of tetrachloronaphthalene.—The first group of inhalation experiments showed that this material in concentrations averaging 1.31 mgm. per cu. m. of air was relatively innocuous, judged both by direct observation and by the carbon tetrachloride test. This is an interesting fact since such compounds cause acne, though less potently than substances of higher chlorination. In order to explore the matter further one of the inhalation boxes was arranged

TABLE 2
CONDITIONS MAINTAINED DURING INHALATION OF HIGH CONCENTRATIONS OF
TRICHLORONAPHTHALENES PLUS TETRACHLORONAPHTHALENE

MATERIAL	TEMP. °C.	AV. CONCENTRATION OF AIR IN BOX		TOTAL EXPOSURE hours	AV. DAILY EXPOSURE hours
		mg./cu. m.	range		
Trichloronaphthalenes plus traces of tetrachloronaphthalene	137-200	10.97	High 16.49 Low 5.78	1232	16

naphthalene, rats after 2 months' removal from exposure still showed swollen liver cells, increased granularity, hyalinization and mitotic figures. The condition was not advanced as compared with rats killed at the time of removal from exposure but on the other hand 2 months were insufficient for recovery.

The same findings were true of the mixture of penta and hexachlorinated naphthalenes and chlorinated diphenyl and for chlorinated diphenyl alone.

Apparently the changes induced in the liver cells by these substances are exceedingly persistent and one must expect that an individual showing any

so that fumes from four glass containers were delivered to the air line instead of one. This resulted in the conditions shown in table 2. The animals subjected to these conditions showed no clinical effects of any sort. After 1 month the liver cells were slightly swollen and over-granular and there were occasional mitotic figures. These changes were similar to the early effects of more highly chlorinated compounds, and progressed only slightly during the third and fourth months. When rats in this condition were given carbon tetrachloride and alcohol, in some instances their livers showed massive central necrosis and

In others this did not occur. In one may conclude that chloronaphthalene is toxic as those of the others are not entirely upon the liver if the conditions are inha-

The effects of penta and hexachloronaphthalene. There can be no doubt that the liver is damaged but in the conditions reported no symptoms could be recognized except nothing approaches

CONDITIONS MAINTAINED

MAINTAINED
Penta and hexachloronaphthalene

atrophy occurred. On December 1, 1936, the animals were terminated. The animals were found to be dead and deaths began. Fifty-five of them heavily injured by the exposure. The animals were killed by the exposure. The animals were found to be dead and deaths began. Fifty-five of them heavily injured by the exposure. The animals were found to be dead and deaths began. Fifty-five of them heavily injured by the exposure.

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In others this did not develop. Fifty rats were used in this experiment and one may conclude that while the trichloronaphthalenes are in no degree as toxic as those of higher chlorination they are not entirely free from effects upon the liver if high enough concentrations are inhaled over long periods.

The effects of high concentrations of penta and hexachloronaphthalenes.—There can be no doubt as to the damage done the liver by these compounds but in the concentrations so far reported no symptoms were caused that could be recognized clinically and nothing approaching acute yellow

the liver after 35 days of freedom from inhalation. It is thus evident that penta and hexachloronaphthalenes are markedly toxic compounds and that recovery from their effects is extremely slow.

The effects of penta and hexachloronaphthalenes, the mixture of these with 10 per cent chlorinated diphenyl, and of chlorinated diphenyl alone, when inhaled in low concentrations through an 8-hour day instead of a 16-hour day as in the first experiment.—Since steady human exposure to any of the compounds tested would invariably be for 8 hours rather than 16-hour periods, a further

TABLE 3
CONDITIONS MAINTAINED DURING INHALATION OF HIGH CONCENTRATIONS OF PENTA AND HEXACHLORONAPHTHALENES

MATERIAL	TEMP. °C.	AV. CONCENTRATION OF AIR IN BOX		TOTAL EXPOSURE	AV. DAILY EXPOSURE
		mg./cu. m.	range	hours	hours
Penta and hexachloronaphthalenes.....	137-195	8.88	High 14.0 Low 5.75	608	16

atrophy occurred except through the use of the carbon tetrachloride test. On December 1, 1936, 80 rats were subjected to the conditions summarized in table 3. This experiment was terminated on January 21. All of the animals lost weight and appetite and deaths began after 8 days of exposure. Fifty-five rats died, most of them heavily jaundiced, 8 were killed for microscopic examination, 9 were killed by the carbon tetrachloride test and 8 lived through the period of exposure. The livers of the animals killed for examination showed marked fatty degeneration, central in type with necrosis of liver cells. Surviving animals showed pronounced changes in

inhalation experiment was arranged under the conditions shown in table 4 which are quite comparable to those in table 1 except for the shorter inhalation periods. Eighty rats were used for each of the three compounds tested. None at any time showed the slightest evidence of illness. Microscopic examination beginning after 6 weeks' exposure showed swollen liver cells, excess granulation, hyaline inclusions and occasional mitotic figures. These changes did not progress and were very similar to those in the animals exposed for 16 hours under the conditions set forth in table 1. The carbon tetrachloride test was uniformly fatal to them and one must conclude that con-

centrations of these compounds such as were employed cause a certain degree of liver damage even if inhaled for but 8 hours daily. This injury is resisted successfully by the rats just as was the 16-hour injury but it is none the less there and destroys the ability of the animal to resist the carbon tetrachloride test.

Summary of inhalation experiments. The findings that have been described briefly will be amplified upon the pathological side in a further paper by Dr. G. A. Bennett. What has been given is, however, sufficient to indi-

men never inhale enough of any of these substances to get acute yellow atrophy. They may, however, acquire a substratum of liver damage upon which acute yellow atrophy may develop. Experience in a number of plants has shown how easy it is to reduce concentrations of these compounds practically to the vanishing point, and every effort should be made to attain such conditions.

Gross Feeding Experiments

The various compounds used were ground as finely as possible and mixed with a standard balanced ration for

TABLE 4
CONDITIONS MAINTAINED DURING INHALATION OF LOW CONCENTRATIONS OF THREE COMPOUNDS DURING 8-HOUR INSTEAD OF 16-HOUR PERIODS

MATERIAL	TEMP. °C.	AV. CONCENTRATION OF AIR IN BOX		TOTAL EXPOSURE hours	AV. DAILY EXPOSURE hours
		mg./cu. ft.	range		
Penta and hexachloronaphthalenes.....	149-193	1.44	High 2.58 Low 0.42	920	8
90% penta and hexachloronaphthalenes plus 10% chlorinated diphenyl.....	150-197	1.66	High 3.30 Low 0.56	912	8
Chlorinated diphenyl.....	153-174	0.93	High 3.23 Low 0.03	920	8

cate that compounds more highly chlorinated than trichloronaphthalene are capable of causing liver injury when inhaled steadily in quite low concentrations. It is an extraordinary thing that even the most searching examination fails to show injury in any other region. It is not easy to grade the toxicity of the different compounds tested, but the chlorinated diphenyl is certainly capable of doing harm in very low concentrations and is probably the most dangerous. Industrial experience combined with these experiments make it appear probable that work-

the white rat. The food was placed in a single container, at which the 10 animals in a cage had an equal chance, the amount of the compounds added being reduced as the number of rats lessened during the feeding period. The experiments were designed to give an idea as to the possible toxicity of the compounds selected and, if toxicity was observed, some idea as to the site or sites of damage.

The experiments were successful in both respects, and indeed one may anticipate that future appraisals of the possible toxicity of chlorinated hydro-

carbons may often feeding and do not rate apparatus and sary for inhalation essential reason for in the identity of tl by both methods, a different compound seem to arrange the so far as toxicity i ever way they are

Trichloronaphthalene tetrachloronaphthalene on May 4, 1936 until November 2, 1936, during 3 gm. of this n to the food for 1 and this concentrati throughout the ex animals were killed which died on Nov. loss of weight and wasting illness of an death was due to s spiratory infection tion to the material Histological exa slight changes in the of great significance.

Tetra and penta Feeding began on J dosage of 0.5 gm. da All the animals sick were either killed o 29, 1936.

At autopsy both logically the liver w affected. The liver ing, hypergranulatio sions and vacuole there necrotic cells w was a tremendous ac *Penta and hexach* Feeding began May dosage ed.

carbons may often be made by simple feeding and do not require the elaborate apparatus and the expense necessary for inhalation experiments. The essential reason for this opinion resides in the identity of the lesions produced by both methods, and the fact that the different compounds so far studied seem to arrange themselves identically so far as toxicity is concerned whichever way they are administered.

Trichloronaphthalene plus traces of tetrachloronaphthalene.—Feeding began on May 4, 1936 and continued until November 2, 1936. In the beginning 3 gm. of this mixture were added to the food for 10 rats each day, and this concentration was maintained throughout the experiment. All the animals were killed except the last which died on Nov. 2. There was no loss of weight and no appearance of wasting illness of any sort. The single death was due to some variety of respiratory infection which had no relation to the material inhaled.

Histological examination showed slight changes in the liver but nothing of great significance.

Tetra and pentachloronaphthalenes.—Feeding began on June 29, 1936. A dosage of 0.5 gm. daily was employed. All the animals sickened gradually and were either killed or died by August 29, 1936.

At autopsy both grossly and histologically the liver was the single organ affected. The liver cells showed swelling, hypergranulation, hyaline inclusions and vacuolation. Here and there necrotic cells were found. There was a tremendous accumulation of fat.

Penta and hexachloronaphthalenes.—Feeding began May 4, 1936, a 3 gm. dosage being used. By June 6, nine

rats had died. The last one was obviously ill and was killed for autopsy examination. All animals lost weight from the beginning and were ill. At autopsy the liver alone was affected, the lesions observed being similar to those that have been described for tetra and pentachloronaphthalenes but worse.

90 per cent penta and hexachloronaphthalenes and 10 per cent chlorinated diphenyl.—Feeding began May 4, 1936 on a 3 gm. dosage. On May 16th feeding was stopped but all the animals went on to death, the last dying on June 8th. An autopsy the liver lesions were extremely severe and of the usual type.

On account of the high toxicity of the 3 gm. dosage, four rats were given a 0.5 gm. dose every other day. Feeding began June 24, 1936 and the last animal was killed Sept. 11th. There were no deaths but all the animals lost weight. At autopsy the liver as usual was the single organ affected, the lesions being characteristic and extensive.

Chlorinated diphenyl.—Feeding began May 4, 1936 on a 3 gm. dosage and was discontinued on May 10th. Seven of the 10 rats were dead by May 12th. The three remaining rats gained in weight but were sacrificed for autopsy purposes on July 8th. The liver changes began at once. There were no changes in other organs.

A second group of 10 rats was fed a much smaller dose—0.5 gm. every other day. Feeding began May 20, 1936. The first rat died on May 29th and four more before June 24th. The remaining were sacrificed. Those rats that died showed losses in weight, while those sacrificed had recovered

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their initial loss in weight and were gaining. The liver lesions were similar to those found in rats fed penta and hexachloronaphthalenes plus 10 per cent chlorinated diphenyl but not so marked.

Summary of gross feeding experiments.—Of the various materials fed rats in large doses trichloronaphthalene plus traces of tetrachloronaphthalene was quite innocuous. Tetra and pentachloronaphthalene showed definite liver damage. Penta and hexachloronaphthalenes caused a similar grade of injury. The addition of chlorinated diphenyl to penta and hexachloronaphthalenes increased the toxicity. Chlorinated diphenyl alone produced liver lesions but in the dosage used was less effective than when mixed with highly chlorinated naphthalenes. In no case did the compounds used produce acute yellow atrophy but the lesions observed indicate this might be possible if one found a dosage which could act for the proper period of time.

Feeding Precise Doses by Stomach Tube

The compounds employed were suspended in gum acacia. In figuring the dosage the total amount a man of 50 kg. would inhale in an 8-hour day assuming an air concentration of .20 mgm. per cu. m. was first calculated and reduced to milligrams per kilogram. The rats and rabbits received this dose each day. The compounds used were those employed in the gross feeding experiments and the results were essentially similar though the lesions were less severe.

Subcutaneous Injections

The same gum acacia suspensions were injected subcutaneously into rats

and rabbits, the dosage being calculated on the basis of 4 mgm. per cu. m. of air. Again similar results were obtained. In all such experiments there must of necessity be differences in the degree of effect but invariably the liver was the sole organ affected and the lesions were those already described many times.

DISCUSSION

These experiments leave no doubt as to the possibility of systemic effects from the chlorinated naphthalenes and chlorinated diphenyl. As in the case of the effects upon the skin, the degree of chlorination seems to determine the systemic toxicity, and it is a striking thing that when trichloronaphthalene is reached systemic effects are never marked and are produced with the greatest difficulty. It is most remarkable, too, that all the compounds tested attack the liver and the liver alone. During the past few months we have determined the organically combined chloride in the livers of animals very severely poisoned by penta and hexachloronaphthalenes but have found no increase over normal figures, though the livers, as determined histologically, were very severely affected. At the present time we are conducting inhalation experiments on a chlorinated diphenyl containing 55 per cent of chlorine instead of 64 per cent as in the case of the experiments reported in this paper and on a compound with a chlorine content between tri and tetrachloronaphthalene. We are also determining the degree to which the diet may increase or decrease toxicity, this being suggested by similar work upon carbon tetrachloride.

In the basis of these experiments

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and on many different rooms, it is fairly easy that the amount of these naphthalene compounds are present in many plants that have been greatly increased in 20 years, a fact that has been in excess of human exposure. Time and change these but today we are safe. Improvements in arrangement of hydrocarbon safeguard. lead tetraethyl

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and on many field determinations of different compounds in the air of work-rooms, it appears safe and it is certainly easily attained, to ventilate so that the air breathed does not contain more than 0.5 mgm. per cu. m. of any of these compounds above trichloronaphthalene. In the case of the latter compound concentrations of 10.0 mgm. are permissible. We know from many examinations in many different plants that such concentrations have been greatly exceeded during the past 20 years, and we are conscious of the fact that our rat exposures have been inexorably constant whereas human exposure is never so ordered. Time and careful observation may change these opinions as to standards, but today we are convinced they are safe. Impregnating tanks and other arrangements utilizing the chlorinated hydrocarbons are easy to hood and to safeguard. Compared with benzene, lead tetraethyl and many other com-

pounds, these substances are very little toxic and operations employing them can easily be safeguarded. It may be argued that where possible trichloronaphthalene should be used, but this compound will cause acne and if employed very carelessly might do more. Furthermore, higher chlorination is often essential for highly practical reasons. The solution consists in thoroughly adequate ventilation plus good housekeeping around all wax containers.

A final word of caution bears upon the use of carbon tetrachloride as a wax solvent. Obviously this compound adds readily to the toxicity of the highly chlorinated waxes. If carbon tetrachloride is used, ventilation should be excellent, but in our opinion it would be better to dispense with carbon tetrachloride and depend on other solvents, especially upon those containing no chlorine.

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DISCUSSION

DR. CECIL K. DRINKER: We have had quite a long morning, but since Dr. von Oettingen has to leave, I am going to ask him to say a word.

DR. W. F. VON OETTINGEN (Director, Haskell Laboratory of Industrial Toxicology, Wilmington, Delaware): I wish to congratulate Dr. Drinker and his group on the very interesting and excellent work on the subject. I also wish to congratulate the Halowax Corporation on the fact that they didn't spare any effort to elucidate the problem so that the dangers which apparently are connected with the use of this material can be controlled.

I personally believe that there is no toxic material which cannot be used safely if it is handled properly. In order to handle such materials properly during the different operations it is absolutely essential to be familiar with the toxicity and especially with the mechanism of the action. Since there is no animal which corresponds in all its physiological characteristics to the human being it is important that such compounds be studied with different species of animals so that one can get a cross-section of the potential dangers.

In addition, this fact illustrates the importance of the pre-employment and periodical examination of workers in such work. As was pointed out by Dr. Drinker, there are individuals who are apparently more susceptible to certain toxic agents than others. On the other hand, we have to try to detect the very first signs of incipient poisoning in order to prevent more serious damage. In the present instance it is very difficult to find these very first symptoms because there are no adequate methods, but I trust that in time the scientific profession will supply the medical profession with adequate methods which will allow the physician to determine incipient damage of the organ before serious clinical symptoms become manifest.

Thank you.

Afternoon Session

DR. CECIL K. DRINKER: In this discussion I will call on one or two individuals and I shall expect others to speak as their notes

incline them to. First of all I shall ask Dr. Sayers if he will open the discussion for us.

DR. R. R. SAYERS (Chief, Division of Industrial Hygiene, National Institute of Health, U. S. Public Health Service, Washington, D. C.): Dr. Drinker, Ladies and Gentlemen: It gave me a great deal of pleasure to have the opportunity to listen to the excellent and interesting discussion and presentations made this morning. Dr. Drinker, and I might add, the members of the Halowax Corporation, have discussed this matter with us, as well as the manufacturers of the diphenyls.

We have been doing some work but not nearly as extensive as that carried on here. The work that we have been doing seems to confirm the work that Dr. Drinker has carried on. I think there are certain parts of it that we can very well keep in mind.

We are dealing with toxic substances, but we are dealing with toxic substances each and every day in industry—harmful substances, hazardous substances. That these can be controlled is well known, no matter what they are, and that we can use them and use them in a safe manner. Dr. Drinker has called your attention to the fact that this apparently has been done and can be done in any of the plants where halowax is used. I have information from one or two of the other men who are in the audience that in plants where damage has been done—skin damage and apparently liver damage to some of the workers—the manufacturers have since corrected the conditions and apparently have adequate engineering control supplemented with adequate medical control.

After all, the proof of the pudding is in the eating. If the man does not get the disease your engineering control is successful. If he does get the disease, no matter what you have done in the way of engineering, you haven't been successful. We must go hand in hand. Neither profession alone can be successful. We have got to work together whether we like it or not. I happen to like it.

There is one other thing. As far as materials are concerned I think we ought to be

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smart enough to use every one of them successfully. If this material is particularly adapted for a certain purpose we should use it. Another material that was used previous to this for insulation purposes, which was flammable, caused a disaster in which approximately 167 men lost their lives. I say approximately 167 because they were never just sure whether it was 167 or 168. It might have been one or two more but they were quite sure that 167 lost their lives. It happened when they had insulated a cable with this material. They had an armored electric cable. It was covered with lead armor on the outside. It was 1200 feet long and was being lowered into a mine shaft approximately 3000 feet deep. It was lashed to a steel rope. It slipped and fell to the bottom of the shaft. When the foreman was inspecting it he set it on fire with his carbide cap-lamp. The carbon monoxide from the fire killed those men that were in that mine. Many of course escaped.

Here we have one hazard, a fire hazard. Now we have another one, a health hazard due to the toxic materials. We have to evaluate them. Certain of these materials, I am informed, are also flammable. I am not just sure how flammable they are but flammability probably decreases as your chlorination increases. But your toxicity also increases as your chlorination increases, according to Dr. Drinker, and I think that checks with other findings. We have these hazards to balance but we can control them. I feel quite confident that we can.

Perhaps we can find other substances that are better even than this material. At the present time I am advised that we have no better. I am advised that in ships, such as submarines, it is quite important to have a non-flammable substance for the insulation of their electrical wire.

DR. CECIL K. DRINKER: Dr. Gray, would you care to say a word?

DR. ALBERT S. GRAY (Director, Bureau of Occupational Diseases, State of Connecticut Department of Health, Hartford, Conn.): Dr. Drinker, I don't think there is anything that I can say except that we used this material in Connecticut and we had a

number of so-called cases. All I can say is a confession of ignorance on our part at that time and I was very glad to see that your digging into the literature as thoroughly as you have hasn't elicited any further information than we were able to get, basically. About all we could find was about the two cats that our friend, Lehmann, experimented with. We got in touch with him and he confessed that the amount that he had given the cats and his method of determining it were probably subject to very serious scientific criticism, and we agreed with him on that point.

We felt, and I am very glad that it is what you feel as a result of your experiments, that if we put in an efficient ventilation system sufficient to prevent the dermatitis, we probably wouldn't have liver damage. That is what we did entirely empirically.

I think that is about all I have to say. I have been delighted to be here and to have as many members of my staff here as I could jack out of the office. We have been delighted to listen to the discussion.

DR. CECIL K. DRINKER: May we now make the discussion general and those who have questions please volunteer.

MR. MANFRED BOWDITCH (Director, Division of Occupational Hygiene, Massachusetts Department of Labor and Industries, Boston, Mass.): I would like to second very strongly what Dr. Sayers has said with regard to the approach to this problem in proper control rather than by prohibition, which seems to me wholly unnecessary not only in this case but in the case of other toxic substances with which we have to deal. The problem of proper ventilation seems to me relatively simple from what I have heard of the situation thus far. The problem of maintaining that ventilation properly does not seem to me quite so simple. I think it is going to be quite necessary that there should be a very adequate inspection of the plants using the materials and I can assure you that that will be the case here in Massachusetts.

When this trouble first broke in this state a little over a year ago we issued a quite strongly worded warning letter to all plants using these substances and it has all along

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been my plan to follow that up with a further letter bringing the situation as we now know it, as a result of Dr. Drinker's work, to the attention of users in this state. In that letter we shall unquestionably advocate the concentrations that Dr. Drinker has suggested this morning.

One point that I think is worth commenting on in that connection is the question of identification of the substances. It is extremely important from the state administrative point of view that employers using these substances should know what they are using. They are identified at present only by numbers. If we list those numbers in a warning letter which we send out there are likely to be changes in those numbers. The Halowax Corporation is a progressive concern and it is going to be putting out bigger and better halowaxes all the time. The company's cooperation in this present investigation has been such that I feel assured that they will take the proper steps to see that we in the state offices and also the users of the products will know what we are using.

I wonder whether Mr. Brown would care to say anything about that.

MR. SANDFORD BROWN (President, Halowax Corporation, New York, N. Y.): There are some aspects of this situation on which I think I can enlighten the medical and state and civic authorities, with respect to the commercial and practical aspects. If you go into the research laboratories of any large chemical manufacturing company today you will find anything from one to a thousand different new chemical products which have not yet been put on the market. Some of those may or may not be toxic. The problem so far as the chemical manufacturer is concerned is a question of timing. You have heard this excellent presentation given this morning by the Drinker brothers as to the work that they have done here. Should you take a product of which you have developed, say, 5 or 10 gm. and spend \$50,000 on research to determine whether or not it is toxic or should you wait until you have determined whether you have a market for it?

If you are producing only one hundred substances a year you can see that that would run into boxcar numbers in the way

of dollars and cents before you ever sold any. That is the problem we have had in this case. It has been on the market for 25 years. Until within the past 4 or 5 years there has never been any intimation that it would cause any systemic effects. Thousands and thousands of workmen have dealt with millions and millions of pounds of certain of these materials, particularly the trichloronaphthalenes. Then we come to the higher stages, combined with chlorinated diphenyl and other products, and suddenly this problem is presented to us.

We had asked various authorities interested in public health, going back over a period of 15 to 20 years, to investigate it but there wasn't much enthusiasm for it. Mr. Bowditch suggested that we take it up with the Drinker brothers at this institution, which we did. You know the results of that work.

Now so far as these changes are concerned, they are beyond our control to a certain extent. We will manufacture a product—let's call it 1234. It has certain chemical and physical characteristics. It is supplied to a cable manufacturer. It is composed of certain constituents. There may be some tetrachloronaphthalene, trichloronaphthalene, paraffin, a little pitch or bitumen, and possibly some chlorinated diphenyl. It does a certain job but he wants it to a little more plastic or he wants its viscosity or the specific gravity changed. Possibly by a change in those constituents of only 1 per cent we can get that particular property. We can't sell it to him as the same product so we put a new number on it. Basically, however, if the variation in the chlorinated naphthalene or the chlorinated diphenyl constituent hasn't changed, the toxic property of that will not change.

When it comes to a question of cooperating with the state authorities in that connection, if there were some major change made in a product we would have no hesitancy in advising them and we would also advise our customers. Virtually every consumer of these materials at some time or another has been given their technical or chemical designation along with their various properties, whether they be physical or chemical.

Those are some of the practical problems

with which all are confronted synthetic organism is so rapid can't even keep up with the changes.

Mr. F. R. (Mr. F. R. Drinker, New York, Pa.): I think this opportunity to refer to our work in this connection is the best teaching problem at this time.

It is only in the neighborhood of various degrees of all know. I have severely afflicted as their skin man died and noted his vapors but was an atrophy of the autopsy that it was work. Known was employment that he thin, pallid not say from physical malpresentation, ever, it was the time of plainness of it advised that rapidly developed in the hospital.

More serious that we have reaction as far as first reaction had was to plant. That that for treatment said but not as well as have winds and

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with which all manufacturers of chemicals are confronted today, particularly in the synthetic organic field where the development is so rapid that our sales departments can't even keep up with the research departments sometimes, in knowing what they are doing.

MR. F. R. KAIMER (Assistant to Manager, York Wireworks, General Electric Co., York, Pa.): I am certainly pleased to have this opportunity to say a few words with reference to the experience we have had at our York plant. I perhaps should say that again in this case experience alone has been the best teacher. I have lived with the problem at York with the men who went through the experience from its beginning.

It is only 14 years ago that we had in the neighborhood of 50 to 60 men afflicted with various degrees of this acne about which you all know. Eight or ten of them were very severely afflicted—horrible specimens as far as their skin condition was concerned. One man died and the diagnosis may have attributed his death to exposure to halowax vapors but we are not sure of that. There was an atrophied condition found as a result of the autopsy but we are not definitely sure that it was or was not connected with his work. Knowing the man as I did when he was employed, with the superficial examination that he had, he appeared to me very thin, pallid in his appearance, and I would not say from my poor knowledge of the physical make-up of the human being that he presented a healthy appearance. However, it was only for a 6 months' period from the time of his employment that he complained of this constipated condition and we advised that he see his home physician. It rapidly developed to the point where he was in the hospital and in a very short time he died.

More serious than that perhaps is the fact that we had 50 other men in very bad condition as far as the acne was concerned. The first reaction that several of our executives had was to throw it out—get it out of our plant. They didn't want anything like that for treating wire. But that was easily said but not so easily done. We might just as well have thrown our business to the four winds and said, "We'll close up," because

there was no substitute and there is none today in spite of all the efforts we have made through our own research laboratories to find one.

But we did develop—and I was most closely associated with it—and set up a routine for bringing these men back to normal health conditions. A number of them were sent to Dr. John H. Stokes and to Dr. O. H. Perry Pepper of the University of Pennsylvania Hospital, and the others to Dr. Isaac R. Pels at Johns Hopkins. Through their recommendations and studies we employed a trained nurse and two local physicians and you might say established a small hospital and its facilities at the plant. Through the application of quartz light, x-ray, mechanical removal of comedones and the treatment of pustules that developed in later stages, an utterly strict routine where the worst cases were administered to each day for a period of 15 to 20 minutes, another group who were less serious three times a week, and still another group once a week, we have in this year and a half brought each and every man back to a normal skin condition. Those who were very seriously afflicted do show scars, but otherwise their skin is as healthy in appearance as my own. I tell you we are very proud of the fact that they are still all employed and the amount of halowax that we are using today is even greater in quantity and in types than we were using a year and a half ago.

With the adequate ventilation system we have installed, with the routine for change of clothing from street clothing to work clothing when they come to work and the reverse of that process, with the assurance that a shower will be taken before the street clothing is again put on, we have found no recurrence of this skin trouble. Each and every man working with halowax products, either from solution, from solid compounds or handling the wire insulated and treated with it, is examined twice yearly with a complete physical examination, including blood analysis and efforts to determine any liver damage.

However, there is the point which was very definitely brought out this morning. We do not know as yet when this thing starts. I believe it would be of great help

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to us all in industry if some very fundamental work was done on humans, as Dr. Jones mentioned before we came into this meeting, some control in fundamental work to determine some method whereby we may determine the inception of any liver disorder.

We have had our men examined in groups three times since the trouble developed and nothing has shown up in any one man. We have learned and appreciate the fact that we must handle hazardous materials, but we have learned how to handle them. It has been a very great experience for us and for myself, and again the best teacher.

DR. CECIL K. DRINKER: Can you recollect the air concentration that you are maintaining now with your present ventilating equipment?

MR. F. R. KAIMER: We have had two examinations made of the air by Mr. William F. Hemperly and they average from 0.2 to 0.6 mgm. per cu. m. We recently discovered one condition which was found as the cause of a high reading in one of the examinations. The compound is one that is not manufactured by the Halowax Corporation that is used rather infrequently, perhaps not more than 50 gallons of it in a 6 month period. It is in the form of a paste, reduced with solvent to a paste form, and it was not known that it contained a chlorinated solvent in certain percentage. We discovered it only recently through the analysis of a sample and we found that that was the cause of throwing the results off to a high value. It was then about 8 mgm. per cu. m., I believe. That is going to be eliminated now. That is a combination of toluene and carbon tetrachloride solvent. When that compound is exposed to the air the chlorinated solvent odor is completely masked by the toluene. It is lost. I was able to detect it only by removing the head of the drum and immediately smelling the odor of carbon tetrachloride. As soon as that head was removed for a period of 10 seconds the toluene predominated and we had no knowledge of the other being in there.

MR. ARTHUR G. BYER (Research Engineer, United American Bosch Corporation,

Springfield, Mass.): Do I understand you to say that those men who were afflicted are back on the same job?

MR. F. R. KAIMER: They all returned to normal skin health, as I say, and are working on the same job.

DR. CECIL K. DRINKER: Dr. Schwartz, you have seen a good deal of this general subject.

DR. LOUIS SCHWARTZ (Medical Director, Dermatoses Investigations, United States Public Health Service, New York, N. Y.): I am primarily interested in dermatitis and it was only because of my researches in that field that I happened to come across information given to me by Dr. Gray that there were some cases of yellow atrophy of the liver attributed to halowax. I can only talk from personal experience about the skin cases. I know from what I have seen and from what I have heard from doctors who have been treating these cases that if they are treated like an ordinary acne vulgaris and kept away from further large exposure they all get well, with the same results as acne vulgaris. Those who have large pustules may have scars resulting and those who have superficial pustules or only comedones won't have any scars.

As far as prevention goes, I felt even before this investigation was undertaken that this substance, like any other poisonous substance, can be handled and used in industry provided proper safety precautions are taken, and I so advocated at the meeting in Pennsylvania when this was discussed.

About ventilation and safety precautions, I think that while we cannot, with our present knowledge, detect by any chemical tests the early symptoms of intoxication from this substance, the skin offers an easy way of proving whether your method of ventilation is efficient or not. If there are any cases of acne or of this dermatitis occurring in a plant where halowax or the chlorinated naphthalene or chlorinated diphenyls are used, then that shows that there is sufficient concentration of these substances in the air to cause plugging of the follicles and to cause a skin condition. If there is sufficient concentration to do that there may be

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sufficient concentration to cause systemic poisoning in the few people who are hypersensitive to the action of these hydrocarbons. Everybody is not hypersensitive to them. If they were, of the thousands of people who have been handling these substances, more would have contracted this disease and it would have been reported very much earlier. This material was used in Germany as early as 1914 or 1915.

While I cannot add anything to the methods outlined here for safety in the way of ventilation and so forth, I can say that if you go into a plant and find that there is any acne present among the workers with this material you will know that there is sufficient of the substance in the air to cause acne and consequently sufficient perhaps to be dangerous to the few people who are hypersensitive to its action.

DR. CECIL K. DRINKER: There is a practical point in regard to the question of determining these substances in air. My brother pointed out this morning that there are several pieces of apparatus for doing this. It has seemed desirable to a number of the men who are here that during the next couple of years, while we are in a position of learning, that we endeavor, if we can, to confine our analyses to one piece of apparatus, so that at least our results will be as comparable as we can make them from place to place.

I don't know much about this phase of the subject; perhaps, Mr. Cook, you have an idea or two about that.

MR. WARREN A. COOK (Chief Industrial Hygienist, Bureau of Occupational Diseases, State of Connecticut Department of Health, Hartford, Conn.). On the determination of the halowax I wonder if it wouldn't be preferable to have Mr. Hemperly discuss the method he has been using throughout the country for the determination of chlorinated naphthalenes.

DR. CECIL K. DRINKER: I think so far as that is concerned it is best to leave that to discussions with Mr. Hemperly and Dr. Brandt afterward. But the question of determining some uniformity of technic for a while at least is, I think, a matter of general interest to us.

MR. WARREN A. COOK: I am not quite sure that I have in mind exactly what you want in that regard. In connection with sampling?

DR. CECIL K. DRINKER: Yes, In connection with the whole technic of determining the material in air, length of sampling, type of apparatus, and so forth. It has been suggested that we endeavor to agree upon some uniform procedure for that and as figures begin to come in, as they will in the course of the next couple of years, we will at least have them on a comparable basis.

MR. WARREN A. COOK: In that regard there is no question but what the determinations and results of analyses of the concentration of injurious materials in air, correlated with pathological findings or freedom from pathological findings, are real factors in further substantiating toxic limits which are originally given us from animal experimentation. In order to obtain data which are of value along that line it is desirable to know to what extent, in terms of milligrams per cubic meter, workers are exposed to in breathing any potentially injurious material.

It seems to me that one of the things that should be done, which many of the plants and many of the organizations equipped to make determinations of injurious materials in air should do, is to make an effort to develop one group and series of results which will represent average exposures of workers to chlorinated naphthalenes. In getting that figure I think that it is of great importance that we should consider average daily exposure. There is a tendency very often in taking samples of air to determine maximum exposures, to get the exposure over a 15 or 20 minute period when the worker may be actually tending a pot where the material is being used, whereas during the subsequent half hour he may be 40 or 50 feet away from that particular location. Therefore, for one thing, it seems to me it would be extremely desirable to obtain information in as many plants and as many locations as possible of the average exposure, taking into consideration not only the worker's maximum exposure while actually

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at work with these materials but also his much smaller exposure and possibly even lack of exposure as he may go to other parts of the room or even to other departments during the course of the day.

Another type of determination which seems to be extremely desirable to have is concentrations of the chlorinated naphthalenes at certain reference points. I believe that Mr. Hemperly very carefully duplicated these reference points in each of the plants where he took his determinations. He took the samples, I believe, at breathing level and at a certain measured distance from the pots where the chlorinated naphthalenes were being handled, so that next year he could go back to those same locations or others could take determinations at those same locations, which are definitely fixed and recorded, and learn whether, due perhaps to clogged pipe lines or to fans which might become loaded with the condensed chlorinated naphthalene, there might be poorer ventilation than originally designed and higher concentrations of the chlorinated naphthalene than originally determined.

It seems to me that it would be an extremely desirable thing to have made available for all of us who are making these determinations these reference points so that in Massachusetts and in Connecticut, at one plant or at another, a considerable group of workers could be taking samples at this one particular point with reference to the source of generation of the vapor. Such results would permit a comparison of knowledge between plants.

In that regard it happens that there is a committee of the American Public Health Association which is charged with the development of chemical methods for determination of atmospheric contamination such as that now under consideration. It seems to me that it might be a very desirable project for that committee to consult with the investigator of the Halowax Corporation and suggest to all of those who are doing work of this type, after some discussion, what reference points could be adopted and also what should be done in connection with getting these average exposures. As a matter of fact our committee will discuss that very feature and possibly include it in our report

before the A. P. H. A. in October as one of the projects which we shall carry out at that time.

As I have not given this consideration, I am afraid my discussion is not as connected as I might wish it to be. We have a real problem here and one that deserves some study.

DR. CECIL K. DRINKER: Would it be of service to the American Public Health Association Committee if a sub-committee from this meeting, collected perhaps by my brother and those of you involved with these problems, were to make a recommendation to the A. P. H. A. as to the things you have brought up and as to suitable apparatus, and let the final statement come from the Association after they have considered that material?

MR. WARREN A. COOK: I think that would be a splendid idea because we have a bulk of information on this particular material. A number of individuals have given much thought to the development of apparatus, both the combustion method which we have here and also the continuous record type of apparatus which Professor Drinker mentioned this morning. I think that it is a sufficiently important project that a sub-committee made up from this group could give that committee a very definite steer.

[Personnel of the Sub-committee: W. A. Cook, chairman, A. L. Coleman, H. B. Elkins, W. B. Fulton, S. W. Gurney, E. R. Hayhurst, W. F. Hemperly, F. W. Sehl, and A. N. Setterlind.]

MR. HERVEY B. ELKINS (Chemist, Division of Occupational Hygiene, Massachusetts State Department of Labor and Industries, Boston, Mass.): In connection with what Dr. Schwartz has said, I am not sure that I am in complete agreement as regards the use of skin lesions as warning agents. It is my understanding that in insulated wire plants the chlorinated diphenyls are very commonly compounded with the chlorinated naphthalenes. It is also my understanding that these are more likely to cause a severe skin irritation than the straight chlorinated naphthalenes. On the other

hand, from Dr. Drinker's judgment that the straight chlorinated naphthalene was nearly as pure a mixture of it with a chlorinated diphenyl.

In the condenser in our cases there is no used and no acne of the reports on the in-

DR. R. EMMETT KILPATRICK (Medical Co., St. Louis, Mo.): Anything to the laborer has been quite a little bit in the last several years at our plants where we have been using this chlorinated naphthalene. Our observation that we did have a series of skin eruptions which were able to attribute as to impurity in the benzene the chlorinated diphenyl any systemic reaction. We have examined it from what laboratory might help us and I point. Also from alone there have been poisonings reported.

I don't believe that laboratory results in without paying even the volatility of different way they are being

DR. JOHN A. HOCHEM (Dermatologist, Halowax, Mich.): I have had to do with the dermatologist. The experience at Wyandotte definitely did increase in used rather than the naphthalenes.

From the discussion I think the observation that the chances of problems will disappear is probably true. I am certain precautions, yes, you might as hiring men who are these products, even

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hand, from Dr. Drinker's work one would judge that the straight chlorinated naphthalene was nearly as toxic at least as the mixture of it with a small amount of chlorinated diphenyl.

In the condenser factory where we had our cases there is no chlorinated diphenyl used and no acne of the type described in the reports on the insulated wire factories.

Dr. R. EMMETT KELLY (Monsanto Chemical Co., St. Louis, Mo.): I can't contribute anything to the laboratory studies but there has been quite a little human experimentation in the last several years, especially at our plants where we have been manufacturing this chlorinated diphenyl. It has been our observation that although on one occasion we did have a more or less extensive series of skin eruptions which we were never able to attribute as to cause, whether it was impurity in the benzene we were using or to the chlorinated diphenyl, we have never had any systemic reactions at all in our men. We have examined them very closely both from what laboratory tests we thought might help us and from the clinical viewpoint. Also from chlorinated diphenyl alone there have been no cases of systemic poisoning reported.

I don't believe that we can transpose the laboratory results into the actual humans without paying considerable attention to the volatility of different substances and the way they are being used.

Dr. JOHN A. HOOKER (Consulting Dermatologist, Halowax Corporation, Detroit, Mich.): I have had considerable experience with the dermatological angle of this problem. The experience at the Halowax plant at Wyandotte definitely was that the dermatosis did increase when compounds were used rather than the straight chlorinated naphthalenes.

From the discussion we have heard today I think the observation Dr. Drinker made that the chances are that dermatological problems will disappear along with the other is probably true. However, I think that certain precautions, certain insurance measures, you might say, should be taken in hiring men who are going to work with these products, even though we are going

to attempt to get the concentrations low. We saw this morning that the effect of these products was on the liver and that if some one working in these products developed liver damage from some other source the chances of his having serious trouble was increased. Therefore, inasmuch as there is no test to tell whether a person has had liver disease, certainly in the preliminary medical examination of applicants for work the history at least should be gone into very carefully for a history of previous liver diseases.

There are other things that should be taken into consideration also. One is the history of syphilis, because syphilis does have an effect on the liver. If there is any history of syphilis I don't think that that man should be hired. A Kahn test should be taken and I think that it would be a good plan to take Kahn tests on men at stated intervals, because they might develop syphilis after they are hired.

I think those things should be done even though we feel that if the concentration of these vapors in the air is kept as low as was recommended this morning, the chances of having toxic effects are very small.

Mr. F. R. KAMMER: I would like to clarify a point of Dr. Hooker's.

You mentioned at the beginning of your talk that your experience in acne condition was more pronounced from the compounds of various materials with chloronaphthalene than with the straight chloronaphthalenes. Did you mean by that, that the acne condition actually was more pronounced with the compounds than with the straight chloronaphthalene or was that due to the fact that you were in a plant operated in a different fashion? In other words, you handled your numerous wire compounds in more of a batch operation. That is my understanding from Mr. Brown.

Is it a fact that the straight chloronaphthalenes are less harmful in so far as acne is concerned or is it because of the handling of batch compounds?

Dr. JOHN A. HOOKER: That is a question that would be difficult to answer. I based my statement on the fact that in taking a general survey of these cases after I started working with them the men in the plant said

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that they developed acne more often and more severely after they started making compounds. It may be that it was in the method of the handling.

MR. F. R. KAIMER: You say that the condition increases with the increased chlorine content and we are attributing the acne primarily to the chlorine radical. If that is true, what are we to associate insofar as these various other constituents are concerned, such as various plasticizing agents? How much do we know about those insofar as development of acne is concerned? Some of these compounds have a half dozen constituents in them other than chlorodiphenyl and chloronaphthalene. We are at the present time considering the chloronaphthalene as the basic element responsible for the acne condition which we have. We know very little about what the other materials may or may not do.

DR. JOHN A. HOOKEY: I don't know about these other materials. Perhaps Dr. Schwartz would know something more about them.

DR. LOUIS SCHWARTZ: It is well known in industry that there are many compounds that cause acne. For instance, paraffin acnes and oil acnes have been known for a long time. Paraffin acnes, wax acnes, are simply a mechanical plugging of the follicles of the skin by the minute particles of wax that fall on the skin. I think that the acne caused by these chlorinated naphthalenes and diphenyls, because it is caused by both—I was down at the Swan Chemical Company where they make chlorinated diphenyls and they have acne there just the same as over at Wyandotte where they make the chlorinated naphthalenes—I believe that that is caused by the same thing, a blocking up of the follicles of the skin, the formation of the comedone and then the comedone becomes infected and forms a pustule. They don't all pustulate because they don't all become infected. Many of these men never have any pustules. They just have little white elevations on their skin.

In those people who are in the acne age, the youngsters of 18, 20, 22 and 23, acne

vulgaris is most apt to occur. The sebaceous glands are most active and they seem to have it much more than the older people in whom the sebaceous glands are not so active.

We keep a clipping of all articles relating to industrial dermatitis in my office and I recently read an article in a German magazine in which they report in Germany a similar acne condition from chlorinated phenols and chlorinated benzenes and solid waxes. It seems that this acne-like condition is not peculiar to halowax or chlorinated naphthalenes or diphenyls but can occur with any condition that blocks up the sebaceous follicles of the skin.

DR. ROYAL MEXNER (Special Agent, State of Connecticut Department of Labor, Hartford, Conn.): I am full of questions. As a statistician I am a little bit suspicious of averages, so I should think that we should take maxima as well as averages in getting at the threshold dose or the dangerous impregnation of the atmosphere with these poisonous compounds. I just wanted to drop that as a hint for this committee to consider in its work.

In spite of what you said at luncheon, Dr. Drinker, I still think it is rather important to determine how the plugging of the pores actually does occur, whether they are plugged as Dr. Schwartz has suggested, from the particles falling on the outside of the skin or whether they are plugged, as so many doctors have informed me, from inside as it were. The fumes are breathed, the substance gets into the blood stream. It is thrown off through the pores of the skin and the pores are plugged. I think it is rather important to determine that because it seems to me, from the slight knowledge that I have of the industrial application of halowax compounds in insulating wires, that the plugging of the skin, if it is just an outside plugging, may take place either from handling a solid substance or from the coating on the wire after it becomes cold.

I haven't heard anybody say anything about those Massachusetts cases of very severe dermatitis and I am not so sure but what there was some question of liver damage there. Nobody has said anything about them at all. There is no question there

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that the condition, whatever the complications might have been, came from handling cold wire, in a confined area of course.

I think this needs a great deal more study, Dr. Drinker, than you and your associates have been able to give it as yet. All I am curious about is the way we can administer the protective labor laws in order to protect both the employer and the employee.

I listened with very great interest to the expositions of suggested pots for the application of halowax, chlorinated naphthalene and diphenyl. It seemed to me that they left very much to be desired. I don't see why the application of the halowax compound, if it is necessary, as I assume it is, to use this rather dangerous substance, can't be done in a practically closed pot. If you please, Dr. Drinker, I wish you would ask Mr. Reeves of the Rockbestos Products Corporation to tell how they have handled it. If I am any judge of equipment and safety devices they have come as near to eliminating entirely from the atmosphere all contamination from fumigated or evaporated halowax as anyone. All of the application of halowax, either in the melting pots or where it is applied to the wire, is done under hooding and with ventilating apparatus, and it seems to be entirely adequate.

Mr. B. H. REEVES (Vice-president and General Manager, Rockbestos Products Corporation, New Haven, Conn.): I will be very glad to tell of our experience if it will help the picture along. Our experience has been more or less parallel with Mr. Kaimmer's in as much as we manufacture the same type of wire. We have avoided the serious picture that he ran into, probably due to the fact that shortly after 1923 we were using benzene as a solvent for asphaltic materials.

We got into anemia difficulties with benzene fumes and had to install a complete ventilating system to remove all those fumes from the machines that applied the compounds to the wire. Following the installation of that equipment we were able to get a substitute for benzene, so we got it out of the picture.

We are still in the same fix as every one else is as far as finding a substitute for halowax. There is none that we know of. Consequently when we went to the use of halo-

wax we had a head start as far as the ventilating system was concerned, since ours was already installed and adaptable to a compound with a benzene solvent rather than a melted halowax compound. In order to keep the fumes of a highly volatile solvent under control we did develop a practically complete enclosure for the container in which the compound was placed and exhausted that container in order to prevent any escape of the fumes from it. When we changed to the halowax compounds we followed the same scheme of applying the compounds and used a completely enclosed pot. There is a hole in one side for the wire to go in and one on the other side for the wire to come out. There is enough exhaust suction on the enclosure to prevent any fumes from getting out of the openings where the wire enters and leaves. Of course periodically it is necessary to open the pot to replenish the compound or make adjustments. In that case we have the ventilating system interlocked with the door that the operator opens so that when he opens it he increases the amount of air travel about ten-fold.

Dr. ROYAL MEXNER: What is the velocity when the door is open?

Mr. B. H. REEVES: With the door wide open, at breathing level the velocity is 200 feet. That is the linear velocity. We check that every week on every opening at every machine with a velometer, a small instrument which is easy enough to operate and reads directly. Whenever the velocity falls below that figure the pipe connecting that machine is taken down and cleaned, because there will be condensation inside the pipe to cut down the air flow and reduce the ventilation efficiency.

Dr. ROYAL MEXNER: What do you think of that trap device shown?

Mr. B. H. REEVES: I don't know what to think of that. I don't know whether it would be practical or not. I was going to ask Dr. Drinker whether in passing the air laden with halowax fumes through the boxes of rats there was any deposit of halowax in the enclosure.

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DR. CECIL K. DRINKER: Yes. It is detectable readily through the outflow pipe.

MR. B. H. REEVES: Those in the far end probably didn't get the concentration.

DR. CECIL K. DRINKER: We change the position of the boxes each day. The ones furthest away move into the nearest position, so that over a period of weeks all are exposed equally.

DR. EMERY R. HAYHURST (Consultant in Industrial Hygiene, State Department of Health, Columbus, Ohio): I would like to ask if it wouldn't be possible to put a cold water line around that trap and deposit it all before the air escapes from the trap.

MR. B. H. REEVES: We have tried cooling the surface of the exhaust pipes in order to concentrate the deposit in one place and make it unnecessary to remove long lengths of the ventilating system. While we have found a slight advantage in doing so it hasn't at all paid for the expense. It is much easier to take the piping down. Consequently I doubt the possibility of removing it all by cooling the surfaces of the trap. It might be possible, by building a labyrinth of refrigerating coils, to collect it. But then you would have the problem of removing it from the coils after you had collected it and it would involve rather complicated procedure.

DR. B. L. VOSSURON (Medical Director, General Electric Company, Schenectady, New York): We have heard about the possibility of preventing liver damage and skin trouble among manufacturers of wires and cables and so forth, but like the old rhyme, every dog has fleas and the fleas have fleas, we also have customers who use wires and cables in tunnels, in enclosed spaces, splicing them together and doing all sorts of things. I am not at all certain that we know what the concentration of these chlorinated hydrocarbons is under those conditions.

About the time we were having so much trouble at our York factory some of our customers began complaining. We thought we were having a hysteria of halowax mania throughout the country. Some of their

complaints were bona fide. We had no difficulty in handling cold wire and the men had no skin trouble. Yet when they did the same thing with possibly the application of heat in tunnels, ships and so forth, they actually did develop trouble.

We have used, of course, the icterus index in following some carbon tetrachloride cases and I wondered what you have to say about that. Is that of no value at all in the case of liver damage in this material?

DR. CECIL K. DRINKER: I don't think so until it gets so extreme that we know it any way.

DR. B. L. VOSSURON: I did write down a few questions that came to mind. Some of them have been answered and some are foolish but I shall ask them anyhow.

It occurred to me that if trichloronaphthalene has been proved to be practically innocuous, isn't it a problem of research largely for the Halowax Corporation to use only that one material adopted with other known chlorinated compounds to meet the requirements of customers? That is one of the foolish ones probably, but I shall just ask it.

Furthermore, how long is it reasonable to expect the liver to recover after it has been pretty well damaged. I talked to you and you said you hadn't worked that out with the animals as yet.

DR. CECIL K. DRINKER: In that case we set aside a certain number of animals to recover, after knowing that a certain amount of damage had been done. Then we started to kill them but we invariably ran out of rats before they ran out of lesions. We don't know how long it lasts.

DR. B. L. VOSSURON: Have you given them calcium and glucose as you would with carbon tetrachloride?

DR. CECIL K. DRINKER: Not yet, but we are doing an experiment now with one group on a very high calcium diet and another group on a calcium free diet. The whole question of calcium in the diet, of giving milk daily to these people may be worth while.

DR. B. L. VOSSURON: questions in mind. what Mr. Brown would like of using only chlorinated naphthalene.

MR. SANDFORD: simplify our problem from the commercial toxicity standpoint. I think that Mr. K. to object because he the technical effects. The same thing applies industry where we chlorinated products.

The problem as which we intend to our program for that will be done under Drinker brothers), demarcation and complicated chemical some one thing that we could take but remove 1 per cent. with which and eliminate the a lovely solution. able to attain the one of the things.

As I said before with which all in the synthetic organic products some stage, either commercial development question of timing the work, how whether you know to learn that first.

DR. CECIL K. some other important the meeting adj.

DR. R. R. I more with regard to syphilis? I all your work.

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DR. B. L. VOSBURGH: I just had those questions in mind. I would like to hear what Mr. Brown would say as to the possibility of using only this one innocuous chlorinated naphthalene.

MR. SANDFORD BROWN: That would simplify our problem exceedingly, not only from the commercial standpoint but from the toxicity standpoint. But if we did so I think that Mr. Kaimor would be the first to object because he wouldn't be able to get the technical effects he desires in the cable. The same thing applies throughout all the industry where we are using these higher chlorinated products.

The problem as we see it, and it is one which we intend to study further (we have our program for this continuous work that will be done under the direction of the Drinker brothers), is to try to find a line of demarcation and whether or not within this complicated chemical structure there is some one thing that causes the trouble. If we could take hexachloronaphthalene and remove 1 per cent of some unknown constituent with which we are not now familiar and eliminate the toxicity, that would be a lovely solution. Whether we will ever be able to attain that I don't know. That is one of the things we have in mind.

As I said before, that is one of the things with which all manufacturers of these synthetic organic products are confronted at some stage, either in their laboratories or in commercial developments. It is largely a question of timing as to when you should do the work, how much you should do, and whether you know how to do it. You have to learn that first.

DR. CECIL K. DRINKER: Unless there is some other important matter I will declare this meeting adjourned.

DR. R. R. SAYERS: May I say a word more with regard to what Dr. Hookey stated on syphilis? If you are going to eliminate all your workers who happen to develop

syphilis during the time they are working for you, you are probably going to lose some very important employees. It would seem that it would be worth while to give serious consideration to seeing that conditions are proper and suitable for them to continue working for you and that they have proper treatment. In other words, I don't believe that is a good or sufficient reason for discharging those employees who do develop syphilis. We have not found that to be true in other places and I question whether this is one of the places. I may be in error.

MR. SANDFORD BROWN: I want to take this occasion to express on behalf of the Halowax Corporation my thanks for the excellent cooperation we have received from various state authorities and our customers as well in this investigation. I believe you have all formed the opinion, based on what you have heard this morning, that our whole motive here is to conduct this on an ethical, scientific and constructive basis.

In collaboration with the Monsanto Chemical Company we have a much more comprehensive program in view to carry on. Therefore we want to continue that same type of cooperation.

There is one thing that I want to bring up in that connection, which will have to be observed by the state authorities, when they go out to make these inspections. That is the necessity of not creating mob hysteria on the part of the workmen in the plants where these inspections are made. Mr. Hemperly has run into some very interesting situations in the various examinations he has made. I know that he would be glad to relate them and give the benefit of his experience to the heads of any of these state departments who will have the direction of this work. Otherwise I can see where we will be unable to get the full cooperation of not only the individual workmen but the plant foremen and the management, and we must have that if we are to get the results that we are shooting for over the next several months or years. This thing may continue, probably will continue for years.

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REPORT TO THE HONORABLE JUDGE
COLE L. DILLON, M.D.
September 15, 1978

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REPORT TO THE MONSANTO CHEMICAL COMPANY

by

Cecil K. Drinker, M.D.
Dean and Professor of Physiology
Harvard School of Public Health, Boston, Mass.

September 15, 1938

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I. EXPERIMENTS TO DETERMINE THE POSSIBLE TOXICITY OF THE FOLLOWING SUBSTANCES

1. CHLORCOSANE

On July 14, 1937, we were informed by F. D. Smith that each 6 ounce bottle of a soft drink might contain 60 to 70 mgm. of chlorcosane. There was no pharmacological reason to believe the compound would be irritating or toxic in any way, and therefore it was decided to dose rats with it very heavily, the argument being that if they survived heavy dosage without any evidence of damage a verdict of no toxicity might be given and much time saved. If, on the other hand, the large doses proved poisonous it would be necessary to reduce dosage until a non-toxic level was reached. The first of these alternatives proved correct.

Experiments. — August 10, 1937. 20 adult white rats ranging in weight from 162 to 210 gm. were each fed 70 mgm. of chlorcosane in 1 cc. of olive oil daily by stomach tube. These animals showed no evidence of damage in any way attributable to chlorcosane. They were examined microscopically from the 35th to the 92nd day. The only constant change observed was a possible slight increase in the granularity of the cells of the liver cords, but the pathologist in charge felt this to be within normal limits. This finding is doubly reassuring since many of the animals developed a chronic suppurative lung condition very prevalent in Boston stock rats at the time. But even with this added handicap there was no evidence of damage and we thus conclude that chlorcosane even in enormous dosage is an inert material in the body and in all probability passes through the intestine unchanged.

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2. DIPHENYL PHTHALATE

On August 23, 1937, we were informed by Dr. R. E. Kelly that diphenyl phthalate might be absorbed through the skin or might be inhaled and swallowed during spraying operations. After consultation it was decided to feed heavily, and if there were indications of toxicity to project other experiments.

Experiments. -- September 20, 1937. 20 adult white rats ranging in weight from 242 to 301 gm. were each fed 0.5 mgm. of diphenyl phthalate suspended in 1 cc. of water by stomach tube daily. The animals were from new stock and with one exception remained clear of the lung condition which existed in the chlorcosane group. During the period of experiment, which lasted 92 days, practically all the animals gained weight. Examination of 8 animals killed at intervals during this period of test resulted as follows:

The organs were normal grossly, and on microscopic examination the liver alone was of possible interest. The changes in the liver varied from those in which the cells of the liver cords were almost normal, having only a slight swelling and granularity of their cytoplasm, to those in which these changes were pronounced. In the latter there was a moderate degree of vacuolization and a rare hyaline body. These alterations it must be understood were the result of very certain dosage, since the compound was given by stomach tube and the animals had no possible way of avoiding it. Neither the pathologist nor myself was able to consider them of enough moment to cause us to make further experiments.

I am confident that with the ordinary precautions accompanying spray lacquering no possible harm could be done, even if the concentration of diphenyl phthalate in the lacquer was far above the 5 per cent figure given us by R. E. Kelly.

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3. CHLORINATED DIPHENYL - COMPOUND #1258

This material was furnished by the Monsanto Chemical Company. It was said to have a chlorine content of 68 per cent, the highest chlorine figure of any compound tested by us during the past three years. It had been our impression that toxicity and chlorine content followed one another closely, but this has not turned out to be the case for #1268, ~~substantially identical~~ ~~substantially identical~~. Further discussion of this point will follow the description of the experimental observations and their results.

Experiments. — August 2, 1937. The compound #1268 was administered by inhalation, the technique being that described in the paper entitled The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons, Journal of Industrial Hygiene, 1937, 19, 283. For the first observations 80 adult white rats were used. They were exposed as follows:

Group 1. — 80 animals. Temperature to which the compound was heated to introduce fume into air line 140-190° C. Average concentration in air breathed by rats 0.53 mgm. per cubic meter. Average daily exposure 16 hours. The experiment was continued for 119 days, animals being sacrificed at intervals for pathological examination and for the carbon tetrachloride and alcohol test (see paper previously cited).

The conditions described above caused swelling and increase of granularity of the liver cells. Hyaline inclusions were rare. These changes were quite uniform in all animals examined after the 31st day, but were not certainly progressive. The rats were very healthy throughout the period and there was an almost uniform gain in weight. The carbon tetrachloride-alcohol test was positive after 52 days, which indicates that though liver damage was apparently slight some degree of harm had been done the organ. There was no evidence of

damage in any part of the body except the liver.

At the end of 93 days 10 rats, apparently in excellent condition, were removed from the experiment and set aside for observations upon liver recovery. These recovery animals showed no clinical changes of any sort. When sacrificed 72 and 141 days after removal from exposure it was observed that the swelling of the liver cells had disappeared, but the granular and hyaline material remained in the liver cells and had apparently become permanent. There was absolutely no progression of damage after removal from exposure.

These changes may be compared with those produced in rats by inhalation of chlorinated diphenyl #4465, administered in a similar manner in concentrations of 0.57 to 0.93 mgm. per cubic meter over similar periods of time. In the case of this compound the conspicuous difference was the far greater incidence of hyalinization of the liver cells, which in our opinion was the characteristic lesion caused by #4465 and mixtures containing it. One can therefore conclude that #1268 in low concentrations is definitely less toxic than #4465.

Group 2. — After 119 days, the low concentration of #1268 having proved but slightly poisonous, it was decided to increase the concentration in the air breathed by the 54 rats then remaining. Temperature and other conditions were maintained as during the first 119 days, but by the use of 4 vaporizers instead of 1 the average concentration of #1268 in the air was brought to 6.23 mgm. per cubic meter of air. Exposure to this very high concentration was continued for 87 days.

Under these extreme conditions the animals again remained in perfect health. The carbon tetrachloride and alcohol test was positive but there was absolutely no other indication of liver damage and no evidence of disturbance to other organs.

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When examined at autopsy at the end of 87 days — the animals had experienced a total exposure of 206 days — there were no gross evidences of abnormality in any part. On microscopic examination no organ showed changes except the liver. The number of cells containing hyaline and the amount of hyaline in the cells involved increased during this period of exposure to the higher concentration of #1258. The hyaline was most abundant in the portal zone of the lobule with very little in the central area. After 42 days of exposure 10 rats were set aside and were sacrificed 73 days later. They were in excellent condition when removed and did not change. Grossly, at autopsy, they showed nothing abnormal, and on microscopic examination the liver cells had lost their swelling but retained increased granularity and hyaline inclusions.

The experiments on inhalations of high concentrations of #1258 reinforce the conclusion that this compound is of low toxicity as compared with #4463 or with chlorinated naphthalenes above trichloronaphthalene. The question as to why #1258, the most highly chlorinated compound tested, proved but slightly harmful cannot be answered with any definiteness. It has been suggested that the toxicity of all these chlorinated compounds, even though of varied composition, may depend on the ability of the animal to decompose them after lodgment in the tissues, and that this decomposition might be shown by an increase in the chloride in the urine in suitably conducted feeding experiments. In experiments upon this point we have shown a definite increase in the urinary chlorides when dogs and rats were fed a mixture of penta and hexachloronaphthalenes (#1006), a compound highly injurious to the liver and containing 62.5 per cent of chlorine, but similar observations have not been made with any of the chlorinated diphenyls or allied compounds. It may, however, be that when about 65 per cent chlorination is reached the substances formed are quite stable in the body and so cause a minimum of damage.

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In conclusion, #1268, if handled with ordinary precautions as to ventilation should be entirely harmless to workmen. While it cannot be given an absolutely clean bill as to health, it is preferable to #4465 and #5460.

4. MIXTURE OF CHLORINATED DIPHENYL AND CHLORINATED DIPHENYL
BENZENE -- COMPOUND #5460

This substance was furnished by the Monsanto Chemical Company and was said to have a chlorine content of 60 per cent, being in this respect below #4465 and far below #1268.

Experiments. -- The inhalation technique was used as in the case of #1268 and #4465.

August 2, 1937. 80 adult white rats were the subjects. Temperature to which the compound was heated to introduce fumes into the air line 140-196° C. Average concentration in air breathed by rats 0.025 mgm. per cubic meter. Average daily exposure 16 hours. The experiment lasted 119 days. A certain number of animals were sacrificed for pathological examination, others were used for the carbon tetrachloride and alcohol test, and still others set aside for observations as to recovery from possible damage.

In spite of the fact that the concentration in the air breathed by the rats averaged about 1/6 that obtained at comparable temperatures from #1268, a number of these animals became sick and lost weight towards the end of the second month of exposure. When killed, such individuals showed gross swelling of the liver but no changes in other organs. On microscopic examination swelling of the liver cells, increased granularity and hyaline inclusions were noted in animals killed as early as the 16th day of exposure. These changes obviously occurred rapidly. Hyaline deposits were never as numerous as with #1268. Animals

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removed for recovery after 51 and 119 days of exposure did not gain markedly in weight, and one died for no obvious cause. When examined at autopsy the swelling of the liver cells had subsided, but abnormal granularity and hyalinization remained.

Needless to say the carbon tetrachloride and alcohol test was positive whenever used.

In view of the fact that #5460 in such low concentration proved so definitely toxic, no higher concentrations were tested. It seems imperative that whenever this compound is used in industry, great care be taken to keep concentrations in the air at an extremely low level. No liberties can be taken with it, as with #1268.

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II. SOME GENERAL CONSIDERATIONS

In addition to these tests of compounds, certain experiments were done which are of interest to those manufacturing or using chlorinated hydrocarbons. Details as to these experiments are of course available but are not included in this report since they are not of direct industrial interest.

1. EVIDENCE FOR THE DESTRUCTION OF A MIXTURE OF PENTA AND HEXACHLORONAPHTHALENES (#1006) IN THE BODY

It has always been a question as to whether the chlorinated hydrocarbons which have been examined by ourselves and by others do harm per se or whether toxicity depends on their breakdown in the body with the liberation of something harmful to the liver. A partial answer has been obtained by feeding #1006 to rats and dogs which were on a low chloride diet with uniform excretion of chlorides in the urine. When these animals received the chlorinated hydrocarbon (#1006) the urinary chlorides rose. This indicates that the body certainly has power to detach chlorine from this compound, and it is probable that the same condition is true for added toxic compounds. It would be most interesting to see whether ingestion of #1258 results in similar findings or whether in the case of this relatively non-toxic compound there is practically no splitting off of chlorine. Neither time nor our financial resources permitted such tests.

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2. THE EFFECT OF INCREASING THE SODIUM CHLORIDE IN THE DIET UPON ANIMALS RECEIVING TOXIC DOSES OF #1006

On the ground that chlorides might be fundamentally associated with toxicity, a group of 15 rats was fed a low toxic dose of #1006 and compared with a similar group on the same dosage of #1006 plus a marked increase in chloride intake secured by giving 5 cc. per kilogram of body weight of 4 per cent NaCl solution daily.

No differences were found between the two groups, and it may be concluded that chlorine increase secured through the diet does not enhance toxicity. This experiment was done in order to find out whether increase in chloride intake during hot weather might be harmful.

A particular phase of the problem, the possible enhancement of typical skin lesions by increasing chloride intake, cannot be decided by experiments on fur-bearing animals with no sebaceous glands. All that can be said at the moment is that increased chloride intake does not increase systemic toxicity.

3. THE EFFECT OF HIGH AND LOW CALCIUM INTAKE ON ANIMALS INHALING HIGH CONCENTRATIONS OF #1006

It is well known that a diet rich in calcium is markedly effective in preventing the acute yellow atrophy of the liver produced by carbon tetrachloride (The Prevention and Treatment of Carbon Tetrachloride Intoxication. By P. D. Lanson, M.D., A. S. Minot, Ph.D., and B. E. Robbins, M.D., Journal of the American Medical Association, 1928, volume 90, page 145).

To discover whether calcium in the diet would protect against liver damage

ACM 6834

from a toxic chlorinated hydrocarbon, 30 adult white rats were placed upon a diet of lean horsemeat, starch and lard, a combination adequate for maintenance but very low in calcium. Another group was given a diet consisting of dog chow, milk, lettuce and eggs, with added calcium lactate — a ration very high in calcium.

Both groups were exposed simultaneously to inhalation of high concentrations of #1006, an average of 11.21 mgm. per cubic meter for 16 hours a day.

After 16 days, 12 high calcium diet rats were alive and 7 of the low calcium group. At intervals animals were killed for examination. In both groups the liver was abnormal grossly and microscopically, and in both groups animals died from liver damage. It was impossible to consider that the high calcium diet was in the least degree protective. It may, therefore, be concluded that adding calcium to the diet of workers either in the form of extra milk or of calcium lactate will not prevent liver damage.

4. THE EFFECT OF INJECTIONS OF XANTHINE ON ANIMALS

INHALING HIGH CONCENTRATIONS OF #1006

In 1937, R. C. Neale published a brief paper (The Protective Action of Certain Purines against Liver Necrosis Produced by Carbon Tetrachloride and Chloroform. Science, 1937, volume 86, page 83). He claimed that rats injected with sodium xanthine became markedly resistant to carbon tetrachloride. This suggested that xanthine might have similar protective power over liver damage from the chlorinated hydrocarbons on examination in this laboratory.

Accordingly 38 adult white rats were caused to inhale #1006 in concentrations averaging 15 mgm. per cubic meter for 16 hours daily. One group of 20 rats was given 20 mgm. of xanthine subcutaneously every other day and 40 mgm.

ACM CC3441

of xanthine by stomach tube on the alternate days. The second group of 18 rats had the same exposure to #1006 without xanthine treatment. No differences were noted and one cannot expect any efficacy from xanthine either in the prevention or treatment of liver disease due to this chlorinated hydrocarbon, and in all probability the same negative result would be encountered in connection with allied toxic compounds.

ADM 003442

REPORT TO THE MONSANTO CHEMICAL COMPANY

Cecil K. Drinker, M.D.

September 15, 1938

ACM 00341

C-425711

Inhalation Experiments

Animals. White rats have been employed throughout. They permit the use of a large number of animals in a relatively small inhalation installation. They thrive upon a diet very similar to man, and in the case of these chlorinated compounds it is possible that diet may be very significant. Finally, their normal characteristics have been described so well as to make the detection of abnormalities both easy and certain.

Method of Exposure. The inhalation experiments were carried out in four large air-tight wooden boxes, each capable of holding ten rat cages, size 22" x 22" x 14", in two tiers of five cages each. When the experiment was not in progress the doors were opened wide and the cages kept in place (see Figure 1).

At the center of one end of each box — the inflow end — air was introduced through a pipe 7 inches in diameter (see Figure 2). Each box was equipped with an individual electric blower which blew the air through several feet of 7-inch pipe before entering the end of the box. An orifice was placed in the pipe line, and the flow of air in cubic feet per minute could be read off directly from calibrated flow meters. A damper placed at the entrance of the pipe into the box was adjusted to assure a uniform distribution of the stream of air to the two tiers of cages.

At the opposite end of the box — the outflow end — the air from each box was exhausted through a 7-inch pipe fitted with a damper and connected to a large central exhaust fan (see Figure 3).

About 4 inches from the entrance of the 7-inch pipe into the box, the fumes of the substance were introduced into the inflowing air.

ADM 003419

Specially designed pyrex glass flasks (Figure 4), 7 3/4" long and with a diameter of 1 1/2", were used to hold the heated waxes. These flasks were made with a side arm and tube which extended to the bottom. The top of the flask was ground, and into this fitted a short tube 1 1/2" in length. This short tube was inserted into a large rubber stopper which fitted tightly into a hole cut out of the 7-inch pipe on the under side (see Figure 2). The flask in turn was placed in an electric heater made to cover it completely below the side arm and ground glass top. Rubber tubing connected the side arm with a compressed air reservoir and a gentle stream of air blown through the melted wax kept it in motion and assured uniform heating. Into each flask was inserted a long stem centigrade thermometer which was kept in place and could be read at any time above the 7-inch pipe through which it passed (see Figure 2).

Approximately 20 gm. of pulverized ~~chlorinated diphenyl~~ chlorinated diphenyl were placed in the vaporizing flask and melted in the electric heater. Fresh samples were used every other day. ~~collected sublimate was always removed from the upper part of the flask and a clean top used each day. No sample was ever used for more than two runs.~~ The collected sublimate was always removed from the upper part of the flask and a clean top used each day. No sample was ever used for more than two runs.

The flask plus the contents was carefully weighed at the beginning of the run and at the end, and the loss in weight used to calculate the average amount in a cubic meter of air per minute as determined by a series of flow meter readings. The figures obtained were not absolute because of slight variations in the air flowing through the boxes and because of deposition of material on the thermometers and on the inside surfaces of the box, but they checked well with direct determinations through air samples.

ADP 003-27

Approximately one hour was allowed for the wax in the flasks to melt and come to a constant temperature. At that time the box doors were tightly closed, air bubbled through the flasks, and the blowers turned on. This was the beginning of the exposure period. By means of the thermostats on the fans and the dampers in the outflow pipes, the amount of air flowing through the boxes was adjusted and an attempt was made to keep the four boxes as uniform as possible -- usually between 165 and 175 cubic feet per minute..

Experiments

Exposure to chlorinated diphenyl was begun on July 1, 1936 and ceased on November 18 of the same year. The average length of exposure was 16 hours daily for 6 days a week. Each morning at about 9:00 exposure ceased, and between this time and 4:00 p.m. the rats were cleaned, fed, weighed, etc. In order to secure uniformity of exposure the cages were shifted on a regular schedule, since wax concentrations were somewhat higher at the inflow end of the boxes. Preliminary runs showed that once properly adjusted, wax concentrations in the air remained very uniform from day to day, but to insure absolute safety readings of temperature, air-flow, etc. were made every night between 10:00 and 12:00 p.m. as well as on starting and stopping. At different times during the course of the experiment tests for free chloride were made but were uniformly negative and showed that under the temperatures used no decomposition occurred.

Table 1

ACM CC34.

Conditions Maintained in Inhalation Experiment from July 1 to Nov. 18

Material	Temperature	Average concentration of air in box		Total length of exposure	Average daily exposure
		Mg./cu.M.	Range	hours	hours
Chlorinated diphenyl	165-175	0.37	High 1.19 Low 0.23	1895	16

Results of Inhalation Experiments

No abnormalities were seen at any time in the living rats. Blood and urine examinations were made; there were no losses in weight, and one would have considered that the animals were perfectly sound. However, rats sacrificed after 6 weeks exposure showed slight liver damage, which advanced during the next two months. The changes consisted in slight to moderate swelling of the liver cells, increased granularity, and many mitotic figures. Hyaline inclusions were present and were invariably plentiful in animals receiving chlorinated diphenyl by inhalation or by mouth.

One is forced to conclude from the experiments that an average concentration of 0.57 mg. per cubic meter inhaled 16 hours daily produces definite slight changes in the liver and in this organ alone. These changes are resisted efficiently by the animals and cause no depreciation of health. The situation is not unlike that seen in factories where acute yellow atrophy of the liver has occurred. In the case of such instances the patients have been singled out in some way or other from large groups of fellow workmen who have been perfectly healthy.

In considering the entire matter it seemed to us that the ~~hydrocarbon~~ chlorinated hydro-carbons, if inhaled in sufficient concentration, might cause a slight degree of damage to the liver. This damage is resisted efficiently and causes no depreciation of health, but if the individual in question happens to suffer some ordinary disease of the liver the condition is superimposed upon a substratum of injury. In accordance with this hypothesis we determined that a dose of 0.75 cc. of carbon tetrachloride plus 0.75 cc. of ethyl alcohol per kilogram of rat was entirely non-toxic to normal animals. When, however, this dose was given to animals which had inhaled chlorinated diphenyl as has been described in this experiment, the result was acute yellow atrophy

of the liver. It would seem therefore that inhalation of a concentration of chlorinated diphenyl in the manner I have described is capable of producing a condition which may be dangerous to the individual inhaling it, though of itself no visible harm will be done.

Animals removed from exposure to chlorinated diphenyl after two months inhalation and given two months for recovery still showed liver changes when killed and examined, so that it is evident the alterations produced by this hydro-carbon are persistent and individuals who have been caused trouble by it should be removed completely and for a long time.

The Inhalation of a somewhat higher concentration of chlorinated diphenyl over an 8 hour day

The circumstances attending this experiment are given in Table 2.

<u>Table 2</u>					
Material	Temperature	Average concentration of air in box		Total length of exposure	Average daily exp
		$^{\circ}$ C	Mg./cu.m. Range	Hours	Hours
Chlorinated diphenyl	153-174	0.93	High 3.23 Low 0.03	920	8

Again 60 rats were used in this experiment. None at any time showed the slightest evidence of illness. Microscopic examinations, however, showed a degree of change very comparable to that found in the 16 hour experiments which have been described and the carbon tetrachloride test was uniformly fatal.

General Summary.

From these experiments we are forced to conclude that concentrations of chlorinated diphenyl in workrooms should not be allowed to rise above 0.5 mg. per cubic meter of air. This concentration is readily obtained by careful

ALP CC342

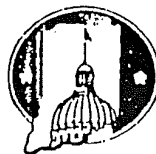
hooding. It is in our opinion safe for workman who would not be exposed with the absolute steadiness characteristic of our experiments on rats and such a concentration limit would probably do away with the troublesome skin lesions which have been the particular cause for worry in regard to these compounds in the past.

In addition to the inhalation experiments many feeding experiments were done with ^{this} chlorinated diphenyl. The general changes in the liver were the same as those already described. No diarrhea or gastro-intestinal aspects seemed to be present.

ACM 663412

STATE OF INDIANA

ADDRESS REPLY TO:
L. E. BURNETT, M. D.
SECRETARY AND COMMISSIONER
INDIANA STATE BOARD OF HEALTH
1806 WEST MICHIGAN STREET
INDIANAPOLIS 7, INDIANA



STATE BOARD OF HEALTH

February 6, 1950

Toxicology Department
Monsanto Chemical Company
St. Louis, Missouri

Dear Sirs:

One of our Indiana industries is using your ARCLOR 1248 (tetrachlorodiphenyl) as a heat transfer media (up to 400° F) in the extrusion of Tenite 2 plastic. Considerable vapor of arclor is present in the workroom due to leaks in the "closed" system. Several workers have reportedly become ill due to the inhalation of these vapors.

This plant called us as to any knowledge relative to the toxicity of this product. We did not have any data that could be transmitted to them. The so called illness was vague in that we could not learn from the plant what the exact complaints were.

We would appreciate any information which you have on the toxicology of this material.

Yours very truly,

Louis W. Spolyar, M.D.

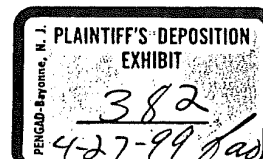
Louis W. Spolyar, M. D., Director
Division of Industrial Hygiene
Indiana State Board of Health

LWS:pm



PUBLIC HEALTH IS "THE ART AND SCIENCE OF PREVENTING DISEASE, PROLONGING LIFE AND PROMOTING PHYSICAL AND MENTAL EFFICIENCY THROUGH ORGANIZED COMMUNITY EFFORT." C.-E. A. WINSLOW.

FUR 003273



WATER_PCB-SD0000071032

C O P Y

Dr. H.R. Newman.

February 12th, 1954.

Newport, England.

We do not know what the maximum allowable concentration of Aroclor is. One milligram per cubic meter has been set up. We have run animals for about 60 days at 7 times this and found some liver damage. We are now running this at a lower level.

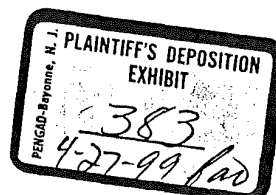
We have never found any liver trouble in any of the workers in our plant, but we watch the control of the fumes in our customers' plants and always recommend exhaust ventilation. I am sure you realize that 1 mg per cubic meter is recommended for an 8-hour day for indefinite periods of time. In painting a room we have found 1 - 2 mg for a day or so, but after that the level drops down to nothing.

independent
What we were really worrying about was the possibility that a man would develop hepatitis on an idiopathic, viral, or serum basis and on questioning would recall that he had painted a room with Aroclor paint and state that he had smelled it very strongly. I am afraid then we might be convicted by association even though we were sure one could not get a level high enough to cause trouble. We have, however, been concerned with the level of Aroclor during spray painting, but I think that level can only be determined by actual measurements.

independent
Please do not worry about asking me these questions because we certainly want you to have the entire picture about Aroclor toxicity. As soon as I get a report on the work at Kettering, I will let you know.

R. Emmet Kelly, M.D.

REK/MTL.



FUR 003274

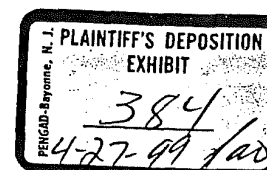
PROCESS FOR THE PRODUCTION OF
AROCLORS, PYRANOLS, ETC.
AT THE ANNISTON AND AT THE WM. G. KRUMMRICH PLANT

April 1955 ---- E. Mather

Distribution List:

1. Mr. J. S. Brough, London
2. Dr. N. B. Dyson, Newport
3. Mr. G. V. Taylor, Newport
4. Mr. G. V. Taylor, Newport
5. Mr. W. E. Hamer, Rusabon
- 6. Mr. J. F. Stickley, -----Krummrigh Plant
7. Mr. J. F. Stickley, -----St. Louis Library
8. M. C. L. file at St. Louis
9. Mr. D. B. Hosmer, Anniston
10. Spare

FUR 003397



XI. HAZARDS.

Toxicity

There are many literature references*to harmful effects of the type of "chlor acne" resulting from exposure to chlorinated diphenyls, especially in cases where people working with small electrical components have been exposed to the fumes of hot, highly chlorinated, Aroclors. Chlor acne is sometimes accompanied by gastric troubles, and there are literature references to liver troubles.

There was some trouble of this kind among the production workers at Anniston in the early days of the development of the Aroclors. At that time highly chlorinated Aroclors were being made from diphenyl which had come from low grade benzene. Since good benzene has been used, the same Aroclors have been made without trouble. In March 1955 it was reported that the Anniston diphenyl and Aroclor plants had run 12 years without lost time accident.

From the start of Aroclor manufacture at the Krummrich plant the operators have been supplied a clean change of clothes every day, and time has been allowed at the end of the shift for bathing. Operators are advised to wash hands and face before eating. The Anniston operators do not have the same issue of clean clothes.

* Percy May, "Chemistry of Synthetic Drugs", 3rd edition, page 19, The "Chemist Analyst", September 1947, Volume 36, No.2 page 33, and a report by Dr. M. C. Lester, Anniston plant, 1937, give data on the toxicity of diphenyl.

MCC Bulletin P-115/^(new edition) mentions 0.5 to 1.0 mg. per cbm in air as the highest safe concentration of higher Aroclors, and 10 mg. for more highly chlorinated Aroclors.

H. B. Edkins "Chemistry of Industrial Toxicology", page 149 gives 0.5 to 1.0 mg. as the allowable limit in working rooms.

The MCC Bulletin "Physical Properties of Aroclors" mentions systemic effects arising from the oral injection of Aroclors.

See the letters, E. Mather to P.J.C.Haywood, December 17, 1951, and Mather to Newman, January 8, 1952, reviewing the literature on the toxicity of Aroclors.

FUR 003781

See also correspondence relating to the article in Chem. & Eng. News May 17, 1954, pages 2038 -, and the warning labels mentioned on page VI-34 above.

XI. HAZARDS, contd.

St. Louis, Main Office

cc: Mr. W. E. Hamer, 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

December 11, 1951

Mr. P. J. C. Haywood

Newport (Airmail)

AROCLORS::TOXICITY

Since writing to you on December 3rd I have come across a letter of mine to Mr. W. M. Cooper, London, June 24, 1948, (copies to W.D.S., W.H.G., and others), calling attention to an article in the J. T. Baker Company's "Chemist Analyst", Volume 26, No. 2, page 33, September 1947.

I attach a copy of this article, and I think you will agree that the warning relates only to really bad exposure, not such as should occur in ordinary analytical work.

On October 27, 1947 Mr. Barbre of the Krummrich plant sent a copy of the Journal to Dr. Jenkins at Anniston for comment. Dr. Jenkins did not make any comments at the time, but the following extract from Mr. Barbre's letter is interesting:

"During the 11 years of production here only one man evidenced dermatitis. He had also shown similar symptoms in several other departments. When making Aroclor #1270 which is flaked, a noticeable amount of fine fume solidifies in the air. If men are exposed to it during hot humid weather, the skin is irritated, but we have not had any difficulty in curing cases of dermatitis from it".

FUR 003782

E. Mather

XI - HAZARDS, contd.

The Chemist Analyst, Vol. 36, No. 2, page 33,
J. T. Baker Chemical Co., Phillipsburg, N. J.,
September 1947

ON THE TOXICITY OF THE "AROCHLORS" (sic)

Robert M. Brown, Chief
Industrial Hygiene Section, Division of Health
Dept. of Public Welfare, City of St. Louis, Mo.

A recently published article (Maglio, M. Martin, Chemist Analyst, 35 94. (1946)), has recommended the substitution of one of the "Arochlors" as the melting-point bath liquid in preference to the customary sulphuric acid. As stated in that article "Arochlors" are a group of chlorinated diphenyls produced by the Monsanto Chemical Company.

There is need therefore to give warning. For the toxicity of these compounds has been repeatedly demonstrated, both from the standpoints of their absorption from the inspired air, as well as from their effects 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 care to see that the 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 careless handling of the material and the resulting contamination of the skin, clothing, laboratory towels, work table surfaces, etc. the way is 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 consequences be presented together with recommendations for correct handling.

FUR 003783

XI. HAZARDS, contd.

Mr. A. C. W. Pennington of Newport, reporting on his American tour, December 29, 1950, page 5, writes:

"HEALTH AND SAFETY":

"At Anniston, no special protective clothing is provided for the Diphenyl and Aroclors operators. A daily change of clothing was provided in the past but this practice ceased before the war. Gauntlet leather gloves and face shields are, of course, available as required on the plant.

"Tins of cold cream ointment, theatrical quality, are to hand in the building, but the application of the cream is left to the operator's decision of the job in question. The men are expected to take a bath, in their own time, at the end of the shift. A good quality soap, and alcohol for rubbing down purposes, are provided. The operators are sufficiently trained in the need for personal cleanliness that a record of bath taking is not warranted.

"Emergency showers are provided on each floor of the Diphenyl building and safety notices are widely used.

"At St. Louis, Plant B, the Aroclors building is rated a toxic department. Each operator is provided with a complete set of clothing comprising hat, coat, trousers, combination under-clothes, socks and rubber shoes. A clean change of clothing, except shoes, is placed in the operator's locker in time for the following shift. Men working extra shifts are given a clean set of clothing. Canvas gloves and goggles are provided and 'Ply' hand barrier cream is available for use when necessary.

"Twenty minutes' paid time is allotted for bathing at the end of the shift but, again, no record is kept that baths are actually taken. Theoretically, food is not allowed to be eaten within the Aroclors building. Instructions are issued that hands and face should be washed well before eating.

"Employees in toxic departments are given an annual medical examination and a lung X-ray every three years."

FUR 003784

XI. HAZARDS, contd.

Toxicity, contd.

A good deal of work has been done on determination of the vapour pressure of the Aroclors, and on the determination of ^{the} concentration of Aroclors in air. See pages 9-, Section III, above, for a summary of this work.

In 1950 (letter April 20, N. F. Rapps to E. Mather) the Admiralty expressed interest in the determination of micro-quantities of Aroclors. MCC have a method for the determination of traces in air by means of the "Halidometer".

Mr. Ellenburg, March 15, 1954, mentions work done by H. B. Richards Jr., of MCC, June 17, 1953, on the determination of the concentration of Aroclors in air. Mr. Ellenburg also states:

"----- work on the safe limits of Aroclor vapour concentration in air is being carried on by the Medical Department at the Kettering Laboratories in Cincinnati. This work on animals is well under way, and will help us to know a little better just what is the safe limit of Aroclor Vapours that one might work in."

A question has been asked about the possible harm to plants if Aroclor-containing paints are used in greenhouses. The reply is that most paints are somewhat harmful, and there is no evidence that Aroclors make them worse. Aroclors have been used as rabbit repellants, without doing any harm to vegetation.

Care is needed in laboratories etc. where Aroclors are used in heating baths; there should be very positive ventilation.

The vapours of hot Aroclors are distinctly irritating to eyes and nose above a concentration of about 3 mg per cbm in air. Newport plant report for December 1951 records burns by hot Aroclor -- a case of a splash into a man's eye -- without serious damage.

Packages of Aroclors leaving the Krummrich plant bear a label calling attention to possible toxic effects.

FUR 003785

XI. HAZARDS, contd.

Fire Hazards

Diphenyl, of course, will burn, and reasonable care is needed in handling it. Precautions with toluene are mentioned also on pages VI-29, and under "Special Risks", below.

The Aroclors are handled as if non-inflammable. Drums of material are melted in the middle of the operating building, by open gas flames, and open gas flames are freely used to heat pipe lines.

An instruction, dated April 28, 1948, calls for a daily inspection of safety showers, fire extinguishers and gas masks, a check list being provided.

Flanged joints on Aroclor heating system can be a source of fume. See the notes on gaskets, page 2, Section XII, below.

Phosgene may be generated in electrical flashes and fires in transformers containing Aroclors, but this is not thought to be a major risk.

Safety Equipment

Each operator in the Krummrich Aroclor plant is supplied with goggles, rubber covered gloves, canvas gloves, rubber shoes and fume respirator. See also page XI-1. A spare suit of clothes is kept in a case in the department. The department has the usual first aid cabinet, gas masks, (chlorine), fire extinguisher, (toluene, diphenyl), stretcher, safety showers, drinking fountain, eye bath.

Special Risks

The usual care is necessary in dealing with chlorine, in lighting the gas furnaces, and in handling hot materials, steam lines etc. Diphenyl might start to burn in chlorine gas if conditions in the chlorinator were badly out of line.

A Davis "Vapotester", model M-1, Type A, (Division of Davis Emergency Equipment Co., Inc., Newark, N.J.) is held in the department for use in testing the air of the working building after toluene has been used, and for testing vessels before men are permitted to enter, and before "flame certificates" are given. The instrument contains a

FUR 003786

XI. HAZARDS, contd.

Special Risks, contd.

catalytic cell electrically heated to a fixed temperature, and the air to be tested is aspirated through it by means of a "squeeze ball". If combustible vapours are present, the temperature of the cell rises, and the indicating thermocouple registers on a calibrated scale.

The instrument has a zero adjustment, and it is checked twice a month by the instrument department. Flame certificates must give the number of the Vapotester used, also the data of its last calibration by the instrument department. The instrument has been useful in detecting gas escapes, and in tracing spills of gasoline, etc., from a neighbouring oil refinery into a public sewer which runs under Monsanto territory.

Mr. Benignus, of St. Louis, September 1953, discussed the dangers of using Aroclors in indoor paints. He discounted the possible dangers from phosgene formed by flash discharges in transformers charged with Aroclors.

See the references to safe handling of glycidyl phenyl ether on pages IX-161 etc.

FUR 003787

XII. EQUIPMENT LIST

The following details are largely drawn from pages 18 - of the report by Lyles, Soffranko and Becker, November 1946, and they relate to the plant "B" (now Krummrich Plant) equipment, unless otherwise stated. A list of Aroclor equipment at the Anniston plant was sent to MCL June 7, 1946.

General Note

Since diphenyl and some of the Aroclors become solid, or viscous, at ordinary temperature, attention has to be paid to steam tracing or jacketing of pipe lines, and to the provision of gas flames for local heating where necessary. With due care, because of the presence of diphenyl and in some cases of toluene and butyl acetate, naked flames are quite freely used in the plant. (See operating instructions, Section XV, below).

Pipelines used for Aroclors need heat insulation, also proper allowance for expansion where high temperatures are involved.

Flanged crosses are freely used to assist in locating and clearing blockages in the pipe lines. Lines for diphenyl and heavy Aroclors should be blown clear after use. This also refers to outdoor water and steam lines, for example rail tank coils, in cold weather at the Krummrich plant.

Schwarting and others, "Process Description -- for Aroclors" November 12, 1953, page 3 state "Since iron has a deleterious effect on Aroclor electrical properties, the distilled product is handled in monel, monel-clad, zinc or tin-sprayed, and 304 stainless equipment. Galvanized iron or stainless steel is used for the process piping beyond the distillation stage ----".

FUR 003788

XII. EQUIPMENT LIST, contd.

Gaskets and Packings

The following gaskets have been found suitable for use in the Aroclor process(1948):

#901 Garlock - 1/16" 1" - 1½" - 2" - 3" and 4".
Used for all crude material transfer lines.

#900 - Yellow Garlock 1/8" and 1/16", sheet Gasket.
Used for finished material transfer lines.

Metallic Asbestos Goetze gaskets 1" - 2" and 3".
Used for solid Aroclor line flanges; will stand heat.

Goetze Aluminium Asbestos. 16" I.D. 21½" I.D. and 9" I.D.
Used for Pyranol Car heads.

Goetze Metallic Asbestos 2" flange gaskets used inside,
top and bottom of 18" sparkler press.

#262. 1/2" x 3/8" square Garlock gasket. Used in flange
face of Sweetland press.

Gum rubber flange gaskets used in HCl valves and lines.

#900 Garlock gaskets used on all Chlorine flanges, tank
manhole covers, inspection plates, inspection plates, and
between all pump and tank flange connections.

Gum or Garlock red rubber gasket material used on all HCl
tank flange connections.

Samples of Goetze corrugated copper-asbestos gaskets were sent to
MCL, April 9, 1947, and again June 24, 1948. The 2" I.D. x 4"
gaskets at that time cost \$0.189 each.

FUR 003789

XII. EQUIPMENT LIST, contd.

Gaskets and Packings, contd.

See also the London Engineering Dept. Final Report on the start-up of the Newport plant, for a discussion of gland packings for use against hot Aroclors.

See also MCL Research reports on packings and gaskets for hydraulic fluids, for example: --

347	50/175/2	November 1950
355E	51/91/1-	August 1951
1151	DF 54/26/3-	June 1954 -
	DF 54/27/1-	April 1954 -
1152	DF 54/16/5	April 1955

Some gaskets failed under test, others damaged the goods.

Samples of the washers used for the bungs on Aroclor drums were sent to MCL, April 9, 1947. The 1" size cost \$0.004 each.

FUR 003790

XII. EQUIPMENT LIST, contd.

PUMP PACKING LIST

EQUIP.NO. PUMPS	SERVICE	SIZE PACK.	TYPE AND NO. OF PACKING
P-0629	#1 Chlor Pump	5/16 inch	#234 Garlock
" 578	#2 " "	"	" "
" 579	#3 " "	"	" "
" 1056	#4 " "	"	" "
" 731	#1 Scrubber Pump	3/8	" "
" 575	#2 " "	"	" "
" 604	#3 " "	"	" "
" 573	#4 " "	"	" "
" 574	#1A " "	"	" "
" 580	#1 Blow Tank Pump	5/16	" "
" 1509	#2 " "	"	" "
" 594	#1 Still Pump	1/2	" "
" 1277	#2 " "	"	" "
" 565	#1 Still Rec. Pump	3/8	Palmetto
" 1258	#2 " "	"	"
" 378	City Water Pump to Tourrill	1/8	#117 Garlock
" 1054	" " " " Tantalum	"	" "
" 1260	18" Sparkler Press. Pump	3/16	" "
	18" " Head Gasket	1/2 x 3/8	#262 "
" 585	#1 Diphenyl Stg. Tk. Pump	1/2	#234 "
" 592	#2 " " " "	"	" "
" 584	#3 Aroclor Stg. Tank Pump	"	" "
" 583	#4 " " " "	"	" "
" 929	#5 " " " "	"	" "
" 617	CT0347 - Diphenyl Stg. Pump	3/8	Palmetto
	Flaker Drum	1/2	#234 Garlock
	1170 Stg. Pot Agitator	3/4	#234 Garlock
P-0595	#1 Still Condenser Pump	1/8	#117 Garlock
	<u>D 218 Dept.</u>		
P-0427	Inhibitor Acid Pump	1/4	#234 Garlock
P-0943	Wilfley Pump at #1 HCL Stg.	--	Do not use pkg.
P-01119	" " " HCL Tr. Tk.	--	" " " "
	<u>Dept. A-246</u>		
P-0725	#7 Sweetland & GE Press Pump	3/8"	Cutno or Palmetto
P-0346	#6 Stg. Tank Pump	--	No Pckg. req'd.
P-01111	TCB Unloading Pump	3/8"	-- Palmetto

FUR 003791

XIV. HISTORY OF THE PROCESS IN MONSANTO.

In the years 1927 - 1928, the Swann Chemical Company developed a process for making diphenyl, but as the expected demand for it did not continue, other outlets were sought for the diphenyl. Aroclors were produced in the laboratory in 1929, and as they showed good electrical properties, fire resistance, and general inertness, the General Electric Company became interested, and developed the use of Aroclors in transformers and capacitors.

A plant was installed to produce 3000 lbs./day at Anniston.

In 1935 Monsanto acquired the Swann Company, so gaining access to their Aroclor patents. As the demand for Aroclors increased, additional production equipment was installed, located at the Monsanto Illinois factory (then plant "B" and now called the Krummrich plant). This equipment came on stream in September 1936.

The Krummrich plant site was chosen partly because of the availability of chlorine there, but when chlorine consumption overtook the production, and chlorine had to be purchased, proximity to the diphenyl production at Anniston had more weight, and additional capacity, largely designed on the plant "B" model, was installed at Anniston in 1941.

By 1946 both plants had doubled their capacity, to give a total production capacity approaching 2 million pounds a month. About 1954 chlorine cells were installed at Anniston.

The Newport plant was designed, mainly on Krummrich plant information, but to a less extent on Anniston information, under Newport Project No. 12 of the London Central Engineering Department.

Chlorination started at Newport in June 1951, Mr. Clegorn from Anniston spending some time at Newport to assist in starting the diphenyl and Aroclor plants there.

The first production of Pyranol by MCC was in 1936, when Pyranol 1488 was made for the General Electric Company, the blending being done at first in rail tanks. Pyranol 1495 was made in July 1938.

The use of tin-tetraphenyl started in 1944, since when the main production has been of 1467 (TCB - 1260 mixture plus tin-tetraphenyl).

FUR 003886

COPY

Dr. D.V.N. Hardy ✓
Dr. H.R. Newman.

Monsanto Chemical Company

St. Louis, Missouri

September 20, 1955

Dr. J.W. Barrett
London

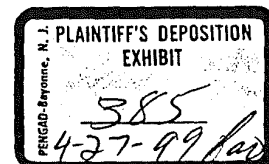
Your memo September 8 to Mr. Nason
AROCLOR TOXICITY

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

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

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

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



FUR 003904

COPY

Page 2 September 20, 1955 AROCLOR TOXICITY

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

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

R. Emmet Kelly, M.D.

REK:k

FUR 003905

WATER_PCB-SD0000071048

From **MONSANTO CHEMICAL COMPANY**

cc Mr. J. Cresce -Krumm. Pl1
Mr. E. W. Lieben -" "
Mr. R. M. Webber -" "

At St. Louis

CONFIDENTIAL

Date November 14, 1955

To Mr. H. B. Patrick Reference

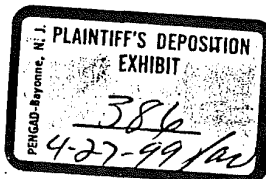
At Krummrich Plant Subject DEPARTMENT 246 (AROCLORS)

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

- (1) Aroclor vapors and other process vapors could contaminate the lunches unless they were properly protected.
- (2) When working with this material, the chance of contaminating hands and subsequently contaminating the food is a definite possibility.
- (3) It has long been the opinion of the Medical Department that eating in process departments is a potentially hazardous procedure that could lead to serious difficulties. While the Aroclors are not particularly hazardous from our own experience, this is a difficult problem to define because early literature work claimed that chlorinated biphenyls were quite toxic materials by ingestion or inhalation. In any case where a workman claimed physical harm from any contaminated food, it would be extremely difficult on the basis of past literature reports to counter such claims.

Jack T. Garrett
Jack T. Garrett

JTG:SMB



FUR 003906

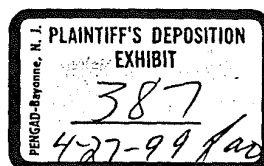
[] IN 10

POLYCHLORINATED BIPHENYLS

PCB's

A Report on Uses, Environmental
and Health Effects and Disposal

FUR 003907



Monsanto

Preface

Section 1. History of Monsanto Production and Sales of Chlorinated Biphenyls.

Section 2. Information on Health Effects.

Section 3. Monsanto Actions Resulting from Health Data.

Section 4. Communicating with Customers.

Section 5. PCB Disposal.

FUR 003908

The following report is a frank, comprehensive presentation of relevant aspects of the PCB issue. From Monsanto Company's perspective, PCBs are a classic case history of a true risk/benefit dilemma.

Monsanto is proud of its conduct with respect to the PCB issue and stands on its record, described in this report, as being totally responsive and responsible to the public interest. The company has continued, since termination of production and sales, to provide the resources to help establish good testing practices. The company further supports ongoing research to more definitively establish the possible risks associated with PCBs in the environment, and funds studies to identify innovative approaches aimed at reducing PCBs in the environment. In addition, Monsanto continues to respond to legitimate requests for technical advice and assistance.

Monsanto believes that this continuing allocation of its resources further demonstrates its commitment to serve the public interest.

FUR 003909

Monsanto entered the chlorinated biphenyls business in 1935 when it purchased the Swann Chemical Company. Production and distribution increased until the early 1970's, when, in response to reports of its presence in the environment, Monsanto restricted sales of chlorinated biphenyls. In 1977, the company ceased production and distribution of chlorinated biphenyls in cooperation with the electrical industry. Chlorinated biphenyls were banned (except for certain applications) in the U.S. in 1979.

Sales and Distribution

The chemical structure of the polychlorinated biphenyls has been known for nearly 100 years. Commercial production of these materials was initiated in 1929 by the Swann Chemical Company in response to the electrical industry's need for improved dielectric insulating fluids which would also provide increased fire resistance when used in transformers and capacitors.

As the unique functional characteristics of these materials became more fully understood, additional uses were found. Their fire resistance made them an excellent choice in high pressure hydraulic applications associated with high risk of fire such as die casting and steel production. Their thermal stability and fire resistance were valuable in heat transfer systems.

Their stability, low water solubility, low vapor pressure and solvency power made them attractive in carbonless paper systems. Their fire resistance, thermal stability and viscosity characteristics made their use desirable in hot melt adhesives and other plasticizer applications.

Chlorinated biphenyls, therefore, evolved as a unique class of chemicals which met important needs for both industry and society. In some instances, fire and building codes required the protection of life and property offered by chlorinated biphenyls. It was within this framework that Monsanto and other producers developed a growing worldwide business for these versatile products.

The following charts show the data for chlorinated biphenyls through Monsanto's voluntary phaseout program to termination of production and sales in 1977. Significant points in these charts are:

- a. **Heat Transfer**—Between 1970 and 1972, a task force of Monsanto engineers worked closely with customers to replace chlorinated biphenyl fluids with materials of equivalent thermal stability but with unavoidable lower fire resistance. Phaseout was completed in 1972.
- b. **Hydraulic Fluid**—Development of replacement fluids began in 1970, and sales of chlorinated biphenyl-based fluids were discontinued in 1971.
- c. **Plasticizer Applications**—Sales of most chlorinated biphenyl plasticizers were terminated in 1970, with phaseout completed in 1971.
- d. **Miscellaneous Industrial Uses** (such as vacuum pump fluids)—Sales ended by 1971.

These voluntary restrictions resulted in a 64 percent reduction in Monsanto sales of chlorinated biphenyls from 1970 to 1972.

However, termination of sales for dielectric uses would have resulted in severe economic and social dislocation. This was recognized by the federal Interdepartmental Task Force on PCBs⁽¹⁾ which concluded in 1972 that "Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use."

FUR 003910

PCB MANUFACTURING AND SALES
MONSANTO INDUSTRIAL CHEMICALS COMPANY
1957 thru 1978
(Thousands of Pounds)

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
U.S. PRODUCTION	(1)	(1)	(1)	37919	36515	38353	44734	50833	60480	65849
DOMESTIC SALES	32299	26061	31310	35214	37538	38043	38132	44869	51796	59078
U.S. EXPORT SALES	(2)	(2)	(2)	(2)	(2)	(2)	3647	4096	4234	6852
DOMESTIC SALES BY CATEGORY										
Heat Transfer	0	0	0	0	0	157	582	929	1237	1766
Hydraulics/Lubricants	1612	1549	2685	2523	4110	3915	3945	4374	4616	4258
Misc. Industrial	704	755	1569	1559	2114	1681	1528	1692	1841	1779
Transformer	12955	5719	5984	7921	6281	7984	7290	7997	8657	8910
Capacitor	17028	14099	16499	16967	15935	15382	15606	19540	23749	28884
Plasticizer Applications	(1)	3939	4573	6244	9098	8924	9181	10337	11696	13481
Petroleum Additives	0	0	0	0	0	0	0	0	0	0
DOMESTIC SALES BY PCB GRADE										
Aroclor 1221	23	16	254	103	94	140	361	596	369	528
Aroclor 1232	196	113	240	155	241	224	13	13	7	16
Aroclor 1242	18222	10444	13598	18196	19827	20654	18510	23571	31533	39557
Aroclor 1248	1779	2559	3384	2827	4023	3463	5013	5238	5565	5015
Aroclor 1254	4461	6691	6754	6088	6294	6325	5911	6280	7737	7035
Aroclor 1260	7587	5982	6619	7330	6540	6595	7626	8535	5831	5875
Aroclor 1262	31	184	359	326	361	432	414	446	558	768
Aroclor 1268	0	72	102	189	158	210	284	190	196	284
Aroclor 1016	0	0	0	0	0	0	0	0	0	0

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

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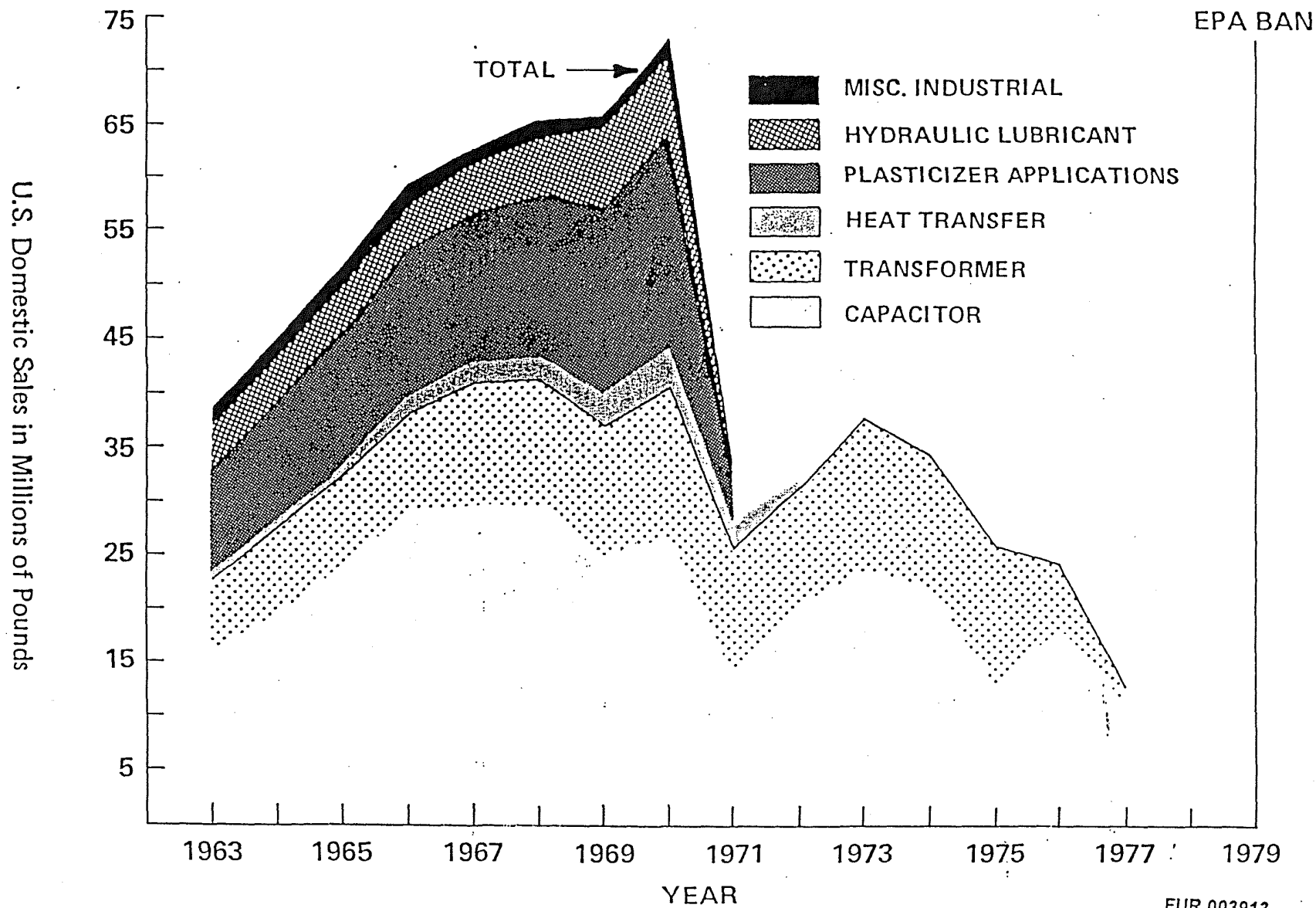
1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
75309	82854	76389	85054	45417	38600	42178	40118	29710	29592	13330	0
62466	65116	67194	73061	34301	32242	37742	34406	25611	24329	12701	0
8124	11231	10624	13651	10648	6388	8346	5395	5712	4744	1548	0

2262	2529	3050	3958	3060	752	0	0	0	0	0	0
4643	5765	8039	7403	1552	0	0	0	0	0	0	0
1426	1283	1079	1627	1155	0	0	0	0	0	0	0
11071	11585	12105	13828	11134	11314	14176	12394	12763	6002	1617	0
29703	29550	25022	26708	14141	20176	23566	22012	12848	18327	11084	0
13361	14404	16460	19537	3259	0	0	0	0	0	0	0
0	0	1439	0	0	0	0	0	0	0	0	0

442	136	507	1476	2215	26	35	57	28	20	0	0
25	90	273	260	171	0	0	0	0	0	0	0
43055	44853	45491	48588	21981	5537	6200	6207	6435	4418	51	0
4704	4894	5650	4073	213	0	0	0	0	0	0	0
6696	8891	9822	12421	4661	6115	7976	6185	6328	1584	1566	0
6417	5252	4439	4890	1725	414	0	0	0	0	0	0
840	720	712	1023	1	0	0	0	0	0	0	0
287	280	300	330	0	0	0	0	0	0	0	0
0	0	0	0	3334	20150	23531	21955	12820	18307	11084	0

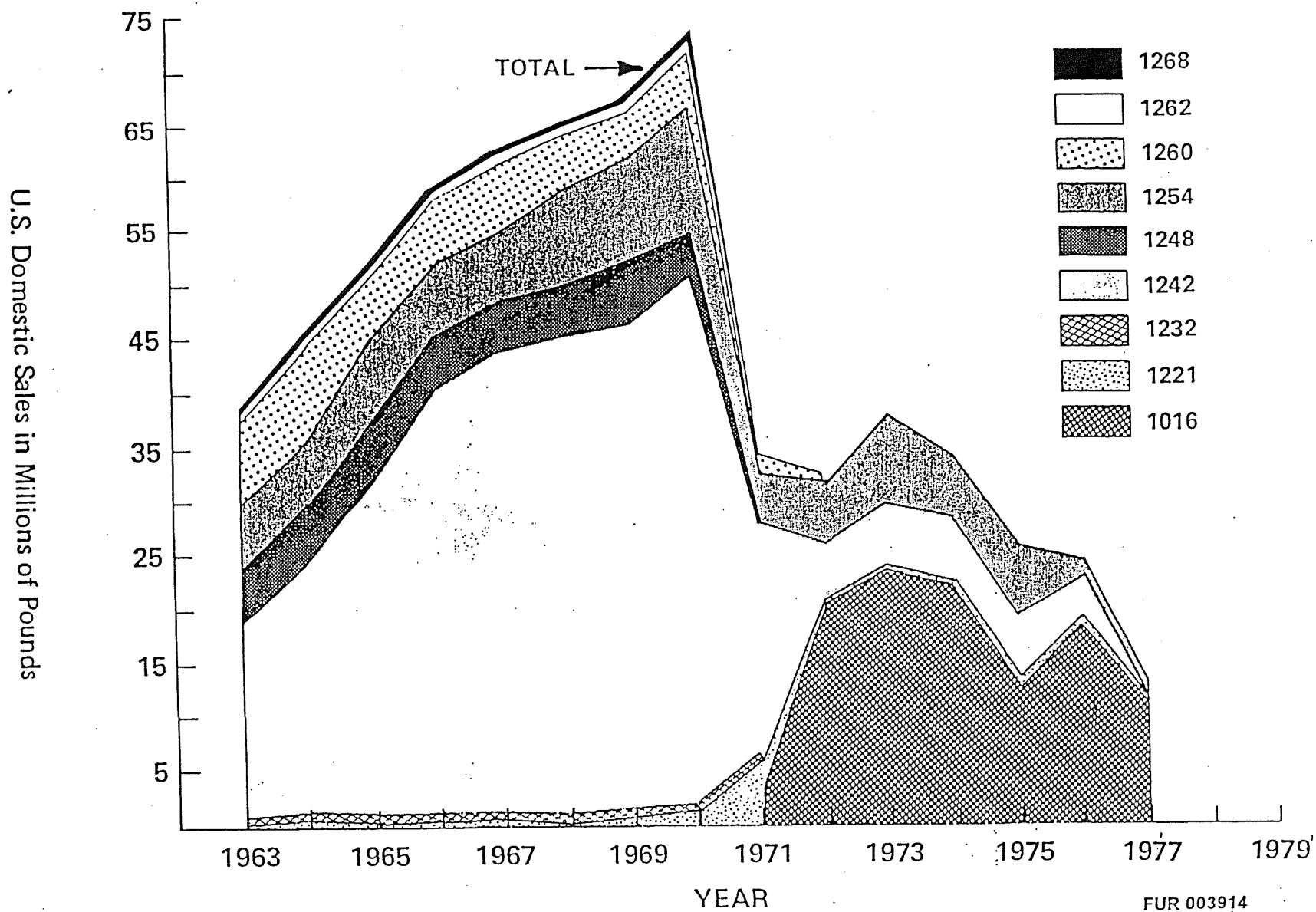
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U.S. DOMESTIC SALES OF PCBs BY CATEGORY (The Uppermost Curve Represents the Total Sales)



FUR 003913

U.S. DOMESTIC SALES OF PCBs BY GRADE (The Uppermost Curve Represents the Total Sales)



Therefore, Monsanto agreed to continue supplying the products to manufacturers of electrical power distribution equipment who use chlorinated biphenyls only in sealed systems such as capacitors and transformers. In continuing to sell to such customers, however, Monsanto required assurances that the materials would be safely handled and properly disposed.

In making this decision Monsanto believed 1) that entry of chlorinated biphenyls to the environment could be effectively limited and controlled by users⁽²⁾; 2) proper maintenance and decommissioning practices could limit fluid escape from transformer operations, and 3) withdrawal from production for these applications would have stopped production of equipment essential to the safe and efficient distribution and use of electrical energy. In addition, a more biodegradable lower chlorinated product (AROCLOR[®] 1016) had been developed by Monsanto for use by the capacitor industry.

Steps Taken in Labeling and Transport Practices for Ongoing Dielectric Sales, 1972-1977

Monsanto shipped PCB fluids in both bulk carriers and in drums. Bulk shipments were made in Monsanto-owned railroad tank cars, which were used exclusively for that service, or in customer-owned tank trucks. Drum shipments were made in special reinforced drums. A multilingual warning label was affixed to each package giving a brief description of the nature of the contents and appropriate actions to be taken in the event of a spill or leak. We also supplied a label to be used on return shipments for incineration, which gave similar information.

Industry Guidelines

In June, 1970, the Board of Directors of the Power Equipment Division of the National Electrical Manufacturers Association appointed a committee to review the chlorinated biphenyl situation as it affected electrical usage. As a result, in April, 1971, American National Standards Committee C107 was established to develop guidelines for the safe use, maintenance and disposal of askarel* and askarel-soaked materials used in electrical equipment. Monsanto participated in this committee. A final draft was completed by November, 1972, and the Standard Guideline was published in 1974⁽³⁾.

Monsanto's Withdrawal from the Chlorinated Biphenyl Business

When Monsanto decided in 1970 to restrict sales of chlorinated biphenyls, there were no satisfactory alternate materials for closed-system dielectric uses. This view was later affirmed by the EPA. At least as late as a 1975 press conference, the EPA reiterated it would not ask Monsanto to stop production because that would shut down the electrical power industry and the railroads in short order. The EPA objective was to find a way to proceed without shutting down the country. That was precisely the objective to which Monsanto had been committed since 1970.

The problems encountered in replacing chlorinated biphenyls were rooted in their unique fire resistant and dielectric characteristics and in their role in electrical and industrial applications for

AROCLOR[®] is a trademark of Monsanto Company.

*"Askarel" is a generic name for fire resistant dielectric fluids, including those which contained polychlorinated biphenyls, made to meet specifications set by transformers and capacitor manufacturers.

45 years. The challenge facing the electrical industry was to replace chlorinated biphenyls in an orderly manner, without creating other hazards of equal or potentially greater magnitude, and at the same time avoiding serious power and transportation disruptions.

Monsanto expended considerable effort and money in major research programs aimed at developing environmentally compatible replacement fluids for the electrical industry. The level of this research was greatly reduced in 1976 when the electrical industry developed the technology to adapt other compounds to its needs. It now appears the ongoing demand for liquid-cooled transformers will be satisfied by using silicone compounds. In the capacitor industry, the trend has been toward materials such as phthalate esters.

In adopting these substitutes, the electrical industry has been forced to accept lower fire resistance. New safety devices have been required to ensure that replacement equipment will not lead to increased risk to society from fire hazards.

In our press statement of October 5, 1976, Monsanto said we would complete distribution of all inventories and withdraw from the chlorinated biphenyl dielectric business by October 31, 1977. In making the announcement, Monsanto said the company would have targeted an even earlier shut-down date had transformer and capacitor manufacturers' conversion timetables permitted. All chlorinated biphenyl production was halted by Monsanto in July, 1977, and all customer shipments were completed by September, 1977. At the time we stopped PCB production, Monsanto established policies which precluded licensing of chlorinated biphenyl technology and restricted sales of biphenyl to uses which would not involve halogenation.

PCBs continue to be manufactured by other firms in Germany, France, Spain, Italy and certain eastern European countries. They continue to be widely used throughout the world.

Reasons for Monsanto Phaseout

Scientific knowledge about the presence of PCBs in the environment, and about its possible significance, began to evolve during the late 1960's. That evolutionary process, which is still incomplete, began with two events—one in Japan and the other in Sweden.

In 1968, about 1,000 people in Japan became ill from eating rice oil heavily contaminated with Japanese-produced PCBs as a result of an industrial accident which has come to be known as the Yusho incident. The level of PCB contamination in the rice oil was 2000 to 3000 parts per million, extremely high concentrations. Conclusions about that incident have been clouded by the unknown impact of impurities in the Japanese-made PCB. However, the incident sounded a cautionary signal.

In Sweden, Soren Jensen, using new analytical technology to investigate DDT residues in the environment, reported the possible presence of PCBs in fish tissue. Monsanto and others began immediately to study the Swedish work, following preliminary news media reports in late 1966. Before the findings could be confirmed or duplicated in the U.S., analytical methods had to be refined in order to definitively separate PCBs from other chlorinated hydrocarbons that were known to be present in the environment. New techniques were required to enable researchers to detect these chemicals in the low parts per billion ranges being reported.

The presence of PCBs in the environment in the U.S. was confirmed by 1970, but little was known about their potential impact. Because PCBs were reported in the environment and tests indicated they could accumulate in the food chain, Monsanto voluntarily decided to terminate sales

FUR 003916

of chlorinated biphenyls to open applications—those which could result in losses to the environment. Plasticizer and carbonless paper applications fell into this category.

Because of the contamination of rice oil in Japan, food processors using Monsanto's chlorinated biphenyl heat transfer fluids were advised to change to alternative heating methods and Monsanto reemphasized the need for improved monitoring of finished food products to preclude contamination by any heat transfer fluid. The decision was made in 1971 to terminate all heat transfer fluid sales of chlorinated biphenyls, substituting other products with equivalent thermal stability.

High operating pressures cause hydraulic systems to leak. Monsanto therefore alerted users to manage wastes to eliminate PCB discharge to the environment. As new hydraulic fluids were developed in 1971, we terminated sales of those containing PCBs.

As described earlier, Monsanto agreed with the electrical industry and government that the benefits to society of continued chlorinated biphenyl dielectric use outweighed the low risk of uncontrolled release from these sealed applications. The key to managing the risk was sound maintenance practice and disposal control.

With particular reference to the use of PCBs in human food and animal feed processing facilities, the FDA proposed usage regulations in 1972, which were adopted in 1973, and continue in force today ⁽⁴⁾.

Although a variety of effects of PCBs has been postulated from research of widely varying quality, there is no evidence of environmental levels of PCBs being a major human health hazard. However, it became apparent that the public perceived risks associated with continued PCB dielectric use and preferred to forego its undoubted functional benefits. Therefore, in October of 1976, we advised dielectric customers that it was our intent, consistent with their progress with substitute products, to terminate chlorinated biphenyl production and sale by October, 1977. Each of them forecast how much product would be required to effect an orderly technical transition. In 1977, we made sufficient dielectric chlorinated biphenyl to satisfy the forecast transition demand and made final shipments in September. The small residual inventory was incinerated in our pyrolysis unit, bringing to a close our chlorinated biphenyl business.

In summary, Monsanto's decision to withdraw from the PCB business was based on concerns about environmental presence rather than health effects.

FUR 003917

1. Federal Interdepartmental Task Force on PCBs. (1972) p. 4.
2. Westinghouse Report. National Industrial Pollution Control Council Meeting (Jan. 3, 1972).
3. American National Standards Committee guideline, ANSI C107.1-1974.
4. Food and Drug Administration regulation: 21 CFR 109.15; 110.40(b); 500.45 (1973).

FUR 003918

Chlorinated biphenyls range from liquid to solid, depending upon the degree of chlorination. On the basis of single dose animal tests commonly used to identify and label hazardous materials, they would be considered to be relatively harmless substances. Monsanto has conducted such acute toxicity and irritation tests on several chlorinated biphenyls over the years⁽¹⁾.

Questions have been raised in four areas of possible health effects of chlorinated biphenyls. These have been related to 1) skin (reddening, chloracne); 2) systemic effects (liver damage, respiratory effects); 3) environmental exposure, and 4) potential carcinogenicity.

A review of the literature from the 1930's and 1940's on the health effects of chlorinated biphenyls contains statements such as "Much of the literature that refers to chlorinated diphenyls is referring to the mixture of chlorinated diphenyl with chlorinated naphthalene." and "A number of the references recorded under chlorinated naphthalenes also discussed chlorinated diphenyl. It is difficult to determine the role played by the chlorinated diphenyls, as, in most instances, they were mixed with chlorinated naphthalene"⁽²⁾. A parallel situation occurred during the late 1960's when reports of the detection of polychlorinated biphenyls in the environment began to appear. There was confusion and disagreement as to whether polychlorinated biphenyls or other halogenated hydrocarbons such as DDT were being measured, since the latter had already been identified as environmental contaminants.

Skin

Sometime before 1934, Swann Chemical Co. observed dermatological symptoms in workers exposed to chlorinated biphenyls. In May, 1934, Swann Research, Inc., requested Dr. F. B. Flinn of Columbia University's College of Physicians and Surgeons to conduct an investigation "to determine whether or not the various chlorinated diphenyl compounds submitted or some impurities contained therein might be the causative agent producing the dermatitis which had developed among some of the workmen in the plant." He commented on these studies as follows:

"One is impressed with the fact that each of the Aroclors giving a positive reaction were of a fluid nature. Attempts were made to expose the animals to vapors but observations made us conclude that the only difference was that the animal would be exposed to the hot material and it was well-known that the reaction where such an exposure is given is more severe."

"One cannot but feel that any styrene compound which may be found to be present as an impurity is the cause of your trouble. I was rather surprised that more of the compounds submitted did not show or give reactions with the skin. It has been shown in some investigations that chlorine did not produce a dermatitis when metallic electrodes were used but did if the metallic electrodes were replaced by carbon electrodes. The theory was advanced that some organic chlorine compounds were produced in the latter case."

"I would suggest that you study your ventilation system in places where fumes are given off. That means be provided for the men to take a bath with soap and water if they come in contact with the type of material found to be positive. By this I mean if a leak or spillage occurs. The immediate bathing under these circumstances should be insisted on. I found that where I had gotten the material on my hands if I washed them thoroughly no trouble arose."

FUR 003919

In his transmittal letter to Dr. J. N. Carothers of Swann Research, Inc., Anniston, Alabama, Dr. Flinn stated:

"It may interest you to know that the dermatitis which was produced by your materials in the case of rabbits cleared up in a couple of weeks, indicating that unless there are repeated exposures the effects are only of a temporary nature. As I said before, I believe that if washing facilities are present and the men are instructed to use them it will do much to supplement the increased ventilation which you have installed."⁽⁴³⁾

In the published literature, "the first observations on the development of acne-like lesions among workers in the United States coming in contact with chloronaphthalenes and chlorodiphenyls as well as acute yellow atrophy of the liver occurring among such workers were reported in 1935"⁽⁴⁾. Results of Swann studies were published in 1936⁽⁵⁾.

There is a letter report dated December 22, 1949, to Dr. R. E. Kelly (Monsanto) from Dr. L. K. Halpern of the Barnard Free Skin and Cancer Hospital (St. Louis) describing a human patch study. This consisted of applying film treated with 11.5 percent AROCLOR and gauze moistened with 100 percent AROCLOR to skin of the upper arm of 218 volunteers using the technique developed by Dr. Louis Schwartz, Medical Director of the United States Public Health Service. Dr. Halpern reported "If the procedure recommended by the United States Public Health Service is sufficient to distinguish between chemical compounds that are innocuous when applied to the skin and other compounds that are primary irritants or sensitizers, then it would seem that Aroclor has no primary irritant effect nor is it a sensitizer of high potency."⁽⁶⁾ Monsanto records show that this study was conducted with AROCLOR 1254.

In 1963, Monsanto received reports of subacute rabbit dermal studies it had sponsored on several chlorinated diphenyls. Salient features of these studies, conducted according to then-currently acceptable procedures, are summarized below⁽¹⁾.

AROCLOR	1221	1242	1248	1254	1268
No effect level*	150	50	10	10	500
LD ₅₀ **	250	75	50	75	1250
Local skin effects	none	none	none	yes	yes
Systemic injury	none	none	liver injury	liver injury	liver injury

*All dosages in mg/kg/day

**Based on 20-day dosing and 14-day observation periods

These studies showed that repeated and prolonged skin contact with the higher chlorinated biphenyls could produce skin irritation and that harmful amounts could be absorbed under such conditions. They also demonstrated that there was a safe level of exposure for each material, and that they could be handled safely if the earlier precautions to avoid excessive skin contact were observed.

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Systemic Effects

On June 30, 1937, a symposium on systemic effects resulting from inhalation of chlorinated hydrocarbons was held at the Harvard School of Public Health. Dr. R. E. Kelly of Monsanto participated in the sessions at which results of investigations requested by manufacturers of chlorinated hydrocarbons were presented. Subsequently, three papers summarizing the results of those studies appeared in the scientific literature^(7, 8, 9). With respect to chlorodiphenyls, the Harvard group concluded that "... it appears safe and it is certainly easily attained, to ventilate so that the air breathed does not contain more than 0.5 mgm. per cu.m. of any of these compounds ...". In a separate unpublished report to Monsanto Company⁽¹⁰⁾ Dr. C. E. Drinker of Harvard described the results of inhalation studies conducted with compound #1268, having a chlorine content of 68 percent. He concluded, "#1268, if handled with ordinary precautions as to ventilation, should be entirely harmless to workmen."

Monsanto sponsored a study at the University of Cincinnati's Kettering Laboratory on "The Toxicity of the Vapors of AROCLOR 1242[®] and AROCLOR 1254[®]." A report of those studies⁽¹¹⁾, presented at the 1956 meeting of the American Industrial Hygiene Association, stated that the investigation "... was undertaken because in the earlier literature dealing with the toxic effects of Aroclors, no distinction has been drawn between the toxic effects of chlorinated biphenyls and those of chlorinated naphthalenes ...".

No injury was observed after prolonged intermittent exposure of several species of animals to AROCLOR 1242 at air concentrations of 1.90 to 8.63 micrograms per liter. Animals subjected to comparable exposures of AROCLOR 1254 showed signs of apparently reversible liver cell injury. The authors concluded their observations by saying "It should be noted that it was necessary to heat these Aroclors in order to increase the rate of volatilization sufficiently to attain the concentrations maintained in these experiments. To the extent that their industrial usage is carried out at ordinary temperatures, the hazard of their inhalation may well be slight or entirely absent."

These studies confirmed earlier work which indicated that no harmful effects were to be expected if these materials were used with adequate ventilation since it was necessary to heat the substances to generate sufficiently high air concentrations to injure the test animals.

Prior to 1956, the American Conference of Governmental Industrial Hygienists (ACGIH) had established a Threshold Limit Value (TLV) of 1 mg/m³ for chlorodiphenyl. In 1956, the listing was changed to read chlorodiphenyl (42% chlorine) as 1 mg/m³. The 1957 list showed chlorodiphenyl (42% chlorine) as 1 mg/m³ and an added TLV of 0.5 mg/m³ for chlorodiphenyl (54% chlorine). The latter two values have been unchanged since then⁽¹²⁾. Results of the Monsanto-sponsored study⁽¹¹⁾ contributed to the decision of the ACGIH to lower the TLV for the more highly chlorinated biphenyls⁽¹³⁾.

Environmental Exposure

In response to reports of the presence of some PCBs in the environment, Monsanto, in 1969, initiated preliminary toxicity studies which led to a series of long-term tests. These tests, on the three predominant commercial polychlorinated biphenyls (AROCLOR 1242, AROCLOR 1254, AROCLOR 1260), consisted of 2-year (lifetime) feeding to rats, 2-year feeding to dogs, 3-generation rat reproduction studies with 2 litters cast per generation, rat teratology studies and dominant lethal mutagenic studies in mice. Toxicity and reproduction studies in chickens were performed to evaluate

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possible untoward effects in birds such as decreases in eggshell thickness. This series of studies⁽¹¹⁾ represented the most comprehensive safety tests of the time, and was similar to the tests required for food additives, although Monsanto certainly had no intention of applying for a food additive permit.

The highest dietary level (100 ppm) in the lifetime rat feeding studies produced a weight depression at 24 months in females fed AROCLOR 1254 and liver weight increases in all groups except males fed AROCLOR 1242. As with other halogenated hydrocarbons, the important histopathologic changes were present in the livers of animals sacrificed at the end of the study. These consisted of hepatocellular (liver) alternations such as focal hypertrophy (localized enlargement), cytoplasmic lipid changes and in some animals from the 100 ppm groups, hepatomas or cholangiohepatomas (benign tumors). There was no evidence of hepatocellular carcinogenicity with any of the AROCLOR products.

In the dog 2-year studies, some slight decreases in body weight gain were noted. At the highest feeding level (100 ppm) or AROCLOR 1260, there was evidence of gastrointestinal inflammatory lesions and ulcerations.

In the rat reproduction studies, none of the AROCLOR products produced adverse effects in the 2 litters of the first generation. In the second and third generations, there was a reduction in the mating index and a decrease in the incidence of pregnancy at the 2 highest feeding levels (10 ppm and 100 ppm). The ability of females to carry pups to delivery, once conception had occurred, and to successfully nourish the young was not affected by the three AROCLOR products. No changes were produced in the reproductive tracts of either male or female rats by any of the 3 AROCLOR products.

There was no evidence of teratogenic or mutagenic changes with any of the chlorinated biphenyls at maximally tolerated dose levels in rats and mice.

In the chicken toxicity/reproduction study, AROCLOR 1260 was without effect at all test levels. AROCLOR 1242 and AROCLOR 1254 at 100 ppm in the diet decreased egg hatchability. Poor hatchability of eggs was found from hens fed 8 ppm of AROCLOR 1242. AROCLOR 1242 at 10 and 100 ppm and AROCLOR 1254 at 100 ppm were associated with reduced eggshell thickness. Chick viability was affected by both substances at a dietary level of 10 ppm.

Data developed by Monsanto and information gained from the Yusho incident in Japan were cited by the Food and Drug Administration (FDA) as a basis for establishing tolerances for chlorinated biphenyls in various foods in 1973⁽¹⁴⁾. Subsequently, the FDA proposed a reduction in those tolerances⁽¹⁵⁾.

In 1976 it was reported that AROCLOR 1248 in the diet of monkeys, at or below FDA tolerance levels for chlorinated biphenyls, adversely affected reproduction⁽¹⁶⁾. FDA limits on PCBs in the human diet are related to a safe level of 1 $\mu\text{g}/\text{kg}$ body weight/day⁽¹⁴⁾. The studies carried out by Allen and co-workers⁽¹⁶⁾ were at dosage levels of approximately 89 and 183 $\mu\text{g}/\text{kg}/\text{day}$. Their work suggested that there could be a previously unknown effect on reproduction in primates and they failed to define a no-effect level. Monsanto, therefore, undertook a detailed monkey reproduction study with carefully administered dosages at and below those previously studied.

In the Monsanto study, 32 female and 16 male rhesus monkeys, divided into 4 groups each consisting of 8 females and 4 males, were given daily dosages of 0, 5 $\mu\text{g}/\text{kg}$, 25 $\mu\text{g}/\text{kg}$ or 100 $\mu\text{g}/\text{kg}$ of AROCLOR 1254. The in-life portion of that study, which lasted about 14 months, has been completed.

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At Monsanto's highest dosage (100 $\mu\text{g/kg/day}$), which corresponded to the low level in the Allen study, we find that AROCLOR 1254 has similar effects to those reported earlier for AROCLOR 1248. The results at the lower levels are not completely evaluated.

Potential Carcinogenicity—Animal Studies

In 1975, Dr. Renate Kimbrough reported the induction of liver carcinomas in female rats fed AROCLOR 1260 for two years⁽¹⁷⁾. The same lot of AROCLOR 1260 was used in her study as in Monsanto's earlier test. Monsanto's study showed that AROCLOR 1260 as well as AROCLOR 1242 and AROCLOR 1254, produced liver injury, but no cancers. Therefore, an extensive reevaluation was made of the original liver slides from the Monsanto studies as well as additional liver sections from all rats in the Monsanto two-year feeding studies. These slides were examined independently by Dr. D. Gordon of Industrial BIO-TEST Laboratories, by Professor W. Richter of the University of Chicago and by Professor Parvis Pour of the Eppley Institute for Research in Cancer. In addition, Dr. Pour evaluated sections of liver from rats in Dr. Kimbrough's study. No carcinomas were seen in the livers of rats from the Monsanto studies, and Dr. Pour did not concur with Dr. Kimbrough's diagnosis of liver cancer in rats from her study⁽¹⁸⁾. The different criteria by which pathologists diagnose cancer, and the reported findings of cancer induced by polychlorinated biphenyls in various animal species, have been discussed by Dr. J. C. Calandra⁽¹⁹⁾.

In 1977, the National Cancer Institute reported results of a bioassay for possible carcinogenicity of AROCLOR 1254. That report stated that AROCLOR 1254 was not carcinogenic under the test conditions⁽²⁰⁾.

Human Epidemiology Studies

The toxicity testing described above has provided a foundation for understanding the potential effects of chlorinated biphenyls. However, firm conclusions cannot be drawn without human epidemiological data drawn from exposed populations.

"The view that human health risks resulting from exposure to chemicals may be determined experimentally by testing laboratory animals is one that is widely accepted in the scientific community and has been adopted by EPA. Because experimentation on human beings raises ethical questions and because epidemiological studies often provide incomplete information, toxicology studies on laboratory animals are often necessary. However, because the extrapolation from animals to man is subject to some uncertainty, corroboration of laboratory test data with sound epidemiological information is desirable." (U.S. EPA, Support Document/Draft Voluntary Environmental Impact Statement for Polychlorinated Biphenyls, 1978). Such epidemiological data on PCBs is now becoming available.

Monsanto is aware of seven epidemiological studies done in the U.S. of persons exposed to PCBs. They include persons with occupational as well as community exposure, and the effects studied range from deviations in biological parameters, through reported symptoms and illnesses, to the occurrence of death from various causes.

Selikoff and colleagues studied 326 volunteers who were occupationally exposed to PCBs. They report the percentage of those workers with various dermatological, gastrointestinal, neurological and other symptoms, as well as the percentage with abnormal values of clinical chemistry parameters and of pulmonary function. They concluded that reported symptoms and abnormal findings in

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physical examinations were not related to duration of employment or level of PCBs in the blood, except for abnormal dermatological findings and abnormal levels of some indicators of liver function. Although the authors claim to have found an unusual impairment of pulmonary function in their study population, no effort was apparently made to determine whether this impairment was related to the other findings. In spite of a correlation of some liver function parameters with PCB exposure, the prevalence of abnormal liver function was low. The authors state, "*The paucity of other abnormalities on physical examination was striking*;" this included a very low prevalence of abnormal liver findings." (emphasis in original).

The Center for Disease Control examined liver function and blood levels of chlorinated biphenyls in a sample of PCB workers, their families, and exposed persons in the community, in Bloomington, Indiana. This study found very mild liver dysfunction (increased levels of the enzyme GGTP) and increased blood levels of a cholesterol-like substance in persons with higher blood levels of PCBs. It is not clear if these findings have any relationship to actual illness.

The Michigan Department of Public Health conducted a study of 182 persons who regularly consumed sports fish, a source of PCB, and classified as "exposed," "intermediate" and "controls" according to the amount of fish consumed. A direct relationship was found between the amount of fish consumed and blood level of PCB. However, no significant difference was found between the controls and the exposed in the incidence of 18 health conditions, many of which described the symptoms reported for Yusho disease. Furthermore, in 12 of the 18 conditions, people with the condition had lower blood PCB levels than those without the condition. The authors conclude, "As a group, the exposed participants had no health problems or medical conditions that could be correlated with PCB levels, exposure to Lake Michigan fish, or known symptoms of PCB poisoning."

NIOSH has completed a study of mortality rates in workers in a transformer plant where there was exposure to PCBs, but Monsanto is unable to comment because a report of the study is not yet available.

The South Carolina State Department of Health and Environmental Control recently completed a study of 32 workers in a capacitor plant, 10 of whom were regularly exposed to PCBs. Details of the study available to Monsanto are limited to those contained in newspaper reports, but the study apparently involved a medical examination and a determination of blood PCB level. The authors state that the study "clearly shows that at present there is no evidence of physical harm resulting from working with PCBs."

These four recent studies appear to constitute the most extensive epidemiological work yet done on chlorinated biphenyls. They each indicate an absence of morbidity (ill health) associated with significant exposure to PCBs.

The Mobil Corporation carried out a study of the occurrence of cases of cancer in a population exposed for varying lengths of time between 1949 and 1957. Plant medical records were used to determine the occurrence of cancer in this group between 1958 and 1975. However, records were not available for about 20 percent of the eligible study group. The 41 men who were actually studied differed from the populations described above in that they were employed in a chemical plant which manufactured a number of different materials to which they might have been exposed during their working careers. The study found an excess of skin cancer (melanoma) based on three cases. After a preliminary report of these findings was made, the Mobil Corporation informed NIOSH that there

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had been "a substantial change" in the definition of the cohort, and that an analysis of the changed cohort might show quite different results. As far as Monsanto is aware, that analysis has not yet been completed.

In 1975, independent of the Mobil effort, Monsanto began to gather information for a mortality study of employees exposed to PCBs at its W. G. Krummrich plant in Sauget, Illinois. Because the plant had manufactured a number of chemicals, those persons exposed to PCBs typically had a mixed exposure to other substances as they moved from job to job. Because the work histories of past employees were not computerized, it would have been necessary to identify those who had worked with PCBs by a manual search through 6,000 records. A preliminary identification was made of 50 deaths from various causes among past workers with PCB exposure, and a review of these suggested a possible excess of lung cancer, but not of skin or pancreatic cancer. This preliminary finding was announced in 1976.

A further attempt to identify a cohort yielded 89 men who had been exposed for at least six months in the period 1945-1965, who were then followed to determine their vital status as of the end of 1977. There were no excess deaths from pancreatic cancer, but 4 lung cancer deaths were found where about 1.5 would be expected. Smoking histories were not available. The accuracy of the determination of this cohort was limited by the necessity of conducting a manual search of the records.

At the present time, computerization of the Krummrich work histories is underway, and should be completed early in 1980. At that time it may be possible to better define the exposed population, and to better determine the other substances to which the population was exposed. However, because of the mixed nature of exposures in a chemical plant, it is unlikely that the Monsanto study can ever be as specifically related to PCBs as those conducted by Dr. Selikoff, CDC, the Michigan DOH, and the South Carolina DOH.

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Monsanto has been responsive to health questions about chlorinated biphenyls over the years. Those responses have been consistent with "state of the art" procedures available at the time the questions were raised. It should be noted that Monsanto's decision to leave the PCB business was based on concerns over environmental presence, not health effects.

Skin and Systemic Effects

When first reported in 1935^(1,2), the occurrence of skin and systemic effects from chloronaphthalenes and chlorodiphenyls constituted a new occupational health problem. It rapidly became of concern to federal and state occupational health personnel and to their industrial counterparts. Monsanto was among the sponsors of and a participant in the studies and the subsequent symposium held on this subject at Harvard University⁽³⁾. In addition, Monsanto conducted its own studies on various polychlorinated biphenyls^(4,5,6,7). Earlier, Swann Research, Inc. had conducted human patch tests on these materials⁽⁸⁾. Results of these efforts suggested that controlling skin contact and vapor inhalation would permit safe industrial use of these substances.

In 1936, Monsanto began developing a corporate medical program. From the start, Monsanto's Medical Director ensured that chlorinated biphenyl workers at Anniston were included in this program. This consisted of periodic physical examinations, good work practices to ensure personal cleanliness of employees, adequate ventilation of the work areas, and overall good industrial hygiene practices. The buildings at the Anniston plant were relatively open and most of the processing was done in closed equipment. Therefore, employee exposure was relatively low. However, since some customers were using chlorinated biphenyls at elevated temperatures, with a greater potential for exposure, precautionary statements for handling them were prepared for customer use as early as 1937⁽⁹⁾. As additional information developed, it was incorporated into Monsanto work practices and distributed to customers by way of correspondence, technical bulletins, and other corporate publications. In addition, upon request, Monsanto technical and medical personnel visited customer plants to advise them on safe handling of polychlorinated biphenyls. Finally, the Monsanto-sponsored studies on AROCLOR 1242 and AROCLOR 1254 led the American Conference of Governmental Industrial Hygienists (ACGIH) to lower the Threshold Limit Value (TLV) for the higher chlorinated biphenyls in 1957⁽¹⁰⁾.

Environmental Presence

In late 1966, Soren Jensen of the Karolinska Institute in Sweden reported the detection of polychlorinated biphenyls in the environment. This was confirmed by 1970. In the interim, Monsanto's European office had entered into discussions with the Karolinska Institute in an attempt to obtain details of the findings. In early 1969, representatives of Monsanto went from St. Louis to Sweden to meet with Jensen. He was not available, and discussions were held with his professor, Dr. Widmark. At about the same time, Monsanto decided to develop data on the chronic oral toxicity of chlorinated biphenyls. Although there was no intention of petitioning for such use, the extent of these tests was typical of those designed for the evaluation and establishment of the safety of direct and indirect food additives. This series of tests was undertaken because it represented the most comprehensive requirement of safety at that time⁽¹¹⁾. FDA was informed of the voluntary testing program in October, 1969⁽¹²⁾. Subsequently, as evidence of environmental presence increased, those studies were

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expanded in scope. Chicken studies to determine the effects of chlorinated biphenyls on avian species were completed in 1970 and 1971. Results of all these studies have been distributed to the FDA and other regulatory agencies. During this time period, Monsanto expanded the warnings on its product labels to include cautions against allowing escape to the environment.

When, in 1976, reproductive disorders were reported in monkeys fed chlorinated biphenyls⁽¹³⁾, Monsanto undertook a study to determine the validity of those findings. The Monsanto study is being conducted with AROCLOR 1254, a large volume material, instead of the relatively low value AROCLOR 1248 used by the earlier investigators.

Potential Carcinogenicity

In 1975, after Dr. Kimbrough reported that AROCLOR 1260 produced liver cancer in rats⁽¹⁴⁾, Monsanto undertook a review of liver sections from its earlier studies on AROCLOR 1242, AROCLOR 1254, and AROCLOR 1260. In addition, it retained Dr. Pour of the Eppler Institute for Research in Cancer to review all liver sections from all of the AROCLOR studies, i.e., Monsanto's and Dr. Kimbrough's⁽¹⁵⁾. That review showed no occurrence of liver cancers. Finally, Dr. Calandra was retained to review and comment on available literature dealing with carcinogenicity of polychlorinated biphenyls⁽¹⁶⁾. Results of those evaluations have been made available to regulatory agencies.

FUR 003928

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Notification Procedures

Beginning in February, 1970, Monsanto notified its customers of the early reports that PCBs had been detected in the environment. Additional information was transmitted to customers as it became available, along with details of Monsanto's phaseout. The notification letters included the priority given to terminating applications that seemed relatively likely to lead to environmental release, were food related, or used the more highly chlorinated products. We cooperated with users of hydraulic fluids and heat transfer fluids to discontinue PCB use.

Simultaneously we introduced AROCLOR 1016, a lower chlorinated product for capacitor use, and restricted transformer fluid sales to equipment manufacturers only. In the case of both capacitor and transformer producers, we emphasized the need for control of PCBs. In 1974, Monsanto revised its dielectric literature to conform to the ANSI guideline which resulted from the industry work with ANSI referred to earlier. In 1976 the ANSI committee was reconvened to consider the need for revision of the guidelines. Completion of this task has been deferred pending issuance of EPA regulations on PCBs.

Monsanto Provided PCB Disposal Assistance to Customers

In 1969 Monsanto started testing the efficiency of PCB destruction by high temperature pyrolysis and constructed a 6 million pounds/year unit which was completed in May, 1971. This incinerator was designed, and was demonstrated, to destroy PCB wastes at 99.9998 percent efficiency.

By September, 1971, this unit was in continuous operation and was destroying both waste from our production and PCBs returned by customers as they converted to non-PCB replacements. When phaseout from nonelectrical applications was complete, the incinerator was used to destroy waste PCB which collected from ongoing dielectric use.

A system was developed to properly handle customer return of wastes. When some customers did not follow our suggested procedures, Monsanto reemphasized the need for proper packaging. To assist in proper handling, posters were prepared and distributed to further educate those responsible for collection and handling of PCB wastes.

In the period 1975-1976, large (approximately 80 million pounds/year) commercial facilities became available which could handle controlled PCB incineration more efficiently and economically than Monsanto's small prototype unit. These units incinerated PCBs until their operations were curtailed by the need for a specific permit under the EPA disposal regulations for PCBs, which became effective on April 18, 1978. The first permit has yet to be issued. The potential risks of accidental PCB contamination have undoubtedly increased because of the delay in EPA implementation of its incineration policy (see Section 5).

Label Warnings

In 1970 Monsanto modified the labeling of PCB packages to emphasize the need to keep it from the environment. Subsequently, labels on drums were written in seven languages.

Assistance with Identification of PCBs

Because of the changes in composition of PCB dielectric fluids since their introduction, Monsanto worked with the IEC to document such changes. This led to ASTM standard D2283,

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which lists the composition of all transformer askarels used at various times since 1932.

Monsanto researchers worked within ASTM to develop refined technology for determination of PCBs in the environment. This resulted in approval of ASTM D3304 which has become standard methodology for PCB quantification. While many laboratories have the necessary equipment, proficiency in the methodology varies widely. Monsanto's Applied Sciences group regularly consults with laboratories as they gain experience in testing for PCBs. Regulations require many such tests to be performed. The testing load has been greatly increased by the policy EPA adopted in controlling PCB-contaminated oils at the 50-500 ppm level. This is causing serious delays in reporting of test results.

We recognized that after Monsanto terminated production of chlorinated biphenyls, small samples of products which had previous commercial significance would be required for research and standardization of detection equipment. Arrangements were concluded with a laboratory supply house to take custody of a limited drum quantity and to supply such samples.

Continuing Research

Monsanto is funding studies at two major universities which are directed at finding innovative approaches to reducing PCB levels in the environment.

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During the years Monsanto made chlorinated biphenyls, the quantity of waste produced was relatively low and consisted chiefly of distillation residues, after separation of the useful product mix. Until 1971 these residues were landfilled. From 1971 to 1977 production waste was incinerated.

In the 1970's, PCBs were frequently singled out by the EPA, legislators, environmentalists and the news media as the symbolic example of why tough, new toxic substance control regulations (TOSCA) were needed in the United States.

In the process, the hazards of PCBs were greatly exaggerated. Adjectives like "deadly toxins" and "potent cancer-causing agents" were and still are typically used to describe PCBs in government handouts and press accounts.

The result is that the public becomes hysterical at the mere mention of these compounds, and with small wonder.

The present EPA moratorium on disposal of PCB waste products is another by-product of this hysteria. Once a disposal program is approved, it's almost certain that the problem will shift to obtaining disposal permits in the face of public opposition to disposal facilities. John Dickinson, chief of the hazardous waste section of EPA Region IV in Atlanta, Ga., spoke to this point at a Toxic Substances Control Institute Seminar, Oct. 15-19, 1979. He termed PCBs "political pollutants" which he defined as pollutants which can be safely and securely disposed of, but ones which no one wants to handle because of public opposition. He pointed out that other chemicals are much more dangerous than PCBs, but PCBs have received the major share of media attention.

At the same seminar, Raymond D. Harbison, director of the Toxic Substances Control Laboratory at Vanderbilt University, said PCBs are totally immobile and are *not* carcinogenic to humans.

FUR 003932

FUR 003933

1-4296-0680-6 Litho in U.S.A.

WATER_PCB-SD0000071076

FUR 003934

Monsanto Company / Public Relations Department / 800 N. Lindbergh Blvd. / St. Louis, Mo. 63166 / (314) 694-2891

WATER_PCB-SD0000071077

Monsanto
EUROPE S.A.

FROM : Brussels, Belgium
(NAME & LOCATION)
DATE : 1st December, 1966
SUBJECT : Aroclor Sweden
REFERENCE : DW:gb
TO : G. R. Buchanan - St. Louis

cc A. Arpino - Brussels
Dr. Emmet Kelly - St. Louis
D.V.N. Hardy - London
R.A. Steenrod - St. Louis

Dear George,

I attach a copy of a letter received from Ola Palm in Stockholm. I have sent copies of this letter also to the appropriate departments within our own organisation. In consideration of the importance we are placing on development of the Swedish market for Aroclor over the next five years, we would be grateful if you could arrange for this information to be considered by the appropriate departments in St. Louis and their comments transmitted to us as soon as possible.

Based on the recommendations made by our medical departments we shall have to decide whether to arrange for publication of data in Sweden or not.

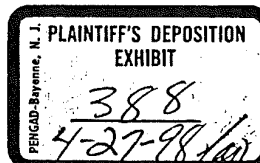
In relation to the specific problem mentioned of disposal of used materials, we would be interested to learn how this problem is handled in America. In the U.K. many companies have been burying material in drums, material in the drums having been absorbed into vermiculite or some similar porous material. Has any entirely safe method been developed for the disposal of waste Aroclor ?

Best wishes.

G.B.

pp. D. Wood.

P.S. Thinking of the total quantities of Aroclor used in Sweden compared with the much larger volumes of Pentachlorophenol and Sodium Pentachlorophenate, for water treatment in the paper industry and sapstain control in the timber industry. Is it likely that the chlorinated phenols show similar chromatographic traces to the chlorinated bi-phenols?



FUR 003944

cc: Mr. D.S. Cameron - ME

RISING & STRAND

AKTIEBOLAG

OP/BO

TELEFON: 34 01 55

TELEGRAM: HENRIS

TELEX: 1624

POSTGIRO: 5 44 43

BANKGIRO: 73-0445

STOCKHOLM VA November 28, 1966
SVEAVÄGEN 47

Monsanto Europe
BRUSSELS 3
Belgium

For the attention of Mr. D. WOOD

Dear David,

re: AROCLORS

As mentioned, there has been some publicity in Sweden concerning investigations made at the Institution of Analytical Chemistry at the Stockholm University. These have revealed that a group of products called Polychlorinated Bi-Phenols - PCB for short - accumulated in certain organs of animals. They are said to be related to DDT and equally poisonous.

The findings were discussed at a meeting of scientists at the Wenner-Gren Centre in Stockholm on November 22. Below please find a translation of an article in the Swedish daily paper "Dagens Nyheter":-

"It is found in salmon and in pike. It is found in sea eagle living on fish. It is found on the surface of the needles of the fir trees, that is in the air. It is found in the hair of a five months baby...

The scientists working with biocides have for a long time seen this something as unknown "peaks" on their gas chromatographs and at a meeting at the Wenner-Gren Center, Research Assistant Sören Jensen of the Institution for Analytical Chemistry at the Stockholm University could reveal the identity of these peaks. It has been found that they consist of a group of poisons, Polychlorinated Biphenols (for short PCB) which are closely related to, and equally poisonous as, DDT.

PCB is broken down considerably slower than DDT and gives rise to damage of liver and skin. PCB is not

FUR 003945

WATER_PCB-SD0000071079

used as a herbicide. It is not manufactured in Sweden but is supposed to be used by the industry to quite some extent. No special industry can so far be accused of being the source of contamination.

Research Asst. S. Jensen has tested 200 fishes and a number of birds. He has taken several samples of air and has reached the conclusion that PCB is equally common in Nature as chlorinated hydrocarbons of the type of DDT, DDE, and Lindane. Even fish in Laddjojaure in Lapland contain PCB. Mr. Jensen has also found that PCB does not appear in animals living on a vegetarian diet, such as the elk.

In the course of his work, Mr. Jensen has not found anything indicating that the source of contamination comes from agricultural additives. It is, however, obvious already now that PCB is most frequently found in organisms living in water or feeding from water animals. In all examined pikes PCB was found. In a sea eagle found dead outside Stockholm it was found that the liver contained 30 mg of mercury per kilo, 76 mg DDT and considerably more PCB. The exact figure has not yet been determined.

PCB is found in water and in air, and not only in the Swedish air, but also in e.g. London air. Mr. Jensen has not yet been in London for sampling but could identify the poison by studying a gas chromatogram of air published in a British technical journal.

Mr. Jensen has also examined the hair of his family and himself and has found PCB on all samples. Most PCB was found in the hair of his wife but most sensational was that the girl aged 5 months had more PCB in her hair than her brothers and sisters of 3 and 6 years. Probably the girl had got the poison via the mother's milk.

In the State Museum Mr. Jensen has examined the whole collection of sea eagles dating back to 1880. By testing it could be established that PCB was present only in birds from 1944 and thereafter while birds collected before 1944 were quite free from PCB.

The use of PCB in Sweden is not established in detail. According to American sources these types of products are used in the manufacture of a variety of heat-resistant materials. They are used for electrical insulation, for fire-proof heat transport in hydraulic oils, in lubricating oils used at high

FUR 003946

temperature and pressure, in paints and as pigments in various plastics. PCB is not imported only as such. It is also part of several finished products. Nothing is known as to the way in which it reaches the water and the air. According to Mr. Jensen, products containing PCB should have this openly declared.

PCB is equally harmful whether absorbed via the skin, through the food, or by inhalation. In contact with the skin it can cause oedema. For DDT the highest permissible concentration in the air has been set at 0.5 - 1 mg/cu.metre. For PCB it has been mentioned to be 0.5 mg/cu.metre. Mr. Jensen will now try to get more complete analytical material. He hopes eventually to be able to disclose the source of the contamination and will also increase his cooperation with toxicologists and geneologists."

Another daily paper, Svenska Dagbladet, has a similar article. Here it is mentioned that Mr. Jensen, working under Laborator (Professor) Gunnar Widmark, has disclosed facts which will have far-reaching importance since the findings have proved a new source of pollution of the nature.

One of the participants at the meeting was Dr. A.V. Holden of Scotland, scientific contact man between the twelve O.E.C.D. countries, who has established coordinated analysis of chemicals used and found in nature.

I suppose there is no doubt that what has been termed Polychlorinated Biphenyls is equal to Aroclor. There is also no doubt that the published facts will cause considerable unrest in several quarters. We probably will have to have Aroclor registered with the Swedish Board of Poisonous Substances and the industry will have to be particularly careful in handling the material. The problem in some cases of course may be the disposal of used material. I understand that there hardly exists a convenient method of destroying Aroclor and that possibly burying unuseable material may be the only answer.

We shall be glad to hear from you soon.

Yours sincerely,

FUR 003947

RIISING & STRAND
HENRY STRAND

(6/1)



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
BUILDING 16, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

WRcs

January 16, 1968

Monsanto Chemical Company
800 N. Lindbergh Boulevard
St. Louis, Missouri

Gentlemen:

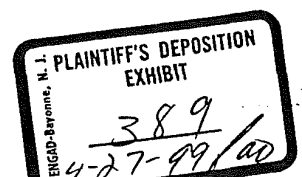
It has been brought to our attention that presumptive evidence of chlorinated biphenyl and chlorinated polyphenyl compounds have been found in avian and animal tissues.

We are in the process of further investigation of compounds of this series and would appreciate your sending us samples of your Arochlor compounds numbers 1242, 1254, 1260, 1268 and any others which might be extensively used.

Sincerely yours,

Richard A. Wilson, Sr.
Research Chemist (Biochemistry)

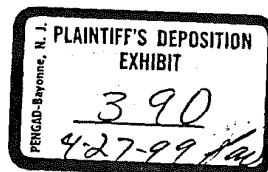
FUR 003948



Minutes of Meeting of the
CORPORATE DEVELOPMENT COMMITTEE

April 22, 1968.

Present: C. H. Sommer - Chairman
E. J. Bock
J. L. Christian
J. L. Gillis
R. K. Mueller
E. A. O'Neal
M. C. Throdahl
R. K. Flitcraft - Secretary



FUR 003336

Dr. Anagnostopoulos reviewed the functional fluids group. Phosphate esters and AROCLOR are the two major products in this group. The product group expects to be above the 1968 budget in terms of ROI and on the objective line for net income.

The major issue in the SKYDROL area becomes one of accelerated competition and more stringent performance requirements. The over-all strategy will be to stay ahead of our competition by providing a demonstrated significant performance edge over potentially competitive products. SKYDROL HT is believed to be a long term solution in this market area, with SKYDROL 500-C being an interim solution between now and 1970.

In the case of jet engine lubricants, the key issue is how to commercially exploit the research investment in jet lubricants. It is believed that we have materials that are ahead of our competition in most categories. The strategy between now and the middle 1970's will be to become suppliers of formulated lubricants to one or more of the oil companies.

In the case of AROCLOR the key issue becomes how to significantly increase the sales growth while maintaining the domestic supply position and profitability. It is believed that transformers and heating systems provide the major opportunities. A target of 10 per cent of the transformer market by 1972 has been set. In the case of THERMINOL we have about a \$1 M business in 1968, and a target of a \$10--20 M business by 1972. In this area, a total systems approach is being used; supply the fluids, design the system and supply the hardware.

FUR 003337

152470

12/30/68

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

DATE December 30, 1968

SUBJECT AROCLOR - WILDLIFE

REFERENCE

TO : W. A. Kuhn - WKUHN

cc:	H. Bergen	HBURG
	P. Hodges	PHODG
	E. Wheeler	EWHEE
	E. Tucker	JFQ
	D. Olson	DOLSO
	R. Kountz	RKOUN
	R. Davis	RDAVI
	W. Johnson	WJOHN

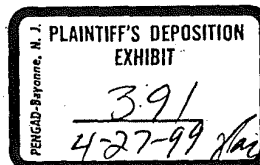
Bill, you wanted to become more familiar with the legal-political problems facing Aroclor with regard to pollution and the accusations in the literature that chlorinated biphenyls are poisoning and killing wildlife.

These wildlife people have to be taken seriously. They have taken the DDT industry to court in Wisconsin to prevent the use and sale of DDT in Wisconsin and if they win in that state, DDT will be banned in many others. This case was on National Television last week. The wildlife people are dedicated to the demise of DDT.

Our problem is that Aroclor has been "identified" along with DDT residues and hence we are almost certain of being drawn into the court records and may also be one of the scapegoats of the DDT defense. The wildlife people have accused Aroclor of doing all the bad things of DDT.

We are taking 3 steps to protect ourselves. Scott Tucker and R. Keller are to repeat some of the analytical identification work feeding Aroclor to chickens and seeing if Aroclor is really present as "shown" by the literature. I hope we have been falsely accused but maybe Aroclor is present.

E. Wheeler is having feeding tests done on animals to establish a "safe" level for Aroclor feeding. If we can find a "safe" level Calandra's Lab will do 2 year experiments on animals including effects on succeeding generations. This will help a bit but the wildlife people won't be stopped by this kind of evidence.



FUR 003949

W. A. Kuhn

-2-

Dec. 30, 1968

The third step is to minimize exposure of Aroclor, to reduce air and water pollution, to restrict Aroclor to uses which can be controlled. This is the only way I see to survive.

I believe we should make sure that our plants have minimum air or stream pollution. I believe Anniston is vulnerable and that off-gas HCl and Aroclor should be 100% controlled. Krummrich may also need help.

I believe we should demonstrate that Aroclor can be incinerated to harmless products for disposal.

I believe we should help our customers dispose of off-grade or non-reworkable Aroclor, either by incinerating or by toxic dump.

I believe plasticizer group marketing should know where their product is going and be able to minimize exposure risk if Aroclor has truly been identified as a pollutant.

We probably have 6 months to 1 year while they fight out the DDT case. I want to use this time to minimize our exposure. We will need your help in setting TSD targets.

Bill R.

W. R. Richard

ms

FUR 003950

Monsanto

C O M P A N Y

ORGANIC CHEMICALS DIVISION

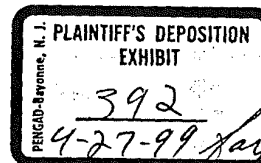
600 N. Lindbergh Boulevard
St. Louis, Missouri 63166
(314) OXford 4-1000

March 3, 1969

On February 24, the San Francisco Chronicle carried a major feature about "a menacing new pollutant" found in the San Francisco Bay area. The article was based on marine life research carried out by Dr. Robert Risebrough of the University of California. It stated that residues of polychlorinated biphenyl (PCB) were killing certain marine birds and posed a long-term threat to humans.

This story has caused considerable comment on the West Coast and its claims may be repeated elsewhere. As you know, Monsanto manufactures polychlorinated biphenyl and markets it under our Aroclor trade name. We, therefore, would like to present some additional facts.

The work done by Dr. Risebrough dates back to earlier research by other scientists to analyze the amount of pesticides in wildlife, soil and water. The initial pesticide research was extremely difficult since any search to detect materials in the parts-per-billion range also brings out other "interfering" substances.



FUR 003967

Several years ago, two Swedish scientists at Stockholm University's Institution of Analytical Chemistry, Professor Gunnar Widmark and Soren Jensen, reported they had identified the other substances which were appearing during analysis of chlorinated pesticide residues. They said some of the materials were polychlorinated biphenyls or PCB. The amount reported was in the parts-per-billion range, or less. Since PCB's are not "broadcast" or spread around the land as are pesticides, the scientists theorized that the source must be the industrial wastes of PCB users.

Dr. Risebrough's more recent work reports the identification of PCB, along with DDT and DDE pesticides, in the tissues of birds and fish on the West Coast.

The conclusions of these scientists are puzzling from several aspects. Polychlorinated biphenyls are stable chemical compounds which are essentially insoluble in water. Their use does not make them easily released into the natural environment.

A principal market for PCB is in electrical applications where they are used as insulating fluids for transformers and capacitors. In this use, the chemical is completely sealed in metal containers. Another market is for heat transfer applications where the PCB fluid functions in a closed system.

PCB's are also used in several "plastic type" applications. Here the chemical is incorporated into the polymer as an integral part of the solid material. This applies whether the polymer is used as an adhesive, an elastomer or a surface coating.

The Swedish and American scientists also imply that polychlorinated biphenyls are "highly toxic" chemicals. This is simply not true. The toxicity of any material, whether it be chemicals, drugs, natural plants or even foods, is relative. Compared to the thousands of industrial chemicals and home products, PCB's are not toxic unless they are mishandled or misused. During more than thirty years of U.S. production and use, cases of any toxic effect have been extremely rare -- and then only where the simple precautions recommended for use were not followed.

FUR 003968

To our knowledge, polychlorinated biphenyls are not sprayed or dusted on crops, woodlands or any other areas, as are pesticides. It is, therefore, not only puzzling, but extremely difficult to conceive how commercially produced PCB can show up in wildlife as DDT and other pesticides appear to be. This raises the question whether the substance identified in the Swedish work, and now in California, is actually PCB -- or whether they are materials which, due to the metabolism of other materials in the marine environment, appears to be PCB.

Unfortunately, even though techniques for analyzing tissue samples have become quite precise, the ability to analyze the possible impact of naturally occurring substances in the food cycle of living organisms has not made comparable advances.

Monsanto has a research program to confirm the identity of the compounds reported to be PCB by the Swedish and California scientists. We also cooperate, on a regular basis, with federal, state and university laboratories in their analysis of chlorinated hydrocarbon residues.

Additionally, Monsanto will continue to exercise the highest degree of control in its manufacturing, shipping and storage of PCB -- as we do with all products. In the functional fluids market, we have carried out a program for several years for the reclamation of used PCB's to avoid disposal of these valuable materials.

The source of the marine life residue identified as PCB is not yet known. It will take extensive research, on a worldwide basis, to confirm or deny the initial scientific conclusions. We will keep you advised of our own research and are available to answer questions as they may arise.

Very truly yours,

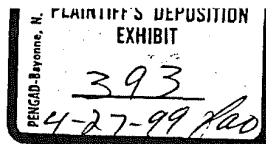
Elmer P. Wheeler
Manager Environmental Health

/ecd

FUR 003969

Monsanto

MAR 10 REC'D



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

DATE	March 6, 1969	cc	H. Bergen	HBERG
			J. Springate	JSPRI
SUBJECT	<u>AROCLOR WILDLIFE ACCUSATIONS</u>		W. Schalk	WSCHA
			D. Olson	DOLSO
REFERENCE			R. Kelly	RKELL
			J. Garrett	JGARR
TO	E. Wheeler - EWHEE		P. Hodges	PHODG
			P. Park	PPARK
			R. Keller	JKFQ
			E. Tucker	ETFKQ

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

- (1) a pollutant - widely spread by air-water; therefore an uncontrollable pollutant.
- (2) a toxic substance - with no permissible allowable levels causing extinction of peregrine falcon by induced hepatic enzymes which degrade steroids upsetting Ca metabolism leading to reproductive weakness, presumably through thinner egg shells.
- (3) a toxic substance endangering man himself; implying that the peregrine falcon is a leading indicator of things to come.

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

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

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

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

FUR 003970

March 6, 1969

- (b) We are not prepared to defend ourselves against the accusations made of enzyme and hormone activity, the isolation of enzymes or metabolic products, the indirect accusation of cancer, or the splitting of genes, when this accusation is made. Whether we can defend this route or not needs further discussion.
- (c) Through the Industrial Bio-Test program we are to establish the long term allowable limits of chlorinated biphenyls for certain birds-fish-animals by feeding experiments, pathological examination, and tissue analysis for chlorinated biphenyls. We may be able to answer reproductive ability in some animals.

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

Where does this leave us?

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

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

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

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

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

E. Wheeler

-3-

March 6, 1969

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

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

Thanks,

W. R. Richard

ms

Att.

FUR 003972

Monsanto

FROM (NAME & LOCATION)

St. Louis - General Office

DATE

March 17, 1969

cc.

SUBJECT

REGIONAL WATER QUALITY
CONTROL BOARD

REFERENCE

Their letter to you of March 7
from Mr. Fred H. Dierker

TO

TO

H. S. Bergen - HBERG

*Hold
This Card*

About Aroclor used in the dielectric area, we respond to items 4, 5, 6, and 7 of Mr. Dierker's letter as follows:

- 4) The solubility of Aroclor in tap water at 25° C. is as follows:

<u>Product</u>	<u>Solubility in Water</u>
Aroclor 1242	203 ± 10 ppm
Aroclor 1248	106 ± 14 ppm
Aroclor 1254	50 ± 2 ppm

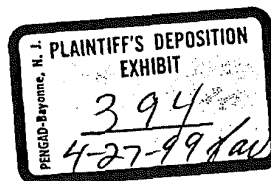
See sec 17 C

Although the solubility of Aroclor 1260 has not been determined, the above data certainly serves to indicate that the more highly chlorinated Aroclors such as 1260 are the least soluble in water. Accordingly, it is quite reasonable to say that the solubility of Aroclor 1260 in water would be significantly lower than 50 ppm.

- 5) Aroclor 1242 and a small amount of Aroclor 1254 are used in hermetically sealed capacitors. The hermetically sealed can construction is of aluminum, mild steel, and stainless steel. These capacitors are used imbedded in asphalt in fluorescent lighting systems. They are used for power factor correction on utility lines. They are also used as motor run capacitors for air conditioning systems.

Attached are the specifications for Aroclors 1242, 1254, 1248, and 1260, which describes the physical properties of these materials.

Aroclor 1260, and to a lesser extent Aroclors 1242 and 1254, are used as components in transformer fluids of the askarel type. In general, the amount of Aroclor used in the transformers fluid ranges from 45 percent to 60 percent.



FUR 003324

March 17, 1969

On the West Coast in 1968, about 300,000 pounds of Aroclor was contained in the transformer askarel fluid used in that region to make transformers.

These askarel transformers are also hermetically sealed, non-breathing apparatus. Very little of the fluid is used to replace spent fluid. Askarel transformer failure that would require replacement of the fluid is very rare. For example, the Edison Electric Institute found that the incident of such failure is in the range of 0.05 percent.

- 6) No Aroclor capacitors are made on the West Coast.

Transformer manufacturers on the West Coast who handle Aroclor containing fluid include:

Federal Pacific - Santa Clara, California
Hill Magnetics - Redwood City, California
H. K. Porter - Bellmont, California
Sierra Transformer - Redwood City, California
Spokane Transformer - Spokane, Washington

- 7) In the normal use of capacitor or transformer fluid containing Aroclor, Monsanto advises the capacitor and transformer manufacturers to avoid breathing vapors that would be emitted from the fluid if it were heated to elevated temperatures. Monsanto also advises the user of the fluids to avoid continuous contact with the skin. If clothing becomes saturated, the workman is advised to launder it before wearing it again. If there has been spillage on the skin, it should be removed by washing with soap and water. Normal, ordinary good housekeeping practice is recommended.

Normal filtration of the fluid as done in the electrical industry has not presented health hazard provided that ordinary normal cleanliness is followed.

FUR 003325

March 17, 1969

The amount of Aroclor dielectric fluid discarded is indeed relatively small. However, such relatively small amounts have been discarded in drums by removal to dumping areas. In rare instances, when a significant amount has become available for disposal, Monsanto practices having the fluid sent back to our plant for reworking and reuse in non-electrical areas.

We would suggest answering Mr. Dierker's questions about Aroclor dielectrics in accordance with the above.

As he also seeks our views on PCB materials used in non-electrical areas such as hydraulic fluid, heat transfer media, plastics, etc., may I assume that you have asked people handling those areas to submit their views?


P. G. Benignus

/ecd
Enclosures

FUR 003326

AROCLOR 1242 (Trichlorobiphenyl)
Specification Properties - September 27, 1962

<u>PROPERTY</u>	<u>TYPICAL</u>
Visc. at 37.8°C. (ASTM D88-56)	82 - 92 seconds Saybolt Universal
Specific Gravity at 25/15.5°C. (ASTM D1810)	1.381 - 1.392
Color, APHA	50 max.
Condition	Clear
Acidity, mg. KOH/g. (ASTM D974, D664)	0.01 max.
Pour Point, °C. (ASTM D97-57)	-14 or lower
Inorganic Chlorides (ASTM D1821)	0.05 ppm. max.
Refractive Index at 25°C. (ASTM D1807)	1.6240 - 1.6260
Distillation Range (ASTM D20-56)	
°C. corrected for stem and barometric pressure	10% 325 min. 90% 360 max.
Water content (ASTM D1533-60)	35 ppm. max
Resistivity, 100°C. 500 volts DC at 0.1 inch gap. (ASTM D1169)	500 X 10 ⁹ ohm-cm. min.
Dielectric constant, 100°C. at 1,000 cycles (ASTM D924-49)	4.7 to 4.9
Flash Point, Cleve. open cup (ASTM D92-57)*	170° to 200°C.
Fire Point*	None to boiling point
Sulfates (ASTM D117-31)*	None
Fixed Chlorine Content (Carius)*	43 ± 0.5%
Specific Heat at 25°C.*	0.29
Evaporation at 100°C. for 6 hrs.*	0.4% max.
Dielectric strength (ASTM D877-49) at 25°C. KV min.*	35
Hydrolyzable Chlorine Compounds, (ASTM D1820-61) ppm. chlorides, max.	0.5
Thermal Stability (ASTM D1936) ppm. chlorides, max.	0.4
Coefficient of Thermal Expansion* (ASTM D1903)	0.00068 cc./cc./°C.

*Not determined unless by special request.

FUR 003327

AROCLOR 1248

PROPERTY

Visc. @ 54.4°C. (ASTM D-88)
Spec. Grav. @ 65/15.5°C.
(ASTM D-287)
Color, APHA
Condition
Acidity, mg. KOH/g.
Pour Point °C. (ASTM D-97)
Refrac. Index @ 20°C.
Dist. Range (ASTM D-20)

Water Content, ppm.
Resis. 100°C. 500 v D.C.
@ 0.1" gap
Dielectric Constant, 100°C.
1000 cycle
Dielectric Strength 25° C.*
Flash Point, (C.O.C.)*
Fixed Chlorine (Carius)*
Specific Heat @ 25° C.*

TYPICAL

73-80, sec. Saybolt Univer.
1.404-1.414
100 max.
Clear
0.01 max.
-7
1.630-1.631
343 - 373°C.

35
500 x 10⁹ ohm-cm, min.
4.6
35 KV min.
193°C.
47.5 - 48.5%
0.27

*Not determined unless by special request.

FUR 003328

AROCLOR 1254 (Pentachlorobiphenyl)
Specification Properties - September 27, 1962

<u>PROPERTY</u>	<u>TYPICAL</u>
Visc. at 98.9°C. (ASTM D88-56)	44 - 48 secs. Saybolt Universal
Specific Gravity at 65/15.5°C. (ASTM D1810)	1.495 - 1.505
Color, APHA	50 max.
Condition	Clear
Acidity, mg. KOH/g. (ASTM D974, D664)	0.01 max.
Pour Point °C. (ASTM D97-57)	7 - 12
Inorganic Chlorides, ppm. (ASTM D1821)	0.05 max.
Refractive Index at 25°C. (ASTM D1807)	1.6370 - 1.6390
Distillation Range (ASTM D20-56)	10% 366 - 378°C.
Corrected for stem and barometric pressure.	50% 371 - 383°C.
	90% 378 - 394°C.
Water Content, ppm. (ASTM D1533-60)	35 max.
Resistivity 100°C., 500 v. D. C. at 0.1" gap (ASTM D1169)	500 X 10 ⁹ ohm-cm., min.
Dielectric Constant, 100°C. 1000 cycles (ASTM D924-49)	4.15 - 4.35
Dielectric Strength 25°C.* (ASTM D877)	35 KV., min.
Burn Point (ASTM D92)*	Higher than 350°C.
Sulfates (ASTM D117-31)*	None
Fixed Chlorine Content (Carius)*	55 ± 0.5%
Evaporation at 100°C. for 6 hours*	0.4% max.
Specific Heat at 25°C. *	0.26
Hydrolyzable Chlorine Compounds, (ASTM D1820-61) ppm. chlorides, max.	1.0
Thermal Stability (ASTM D1936) ppm. chlorides, max.	0.5
Coefficient of Thermal Expansion* (ASTM D1903)	0.00066 cc./cc./°C.

*Not determined unless by special request.

FUR 003329

AROCLOR 1260

<u>PROPERTY</u>	<u>TYPICAL</u>
Visc. at 98.9°C. (ASTM D88)	72 - 78 seconds Saybolt Univ.
Specific Gravity at 90°C. / 15.5°C. (ASTM D287)	1.555 - 1.566
Color, APHA	150 max.
Condition	Clear
Acidity, mg. KOH/g.	0.01 max.
Pour Pt., °C. (ASTM D97)	25 - 34
Inorganic Chlorides, ppm.	0.10 max.
Refractive Index, 25°C.	1.6455 - 1.6470
Distillation Range (ASTM D20)	10% 385 - 398°C.
Corrected for stem and barometric pressure	50% 390 - 404°C.
Corrosion	90% 400 - 420°C. After heating with aluminum for 6 hrs. at 210°C. $\pm$ 10°C., the aluminum must not be corroded either on visual or weight in- spection and the Aroclor 1260 should meet the following specs:
	Color, APHA 150 max.
	Free Chlorides, ppm. 0.10 max.
	Acidity, mg. KOH/g. 0.01 max.
	Condition Clear
	35 max.
Water content, ppm.	
Resistivity, 100°C. 500 volts at 0.1" gap	500 x 10 ⁹ ohm-cm., min.
Dielectric Strength 50°C.*	30 KV., min.
Dielectric Strength 100°C.*	30 KV., min.
Dielectric Constant 100°C. at 1000 cycles*	3.6 - 3.8
Burn Pt. (ASTM D92)*	Higher than 350°C.
Sulfates (ASTM D117-31)*	None
Fixed chlorine content (Carius)*	60 $\pm$ 0.5%
Evaporation at 100°C. for 6 hrs.*	0.2% max.
Stability*	There shall be no liberation of chlorine or chlorides when the material is heated at 100°C. in a glass vessel in contact with air for periods of at least one month.
Specific Heat at 25°C.*	0.23

*Not determined unless by special request.

FUR 003330

E. B. Benig, Jr.
Ford

March
1968

March 12, 1968

S. Dargen

I believe the following will suffice for answers to questions 1, 2 and 3.

We have only recently commenced with a feasibility study to undertake the toxicity studies. Due to the low solubility of polychlorinated biphenyl in water as indicated in four below, it would not be surprising if we fail to get a 96-hour LC50. Depending on the results of the initial studies, we may do at least 3 day exposure experiments. We will keep you informed of any results we obtain.

Attachment A is

1. The enclosed is a Xerox copy of a report on the physical and chemical properties of polychlorinated biphenyls. The number of chlorination is significant in that the 1250 series are chlorinated to the extent indicated by the last two numbers. For example 1242 is biphenyl chlorinated to the extent of 42. The 1400 compounds are terphenyls again with the last two numbers indicating the percentage of chlorination. The 1500 compounds are mixtures of biphenyls and terphenyls chlorinated to the percentage indicated by the last two numbers.

We have added to the bottom of these pages the results of acute animal toxicity tests showing the LD50 for rats and the skin minimum lethal dose when applied to rabbits. You will note that the samples were applied as a dust or as a solution-suspension in corn oil. The viscosity and stability of the material.

Chronic inhalation data has been obtained for compounds 1254 and 1254 and a report discussing the results of these studies is enclosed. The author suggests three levels for an industrial environment of 2.0 mg per cu meter for 1242 and 1.0 mg per cu meter for 1254. The author also suggests that the data be used to estimate the risk of these compounds by the rat.

FUR 003331

You will note in the table describing the properties of these materials that the liquid members of the series have extremely high distillation ranges and that waxy or resinous members have to be distilled under high vacuum. These data attest to the low vapor pressure of the materials at ambient temperatures.

In our more than 30-years of manufacture, cases of harmful effects in the industrial use of the materials have been extremely rare. We believe this is due to the low volatility which reduces any possible inhalation at ambient temperatures and secondly the fact that in ^{most cases} uses where the material is heated the system is a closed one so that exposures are limited to the occasion that when due to accidents the hot materials might escape from a system briefly. Where such incidents have occurred, the irritation caused by the vapors from the hot materials have limited voluntary exposures such that systemic toxic effects are rare.

EPW
Elmer P. Wheeler

34

Enclosures

Are

FUR 003332

SAN FRANCISCO BAY REGION

REGIONAL WATER QUALITY CONTROL BOARD

364 FOURTEENTH STREET
OAKLAND 94612

March 7, 1969

In reply please refer to
File No. 2119-1075Monsanto Company
800 N. Lindbergh
St. Louis, Missouri 63166Attention Mr. Howard S. Burgen, Business Director
Functional Fluids Organic Chemicals Division

Subject: Polychlorinated biphenyls ("PCB's")

Gentlemen:

Confirming recent telephone discussions between your Mr. Burgen and Hobar C. Knapp of this office, we request the following information about your polychlorinated biphenyls:

- ✓ 1. Data from fish bioassays which you are now performing; please include 96-hour TL_m and the data pages recording laboratory observations.
- ✓ 2. Existing data on toxicity, including long-term effects.
- ✓ 3. Maximum allowable concentrations in industrial work areas.
4. Solubility in water.
5. Industrial applications by specific Monsanto product item number, and physical nature of these items; please include:
 - a. Dielectric fluids
 - b. Plasticizers for paints, plastics, elastomers, etc., and the uses of products containing "PCB", e.g. tire stocks, floor tile. Please inform about the diffusion or other escape of "PCB" from such products, both in normal use and in the environment of refuse dumps.
 - c. Hydraulic fluid for aircraft, industrial equipment, etc.
 - d. Heat transfer applications.
 - e. Other.
6. Current volume of sales of "PCB" in the San Francisco Bay Area and in California for each of the above applications and extent to which this is to replace spent "PCB". (We understand current inventory turnover at your Santa Clara warehouse is around 40,000 lbs per month, but we have been able to account for only two bbl. per year in purchases.) Please name Bay Area users of "PCB" for these applications.

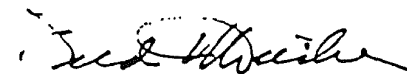
FUR 003333

March 7, 1969

7. Monsanto's advice to its customers for handling "PCB" in normal use, and for its disposal when discarded, e.g., of filtration residues from processing dielectric fluids, discarding the fluids when they must be replaced in dielectric, hydraulic, or heat transfer service, disposal methods for emptied containers, spills, etc..

In view of the recent allegations in the technical press about the serious detrimental effects of "PCB" on fish and wildlife, we are most anxious to receive this information soon. Your cooperation in this matter will be appreciated.

Sincerely,



FRED H. DIERKER
Executive Officer

HCK,FHD/emj

FUR 003334

Monsanto

FROM (NAME & LOCATION)

Tom C. Ford - General Offices

DATE

March 14, 1969

cc:

Mr. E. P. Wheeler

SUBJECT

REFERENCE

TO

Mr. Howard S. Bergen

LR
Aroclor TCM
PF

Regarding the request for detailed information on PCB from the San Francisco Regional Water Quality Board, I have only one observation.

I know our detailed literature on Aroclors lists darn near every potential market where PCB might be used. I understand some of these references will be deleted from future literature.

I have been told in discussions with you and other people that Aroclors are not used, "to our knowledge", in house paints, vinyl plastics, automobile tires, floor tile or pesticides. Of course, these are the potential "polluters" which come to the public's mind.

If I am wrong, or if we give contradictory information to the board, please let me know immediately.



Tom C. Ford

TCF:sfh

FUR 003335

WATER_PCB-SD0000071104

Monsanto

FROM (NAME & LOCATION)

W. R. Richard - Research Center

under wildlip

DATE

April 14, 1969

cc:

D. A. Olson DOLSO
J. Bryant JBRYA
R. M. Kountz RKOUN
W. A. Kuhn WKUHN
N. T. Johnson NJOHN

SUBJECT

DISPOSAL AND INCINERATION
OF AROCLOR

REFERENCE

TO

P. Benignus - PBENI

To defend the Aroclor position, it seems that we should provide for disposal of and incineration of off-grade fluid and work with Westinghouse and Findett on the disposal of the off-grade capacitors as well. I think we can foresee that control of the total material balance for Aroclor will be important for future operation. We should therefore help control the entire cycle of a capacitor.

At present we are putting reclaim Aroclor into new Pydraul hydraulic fluid. We can't really satisfy pollution people with this explanation. This will just bring the focal point to hydraulic fluids that much sooner.

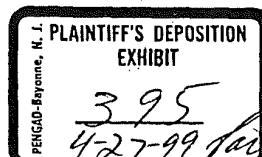
Will you please look over the figure for capacitors, add any disposal Aroclor from transformers. Please convey our guesstimate to Bob Kountz for preliminary sizing of incinerator.

Capacitor Industry

	<u>At Present</u>		<u>Future</u>	
	<u>For Hyd Fluid</u>	<u>For Disposal</u>	<u>For Disposal</u>	
G.E.	180,000 lbs/yr 1.6% Production	450 Drums 230,000 lbs .6% Prod 66,000 lbs	2% Prod	200,000 lbs/yr
Westinghouse	216,000 lbs/yr 6.0% Production	20-40 Drums 20,000 lbs	2% Prod	80,000 lbs/yr
Sangamo	200,000 lbs/yr 6.0% Production		2% Prod	60,000 lbs/yr
Capac. Industry	Say 2% = 500,000 lbs/yr	Say 1% = 250,000	Say 2%	500,000 lbs

Recycle and Destruction of Off-Grade Capacitors for Westinghouse-

IN 10 REV. 11-65



FUR 003973

WATER_PCB-SD0000071105

Westinghouse prefers not to bury capacitor - want to drain
Aroclor, salvage parts, destroy the rest.
Findett-Monsanto asked to see what we can do.

Transformer Industry

Transformer Rebuilders -

Transformers Scrapped -

W. R. Richard

ms

FUR 003974

Minutes of Meeting of the
CORPORATE DEVELOPMENT COMMITTEE

April 28, 1969

Present: Messrs.

E. J. Bock, Chairman
H. H. Bible
J. L. Gillis
E. J. Putzell
C. H. Sommer
M. C. Throdahl
J. N. Ehlers, Secretary

ORGANIC DIVISION - RUBBER CHEMICALS INSTRUMENT & EQUIPMENT PROPOSAL

Present: Messrs. H. L. Minckler, C. E. Anagnostopoulos and
A. Obel

Monsanto is a major supplier of monomers, fibers and chemicals to the \$40 billion tire and rubber industry.

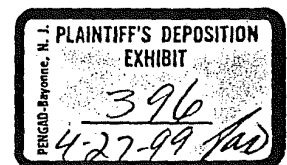
- Opportunities exist for expansion in cord and wire, accelerators, antidegradants and increasingly in precision instruments and equipment for quality control.
- Monsanto's technological contributions are recognized by the industry.

The rubber industry is facing major issues of --

- Reduction of labor costs through greater automation.
- High quality control requirements created by competition and government safety regulations -- to meet these, the industry will increasingly rely upon precision instruments and special equipment with market expected to grow from \$50 M in '68 to \$250 M in '75.
- The rubber industry needs special equipment suppliers who can contribute innovative technology and engineering, as well as manufacturing capabilities.

Reliable Manufacturing Company in Akron, Ohio, is a specialty equipment manufacturer selling 85% of its output to the rubber industry.

FUR 003975



- 1969 sales estimated to be \$2.5 M and after-tax profit of \$250,000.
- It has a good reputation with the industry and is capably managed.

Targets for rubber chemicals and specialty equipment businesses are \$19 M sales by '74 and with acquisition of a comparable European business, \$6 M sales in Europe. Projected returns on sales (AT) are 11 - 13% and with ROI of 20 - 33%.

Recommendation: Authority to explore the possibility of acquisition of Reliable Manufacturing Company.

Conclusions: The requested authority is granted. The Division is to clear the negotiating arrangements with Mr. Putzell. (Excerpt to Messrs. H. L. Minckler, T. K. Smith, R. Harris, F. Morgan and T. M. Rasmussen.)

INTERNATIONAL DIVISION - PLANS FOR RENEWAL AND GROWTH

Present: Messrs. A. J. A. Bryan, G. F. Wingard, E. W. Burr, A. D. Lapthorne, H. D. Vos

Monsanto's International business was summarized by Mr. Bryan.

- Foreign manufacturing and exports produced \$411 M sales and \$31 M net income in 1968 with ex-U.S. gross investment of \$394 M.
- ROI from local manufacture increased from 1.5% in 1965 (a low year) to 4.6% budgeted in 1969 (a strong year).
- Net income in '69 to be approximately 50-50 from fibers and chemicals & plastics.
- Foreign and export sales (amounting to 22% of MC total) produced 28% of MC profits.

Weaknesses noted:

- 7 product lines of 71 accounted for most of the profits.
- Over 1/3 of the ex-U.S. investment, amounting to \$143 M, is operating at a loss. Thermoplastics a problem area.
- Local manufacturing suffers from small, dispersed plants, weak raw material position and poor logistical support.

Growth objective is to produce 33% of Monsanto's net income, or \$122 M, by 1977; 65% from Europe and 25% from Canada and Latin America.

- Present divisional plans and NED activities will not achieve this.
- New businesses and acquisitions will be required, based on a strong commercial development effort.

FUR 003976

European Renewal & Growth (A. D. Lapthorne)

Our European operations must attain critical size to effectively compete with local producers who have comparable technology and are growing by merger and developing sound raw material bases. Major issues facing us are:

- Fibers: need to reach critical size and economic polymer and nylon salt position.
- Thermoplastics: need to expand polystyrene and ABS polymers to critical size; resolution of LDPE problem and obtain petrochemical supply position.
- Raw materials requirements are sizeable and not in balance with naphtha cracking output.
- Organic product lines do not fill out the organic family tree potential.
- Agricultural: need for local manufacturing and full marketing organization.

Planned Manpower Development Program to be Instituted (E. W. Burr)

- Divisions regularly assign key employees to ex-U.S. operations in their advancement paths and hire a portion of their college recruits with potential for international assignment.
- Area management identify high potential national employees for U.S. assignment and recruit with this view.
- Achieve management of people resources on a comparable basis worldwide with flexibility of assignment of professional managers.

International Financial Management (G. F. Wingard)

Objectives of this newly-instituted function are:

- Develop financial plan to support growth goals requiring \$1 B European investment by '78.
- Develop a financial plan for each area and each major entity covering cash requirements and minimizing devaluation exposure.
- Develop worldwide plans for devaluation protection and money mobilization program in Europe.
- Prepare for local ownership in Mexico, Canada and Australia.

FUR 003977

Financial Reporting (H. D. Vos)

One objective is to improve operating statements to better reflect management performance. This is complicated by reporting for 71 product groups from 6 management areas and over 90 corporate entities.

New operating report system will report actual sales, COGS and direct SARE by product groups and will allocate shared SARE, net-finance expense and other income charges and income taxes by agreed budgeted amounts.

- Net Income will reflect performance by business manager and permit concentration on controllable items.
- Area directors will be responsible for shared SARE.
- Treasury and Tax Departments, respectively, with International Division, will be responsible for net finance expenses and taxes.

A second objective is to recast U.S. export and ex-U.S. financial statements to better reflect our international operations.

- Non-product income items such as third party royalties, interest, etc., will be carried as a separate item.
- Royalties from subsidiaries to be included in ex-U.S.A. manufacture income as their share of U.S. technical costs are presently allocated to them.
- Sales and income will be reported on a marketplace basis.

The Committee accepted the recommendations of the International Division as follows:

1. The plan for manpower development was approved.
(Excerpt to Mr. W. B. Daume.)
2. The financial planning objectives and the modifications of the reporting and accounting systems were approved in principle. The Committee requests the Finance Department and the International Division to advise it as to the proper means of evaluating new projects and computing ROI as one means for evaluating project performances in light of incentives available abroad, such as cash grants, tax forgiveness, accelerated depreciation, etc.
(Excerpt to Mr. F. Morgan.)
3. The growth plan and financial goals to develop 33% of Monsanto net income, or \$122 M, by 1977 (65% from Europe and 25% from Latin America and Canada) recommended by the Division, were approved:
 - a. Growth plans by areas should be developed by the operating divisions in conjunction with the International Division, with plans for Europe to have first priority and to be prepared by year-end.

FUR 003978

- b. The area directors shall be responsible for coordinating the operating divisions' plans in terms of an overall area plan and to develop supplemental programs as may be needed to achieve the overall area goal.

(Excerpt to the General Managers, Group Vice Presidents and Mr. F. Morgan.)

(Excerpt to Mr. A. J. A. Bryan.)

APPROPRIATION REQUESTS

The President advised that he would recommend to the Board of Directors for approval -

Organic Division Appropriation Request No. CEA-2080 for \$1,100,000 for solid Aroclor expansion - Anniston

and would approve --

Organic Division Appropriation Request No. 2026 for \$585,000 to expand Benzyl Chloride from 50 M to 60 M lbs./yr. - Delaware River

MMK Appropriation Request No. 87 for \$389,000 (MC share \$194,500) for hydrogenated Terphenyl facilities

PP&R Division Appropriation Request No. 432-A - Overrun of \$135,000 for waste treatment - Trenton Resins.

J. N. Ehlers
Secretary

FUR 003979

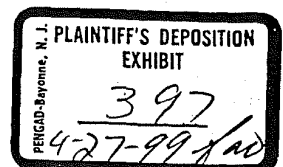
MEETING OF THE BOARD OF DIRECTORS

May 22, 1969

The regular monthly meeting of the Board of Directors of Monsanto Company was held on May 22, 1969, at 9:00 A.M. at the St. Louis County, Missouri, offices of the Company.

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

FUR 003980



Memorandum of Messrs. H. L. Minckler and T. K. Smith, Jr., dated April 15, 1969, recommending the expenditure of \$1,100,000 for the expansion of the solid Aroclor[®] facilities at the Anniston, Alabama plant, was submitted to the members in advance of the meeting. This expansion will enable the Company to supply into the mid-1970's all forecasted U.S. chlorinated polyphenyl needs and also to provide a significant share of ex-USA demands. Upon motion made and seconded, the following resolution was unanimously adopted:

RESOLVED, that the expenditure of \$1,100,000 for the expansion of the solid Aroclor[®] facilities at the Anniston, Alabama plant, is hereby approved. 5-12-69

FUR 003981

CONFIDENTIAL

MINUTES OF AROCLOR "AD HOC" COMMITTEE

First Meeting

Date: September 5, 1969

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

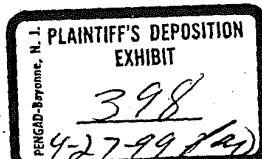
Objectives: (Agreed to by the Committee)

Submit recommendations for action which will:

1. Permit continued sales and profits of Aroclors and Terphenyls.
2. Permit continued development of uses and sales.
3. Protect image of Organic Division and of the Corporation.

Background Discussion of Problem:

1. Agreed that we should concentrate on Aroclor 1254 and 1260. Aroclor 1242 has not yet been incriminated for these possible reasons:
 - a. Nature of uses of 1242 minimizes environmental contamination.
 - b. It may degrade biologically.
 - c. Unless analytical techniques are performed carefully, 1242 can be destroyed by oxidation during the analyses.
2. PCB has been found in:
 - a. Fish, oysters, shrimp, birds.
 - b. Along coastlines of industrialized areas such as Great Britain, Sweden, Rhine River, low countries, Lake Michigan, Pensacola Bay, in Western wild life (eagles). It may be a global contaminant.
3. PCB has been tied to DDT in effects on disappearance of wild birds which have fish diets. Ratio of PCB to DDT has been about 40-50:1 generally. Dr. Reishoro reported almost 1:1 ratio. PCB may be contributing to or exaggerating the effects of other chlorinated aromatics.



FUR 003982

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

5. Toxicity levels:

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

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

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

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

6. Escambia River Problem:

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

FUR 003983

7. Problem in Producing Plants:

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

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

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

8. Environmental Contamination by Customers:

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

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

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

FUR 003984

Action Planned:

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

P. B. Hodges
Secretary

aju

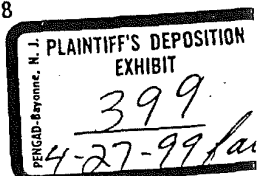
FUR 003985

PCB ENVIRONMENTAL POLLUTION ABATEMENT PLAN

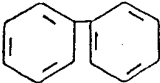
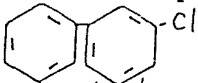
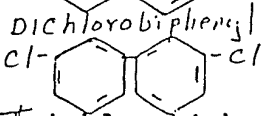
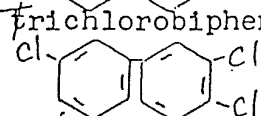
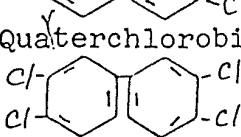
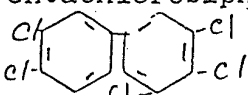
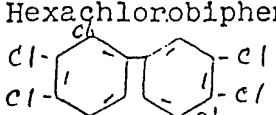
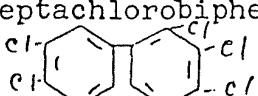
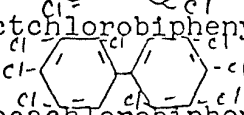
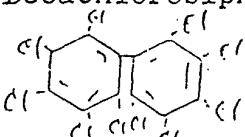
Introduction

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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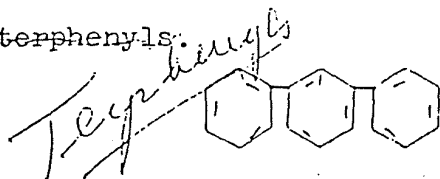


Monsanto entered the Aroclor market in 1930 by acquiring Swain Electrical Company or known today as our Anniston, Alabama plant. The first load of Aroclor which incidentally was Aroclor 1254 -- went out of Anniston, Alabama to GE in 1931: Since that time the market has grown to 170 to 200M^{lb} worldwide.

<u>Chemical</u>	<u>Monsanto Product Line</u>	<u>Nature of Material at Ambient</u>
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
Octachlorobiphenyl 	Aroclor 1268	Solid
Decachlorobiphenyl 	Aroclor 12715	Solid

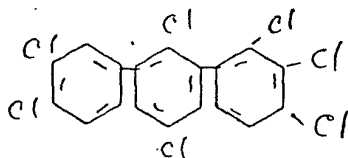
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Total possibility are 210 theoretically possible chlorinated biphenyls & terphenyls.



Santowax or terphenyl

Solid



Aroclor 5460

Solid

II. Problem

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5/11/69*

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

III. Extensiveness

EW

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

EW

Professors Widmark and Jensen of the Institute of Analytical Chemistry at Stockholm, Sweden, in November 1966, announced and confirmed findings of 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.

FUR 003990

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 effect 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 in small quantities (down to 5 ppb) to sensitive marine life such as shrimp. *Confirmation*
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. *Still present 1/21/72*
3. Man - There is no harmful effect known to man or other mammals after 40 years of production. Investigations are underway by various sources. **FUR 003991**
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. *More than 50 samples out of many files*

V. Effect on Monsanto

Business potential at stake on a worldwide basis:

<u>Fluids</u>	<u>Plasticizers</u>	<u>Total/Year</u>
70M lbs.	34M lbs.	104M lbs.
\$16M	\$6M	\$22M
\$5-8M 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^{ly} association (with DDT) will prevail as the background while actual facts may be sparse.

C. Customer Relations

FUR 003994

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

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 controller 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

FUR 003995

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.

FUR 003996

environment today which was deposited over the past forty years. We ~~must~~ 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 - Systems 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 - ^{the} Settling ponds have been built by the large manufacturer 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 chlorinated terphenyl could offer a possible solution.

FUR 003998

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 contract 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.

FUR 003999

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.

This approach would enable us to phase out the higher chlorinated materials in many applications where they are no longer necessary or really desired. We could 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.

FUR 004000

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)

<u>Fluids</u>	<u>Plasticizers</u>
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 Pydrau! where control of the product is difficult.	4. Initiate program to develop A/ 1254 & 1260 substitutes

FUR 004001

5. Emphasize better control over other Aroclor 1254 & 1260 uses.
5. Investigate with manufacturers the feasibility of alternate products.
6. Initiate customer education or 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 Medical studies and confirming analytical results. Expand toxicity studies. Follow developments concerning publicity and those developments covering political implications of PCB contamination.
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.

FUR 004002

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 unduly alarm the market but reduce the exposure in terms of liability. Coordinate recommendations with Marketing.

- 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

FUR 004004

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 duplication 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.

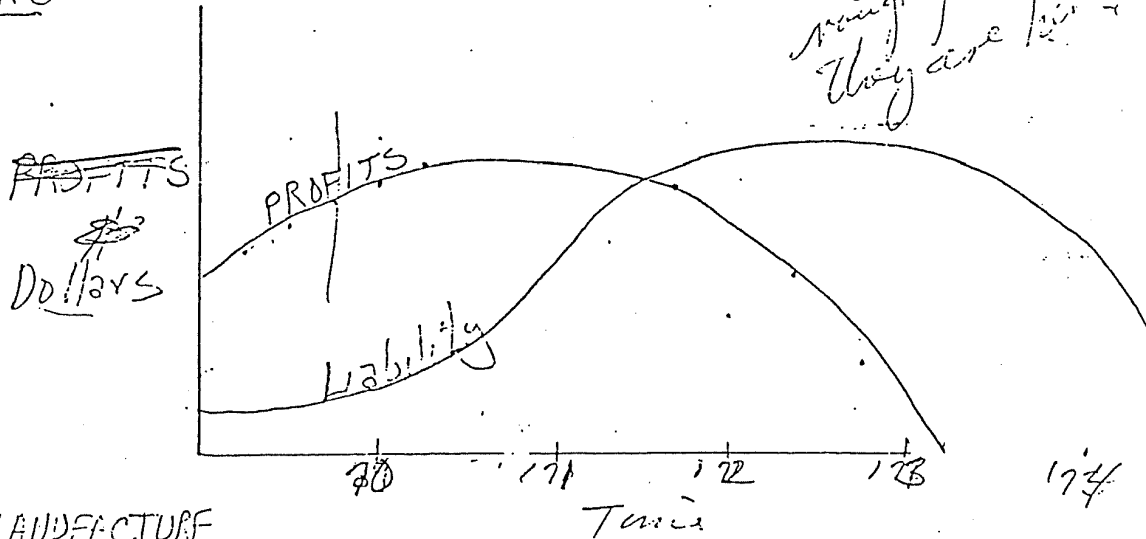
Prepare for "precipitous pullout" or drastic legislative action although we do not feel this is a likely possibility.

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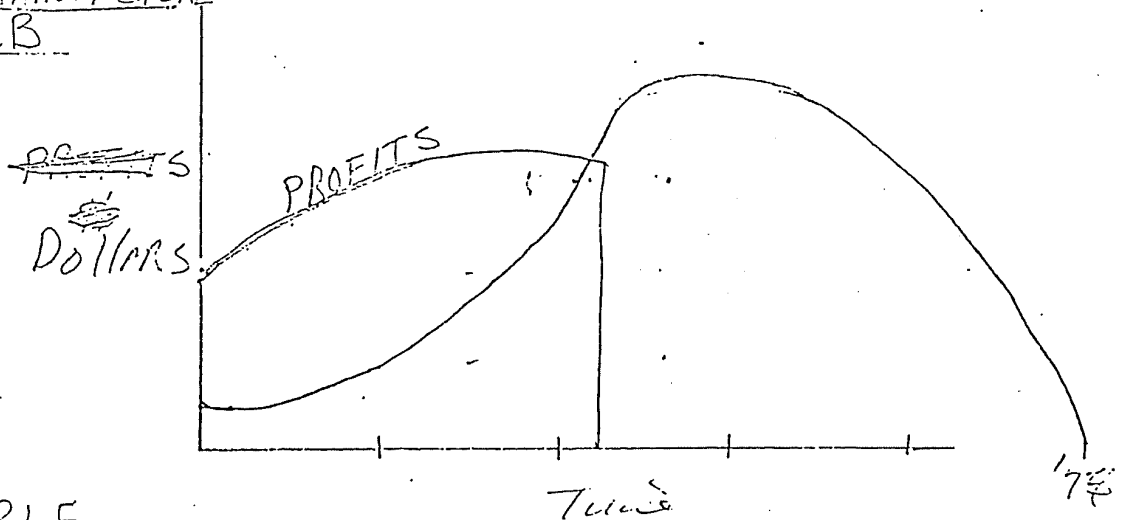
PROFIT AND LIABILITY VS TIME

ACTION

DO NOTHING



DISCONTINUE MANUFACTURE
of PCB



RESPONSIBLE
APPROACH

