

1 York, Binghamton, New York; Master's degree in
2 radiation biology, University of Rochester in New
3 York in 1955. I began --

4 Q The Master's was in what discipline?

5 A The university called it radiation biology. It's
6 more accurately radiation safety. I began work
7 with Dow Chemical September 1st, 1955, as an
8 entry-level industrial hygienist and radiation
9 safety specialist.

10 In 1960 I transferred to the Texas
11 division as chief industrial hygienist, returned
12 to Midland in 1962 as an industrial hygienist in
13 the same laboratory situation. In 1970 I became
14 safety and industrial hygiene manager for the Dow
15 Midland division, now called Michigan division.

16 Q That was in '67?

17 A I said '70.

18 Q '70?

19 A Yes. In 1971 I went back to health and
20 environmental sciences as an industrial hygienist.
21 1976, I transferred to the Dow Badische Company in
22 Williamsburg, Virginia, as director of industrial
23 hygiene, returned to Midland in 1978 as manager of

1 industrial hygiene research and manager of the
2 industrial hygiene lab.

3 MR. WAGNER: That's B-A-D-I-S-C-H-E.

4 A Then in December of 1979 it catches up to where I
5 transferred to Dow Corning.

6 Q From 1970, if my numbers are correct, here, from
7 1971 to 1976 you were present or employed at
8 Midland, Michigan, correct?

9 A Yes.

10 Q And from 1971 through 1976, in your capacity as an
11 industrial hygienist, did you have any
12 responsibility for industrial hygiene in the
13 manufacturing process for 2,4-D or 2,4,5-T or
14 Silvex or their components?

15 MR. WAGNER: I object to the form.

16 A To the best of my recollection, I had no primary
17 responsibility for manufacturing operations during
18 that time period.

19 Q Do you know who would have had responsibility for
20 the industrial hygiene aspect of the manufacturing
21 process for those chemicals?

22 MR. WAGNER: Same objection.

23 A You are challenging my memory, of course. I

1 believe about 1972 Dr. Ralph Langner became the
2 Michigan division industrial hygiene manager, so
3 he would have had the basic responsibility for
4 that.

5 Q Dr. Ralph?

6 A Langner, deceased.

7 Q L-A-N?

8 A L-A-N-G-N-E-R.

9 Q What was his position during that time period, if
10 you know, with the company?

11 A To the best of my memory, he was manager of
12 industrial hygiene for the Michigan division, was
13 the title.

14 Q You mentioned this Michigan division before. What
15 was the Michigan division?

16 A It's the production division of Dow Chemical
17 located in Midland, Michigan.

18 Q Do you know what other divisions are located in
19 Midland, Michigan, other than the Michigan --

20 A It's corporate headquarters for the company, so
21 there are many corporate offices and functions
22 going on there.

23 Q Have you ever seen a flow chart or a diagram of

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1 the corporate organization in Michigan?

2 MR. WAGNER: At any point in time?

3 Q During the time we're talking about, between '70
4 and '75?

5 A I don't remember.

6 Q Who would your boss have been between 1970 and
7 1975?

8 A Harold R. Hoyle.

9 Q And if memory serves me correctly, Dr. Hoyle was
10 head of industrial hygiene in the seventies?

11 A Yes.

12 Q From 1970 to '75, how many industrial hygienists
13 were at Midland, Michigan, involved in the
14 manufacturing process?

15 MR. WAGNER: I object to the form.

16 A Wow, there may have been four or five, but not
17 full time, to my recollection.

18 Q Okay, when I spoke with -- have you reviewed the
19 deposition of Dr. Rowe?

20 A No.

21 Q Dr. Rowe mentioned that he thought, in the
22 industrial hygiene division in the seventies,
23 there were ten to 15 industrial hygienists. Does

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1 that refresh your recollection at all? .

2 MR. WAGNER: Let me object to the form.
3 That question is different than the one you've
4 asked, but --

5 A It doesn't help a whole lot, because I was trying
6 to remember as best I could, you know, from my
7 personal experience, and I gave you my best guess.

8 Q That's fine. Who were the other four or five
9 industrial hygienists that you recall back between
10 1970 and '75?

11 MR. WAGNER: Let me, as a point of
12 clarification, because it's the problem with your
13 initial question then followed up by Dr. Rowe, you
14 initially asked about hygienists involved in
15 production, and then made reference to Rowe's
16 answer about how many industrial hygenists in the
17 industrial hygienists' division. I don't know if
18 that's a greater number, but is your question how
19 many industrial hygienists were there in the
20 safety and industrial hygiene department, separate
21 and apart from whether or not they were involved
22 in the production end of it?

23 MR. SCHULER: Correct.

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1 A You fellows have thoroughly confused me. Would
2 you restate the question, please?

3 Q What I'm trying to find out, Mr. Silverstein, is
4 what was the number of industrial hygienists that
5 worked under Dr. Hoyle from 1970 to '75?

6 A That's a bit clearer, and I think my four or five
7 is the best I can do.

8 Q And as head of industrial hygiene during that time
9 period, Dr. Hoyle -- was industrial hygiene part
10 of the biomedical research lab?

11 A Oh, another memory stretcher, it was part of the
12 biochemical research department when I joined in
13 the fifties. Somewhere in the time period you
14 mentioned the name was changed to health and
15 environmental research, I believe. Biochemical
16 research is not biomedical, careful distinction.

17 Q I understand. Who did Dr. Hoyle report to between
18 '70 and '75, if you know?

19 A Dr. Don D. Irish, for part of that period, anyway.

20 Q Is Dr. Hoyle still alive?

21 A Yes.

22 Q And where is he located, if you know?

23 A Probably on the eighth tee about now.

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1 Q Not in Midland, Michigan?

2 A Delray Beach, Florida. Actually it's too early
3 for the eighth tee.

4 Q Now, to get back to my other question, other than
5 yourself, who are the other four or five
6 industrial hygienists in the department?

7 A To the best of my recollection, Arnold Schaffer,
8 S-C-H-A-F-F-E-R, Richard D. Olson --

9 MR. WAGNER: O-N or E-N?

10 A O-N. The D is important because there's a Richard
11 A. there, too. George Florez, I believe was one
12 of our group at that time, and Edward J.
13 Schneider, S-C-H-N-E-I-D-E-R. Oh, Donald Rapp,
14 R-A-P-P.

15 Q Did any of these individuals, Mr. Schaffer, Mr.
16 Olson, Mr. Florez, Mr. Schneider, Mr. Rapp, have
17 responsibility for industrial hygiene in the
18 production of Silvex or 2,4,5-T or 2,4-D?

19 A To the best of my recollection, each of those
20 folks had some responsibility for some area, but
21 no one had total responsibility for the Michigan
22 division.

23 Q When you say each had some responsibility, do you

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1 recall what the breakdown of that responsibility
2 was?

3 A No.

4 Q What were your duties and responsibilities in that
5 time period between 1970 and 1975? And if they
6 changed, let me know that, too.

7 MR. WAGNER: I object to the breadth.

8 A My recollection of that particular time period is
9 that my main effort was in two projects. One was
10 called Dow Environmental Health Services, a
11 consulting-for-fee effort to offer industrial
12 hygiene and a number of other services to
13 industry. I was the lead industrial hygienist for
14 that effort, which was headed up by Arnie
15 Schaffer.

16 The other role I played was as chief
17 health physicist, which is radiation safety
18 officer for the Dow Nuclear Services program,
19 which offered Dow services to the nuclear power
20 industry.

21 Q Now, back in the 1960s, and I have some memoranda
22 here that I'm going to show you in a minute, you
23 apparently were given some responsibilities with

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1 regard to doing some industrial hygiene work
2 regarding the process for the manufacture of
3 trichlorophenol, correct?

4 MR. WAGNER: I object to the form.

5 A Yes.

6 Q Who initially assigned you those responsibilities?

7 A Harold R. Hoyle.

8 Q Do you know why you were selected for those
9 responsibilities?

10 A I could only guess, conjecture at this point.

11 Q I don't want you to guess, but if you've got a
12 reasonable estimate, I want to hear it.

13 A I was a good industrial hygienist, and I was
14 available.

15 Q Okay, sounds reasonable. And prior to being given
16 the responsibilities or assigned some
17 responsibilities with regard to the production of
18 trichlorophenol and potential TCDD contamination,
19 what were you doing before you were assigned those
20 tasks?

21 MR. WAGNER: I object to the form of the
22 question, no predicate.

23 A To the best of my recollection, in the early

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1 sixties I was doing industrial hygiene in the
2 Midland division production plant, and doing
3 radiation safety for the division and for the
4 company.

5 Q Were there any industrial hygienists prior to your
6 assignment in the sixties that had been assigned
7 to the production of trichlorophenol in terms of
8 monitoring the safety of the workers in that
9 production?

10 A I do not remember.

11 Q What was the reason -- well, let me go back. Your
12 first assignment in that area was approximately
13 what year, do you recall?

14 A 1964.

15 Q Before 1964 had you ever had any responsibilities
16 with regard to industrial hygiene for the
17 production of trichlorophenol?

18 A Not that I recall.

19 Q Or 2,4,5-T?

20 A Not that I recall.

21 Q Silvex?

22 A I don't remember.

23 Q Or 2,4-D?

1 A I don't remember that either.

2 Q Had you worked at all with the industrial hygiene
3 aspect of the production of any agricultural
4 chemicals prior to 1964?

5 A I don't remember specifics on that. I may have,
6 but I just don't recall any specific project.

7 Q Had you investigated any cases of chloracne prior
8 to 1964?

9 A I think one time, yeah.

10 Q And do you recall when that was?

11 A Sometime, oh, a year or so before, maybe.

12 Q About 1963 or so?

13 A Roughly, yeah.

14 Q Prior to that time had you investigated any cases
15 of chloracne at any Dow plants?

16 MR. WAGNER: I object to the form.

17 A Not to my recollection.

18 Q Prior to 1964 or '63, do you know if there was any
19 individual industrial hygienist that was
20 responsible for monitoring the production of
21 trichlorophenol or 2,4-D, 2,4,5-T or Silvex?

22 MR. WAGNER: I object, asked and
23 answered.

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1 A No.

2 Q No, you don't know?

3 A No, I don't know, if I understood your question,
4 yeah.

5 Q Okay. In 1963, when you were first asked to
6 investigate a case of chloracne, what was that in
7 connection with, what process?

8 A It was a different process called Dow 6-X.

9 Q And what is it the 6-X stands for?

10 A I believe it stood for hexachlor -- oh, my
11 goodness, hexachloro, I want to say phenoxy, but
12 that doesn't fit, because you can't put six
13 chlorines in that. It was a hexachlorophenolic
14 compound that I cannot name for you at this point.

15 Q And did you write any reports with regard to that?

16 A I don't remember.

17 Q Now, when you were assigned by Dr. Hoyle to
18 investigate chloracne in 1964, how did you proceed
19 to do that?

20 A Well, I visited the plant to observe the actions
21 of the employees, which is the standard initial
22 step in industrial hygiene investigation.

23 Q So you went to the plants, themselves?

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1 A I spent quite a bit of time in that plant, yeah.

2 Q Did you actually have an office in the plant?

3 A No, I didn't have an office in the plant.

4 Q What else did you do?

5 A Proceeded to do some air sampling and wipe testing
6 of the plant environment.

7 Q Anything else?

8 A I'm pretty sure that I issued a quick report,
9 because we had an urgent situation, so I must have
10 written a report. I don't remember for sure.

11 Q Anything else that you recall?

12 A I'm not sure what you want, but if you give me a
13 specific --

14 Q I'm not sure what you did. That's why I'm asking
15 the question.

16 A Well, that was phase one. Is there a question on
17 the floor?

18 Q If that was phase one, what else did you do, what
19 was phase two?

20 A My recollection is that my next assignment was as
21 safety officer in the plant, with the
22 responsibility for assuring safe operation.
23 Anything that happened in the plant, I had to

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D-2275

1 specify safety precautions and make sure people
2 followed them.

3 Q When you say in the plant, what are you referring
4 to?

5 A The building housing the production process.

6 Q Referring to trichlorophenol?

7 A Specifically.

8 Q Was there more than one physical building that
9 that applied to?

10 A No.

11 MR. WAGNER: That --

12 THE DEPONENT: I'm sorry, I --

13 MR. WAGNER: That's all right. So we're
14 clear, you meant was there more than one building
15 producing trichlorophenol?

16 Q Other than the building that he had responsibility
17 for, right, producing trichlorophenol?

18 A Either way, the answer is no.

19 Q That's what I understood your answer to be. What
20 was the building number, do you recall?

21 A It was 199 building.

22 Q And after becoming a safety officer and
23 instituting safety precautions and making sure

1 there was compliance, was there any other duty
2 that you discharged in connection with the
3 responsibility to review industrial hygiene for
4 trichlorophenol manufacture?

5 A I was involved in a number of things in that whole
6 situation, both some laboratory studies and
7 investigating other buildings in the division, and
8 I just do not remember timing, you know, on that,
9 but I do remember that I was wandering around
10 doing other duties, as well.

11 Q Is one of the things that you did to check
12 exposure levels of the workers in the plant to
13 TCDD?

14 MR. WAGNER: I object to the form.

15 A Well, that was one of my responsibilities, yes.

16 Q And was it one of your responsibilities to correct
17 operating procedures where excessive exposures may
18 be occurring?

19 MR. WAGNER: I object to the form.

20 A At what time period now? During my health officer
21 duties, yes.

22 Q Okay. And was it part of your duties and
23 responsibilities to identify areas where

1 difficulties with exposure may occur?

2 A Yes.

3 Q And did you also serve as kind of a liason between
4 the toxicology department and medical department
5 and production?

6 MR. WAGNER: I object to the form,
7 vague.

8 A Yes.

9 Q Prior to 1964, had there ever been a case of
10 chloracne in a Dow worker working with
11 trichlorophenol that you're aware of?

12 A No.

13 Q Prior to 1964, were you aware of any case of
14 chloracne in a Dow worker working with the
15 finished product of 2,4,5-T?

16 A I do not remember.

17 Q Or Silvex?

18 A I don't remember.

19 Q Or 2,4-D?

20 A I don't remember.

21 Q In the course of your career at Dow Chemical, are
22 you aware of any cases of cancer in Dow workers
23 that were exposed to trichlorophenol in the

1 manufacturing process?

2 A No.

3 Q Same question with regard to 2,4,5-T?

4 A No.

5 Q Silvex?

6 A No.

7 Q 2,4-D?

8 A No.

9 Q As a practical matter, back in 1964, with these
10 workers that came down with the chloracne, how
11 would you first become aware of that? Would they
12 go to the medical department first, to report this
13 before you became aware of it? How did that work?

14 MR. WAGNER: I object to the form.

15 A The answer is yes, they would have gone to
16 medical.

17 Q And somebody, would somebody in the medical
18 department then contact you to make you aware of
19 the problem?

20 A No, they would have --

21 MR. WAGNER: I object to the form, calls
22 for speculation and vague as to time.

23 Q How would you come to be aware of the problem?

1 MR. WAGNER: Same objection.

2 A From Harold Hoyle.

3 Q So the medical department would contact him?

4 MR. WAGNER: Same objection, calls for
5 speculation.

6 A Yes.

7 Q And then he would tell you, and then you would
8 investigate it, is that the way it would work?

9 MR. WAGNER: I object to the form.

10 A Yes.

11 Q How many cases, to your recollection, of chloracne
12 were there from the exposure to trichlorophenol in
13 1964?

14 A I don't know, for a particular year, how much we
15 had.

16 Q Can you give me an estimate, to the best of your
17 recollection?

18 A Before the event, about 60, as I recall it.

19 Q Did you have occasion to see each one of the
20 workers that came down with the chloracne?

21 A I don't remember that.

22 Q Did the workers that came down with the chloracne
23 continue to work in the plant generally, or were

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1 they transferred somewhere or what?

2 A They continued to work in the plant.

3 Q Do you recall the names of any of the workers?

4 A Wow. Just one.

5 Q Who was that?

6 MR. WAGNER: Let me stop you for a
7 moment, because I'm concerned about the medical
8 privilege, and in releasing confidential medical
9 information about that person, and I have not yet
10 gotten a direction from Dow as to whether or not
11 they want pursued by certiorari or not the court's
12 decision to require release of those names.

13 I don't -- Dick, why don't you go ahead.
14 At this point I'm going to instruct you not to
15 answer, but I'm going to ask you to let me know
16 the person's name before we get out of here today,
17 and I won't restrict Mr. Schuler from asking you
18 questions about that person, what he was doing,
19 what position he had, anything else he wants to
20 know, but for the moment let's not reveal his
21 name.

22 MR. SCHULER: My position is we've got a
23 court order saying we can have the names, and the

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1 addresses, as well, and phone numbers. He says he
2 knows one of the names, and there's no stay been
3 entered based on any petition or writ of
4 certiorari, so I think it's a violation of the
5 order not to allow him to answer the question.
6 That's my position.

7 MR. WAGNER: I understand, and I'll give
8 it some thought when we break.

9 Q Dow Chemical was involved in making
10 trichlorophenol since approximately 1946, correct?

11 A Yes.

12 Q And was the trichlorophenol, as far as you know,
13 in your time with the company, always made in the
14 199 building?

15 A Yes.

16 Q Not having been to Midland, Michigan, before, can
17 you describe for me, is the 199 building part of a
18 manufacturing complex, or does it stand by itself
19 somewhere?

20 MR. WAGNER: I object to the form,
21 vague.

22 A It's in the midst of a very large manufacturing
23 complex.

1 Q And around the 199 building are other buildings
2 where other chemicals or components of chemicals
3 are made?

4 MR. WAGNER: I object to the form of the
5 question.

6 A Yes.

7 Q From a timing standpoint, do you recall that the
8 chloracne in the 199 building was first noticed in
9 January or February of 1964?

10 A Yes.

11 MR. WAGNER: Let me object to the form
12 of that as vague. It doesn't identify noticed by
13 whom.

14 Q Was the chloracne mostly due to the exposure to
15 the caustic insoluble oils of the trichlorophenol?

16 MR. WAGNER: I object to the form of the
17 question, calls for conclusion, no predicate for
18 the opinion.

19 A Now I need a repeat.

20 (The requested material was read by the
21 reporter.)

22 A I believe so.

23 Q What are the caustic insoluble oils, is that a

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1 by-product of the manufacture, if you know?

2 A It's a waste stream.

3 Q A waste? I didn't hear you.

4 A Waste stream.

5 Q Stream, okay. Can you describe for me what the
6 chloracne looked like that you saw?

7 MR. WAGNER: I object as to the breadth,
8 time frame.

9 A Collection of blackheads on the face.

10 Q Did it look something like teenage acne?

11 MR. WAGNER: I object to the form.

12 A Yes.

13 Q Did Dow Chemical know that certain chlorinated
14 organic compounds caused chloracne since 1941?

15 MR. WAGNER: I object to the form,
16 imprecise as to Dow and attributing knowledge.

17 A Some people in Dow Chemical knew that.

18 MR. LUTZ: Would you read that back.

19 (The requested material was read by the
20 reporter.)

21 Q Do you know which certain people at Dow knew that
22 since that time period?

23 A Don D. Irish and others in the biochemical

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1 research department are the only ones I know for
2 sure.

3 Q Would Dr. Rowe be one of those?

4 A I believe so.

5 Q In 1944 or '45, did Dow first test the caustic
6 insoluble oil portion of the trichlorophenol
7 production to determine whether that was causing
8 chloracne?

9 MR. WAGNER: I object, no predicate as
10 to personal knowledge, calls for speculation
11 otherwise.

12 A I wasn't employed at that time at Dow Chemical.

13 Q You reviewed the history, however, did you not, at
14 some point in time, as to the trichlorophenol and
15 history of chloracne at the company?

16 A Yes, I did.

17 MR. WAGNER: I object, compound, vague.

18 Q And based on your review of the history in 1944 or
19 '45, did Dow Chemical first test the caustic
20 insoluble oil portion of the trichlorophenol
21 production to see if it caused chloracne?

22 MR. WAGNER: I object, no predicate,
23 vague.

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1 A I believe so.

2 Q At some point in the 1950s, and then, and this is
3 either based on your personal knowledge or your
4 review of the history of this matter, at Dow
5 Chemical, did a German company propose that there
6 may be a compound, TCDD, responsible for causing
7 chloracne?

8 MR. WAGNER: I object, vague, no
9 personal knowledge.

10 A I believe so.

11 Q And I think that, in your memoranda, when you
12 first got involved with the problem in 1964, you
13 called it by the name TCBD, correct?

14 MR. WAGNER: You mean TCDD?

15 MR. SCHULER: Right.

16 A Yes.

17 THE REPORTER: Wait a minute, is it TCBD
18 or TCDD?

19 Q I'll ask the question again to make it clear, in
20 your memoranda, TCDD was called TCBD?

21 A Yes.

22 Q And I'm going to refer to it as TCDD since we have
23 been referring to it in this case, and in the

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D-2286

1 scientific literature, apparently those are the
2 initials of preference --

3 MR. WAGNER: For clarification purposes,
4 you're talking about the 2,3,7,8 isomer?

5 MR. SCHULER: Right.

6 Q Was TCDD the primary culprit in the causation of
7 the chloracne outbreak in 1964 at Dow Chemical
8 Company at the 199 building?

9 MR. WAGNER: I object to the form, calls
10 for opinion, no predicate.

11 A I think so.

12 Q Had you ever been told that TCDD was the most
13 potent chemical ever tested in Dow's toxicology
14 laboratory?

15 A To the best of my recollection, yes.

16 Q Prior to 1964, had the German company, Boehringer
17 Sohn, sent a letter to Dow and other manufacturers
18 of trichlorophenol with suggestions on how to
19 avoid generating the chemical that causes
20 chloracne in the TCP process?

21 MR. WAGNER: I object to the form of the
22 question.

23 A Yes.

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1 Q Do you recall what those suggestions were?

2 MR. WAGNER: Same objection, best
3 evidence rule.

4 A The only one I remember specifically was a
5 temperature limit for the process.

6 Q And what was the suggestion with regard to
7 temperature?

8 MR. WAGNER: Same objection.

9 A I believe it was 150 degrees, but to be honest, I
10 don't remember whether it was F or C, which makes
11 a little difference.

12 Q Do you know, in 1964, whether Dow Chemical, in its
13 manufacture of trichlorophenol, at least to the
14 extent you investigated it, was raising the
15 temperature above 150 degrees Centigrade?

16 A Run that by one more time, please.

17 Q Yes. Do you know in 1964 whether Dow Chemical, in
18 its manufacture of trichlorophenol at the 199
19 building, was raising its temperature in the
20 manufacturing process above 150 degrees
21 Centigrade?

22 A I was told they were, yes.

23 Q Do you know what the temperature was that was

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1 being used for the manufacture of trichlorophenol
2 then at that time?

3 A I don't know it with certainty, but I believe it
4 was around 200 degrees.

5 Q Do you know why the temperature for the
6 manufacturing process of TCP was at 200 degrees at
7 that time?

8 A No.

9 Q Who was responsible for making decisions like
10 that, as far as the manufacturing process is
11 concerned?

12 MR. WAGNER: Temperature decisions?

13 MR. SCHULER: Right.

14 A Engineers or plant management, I don't know for
15 sure.

16 Q Do you know who the person who would have been
17 responsible for that decision at that time was?

18 A I don't know with certainty who that would be, no.

19 Q Do you have some names that you recall of people
20 that were involved?

21 MR. WAGNER: I object to the form of the
22 question.

23 A The plant superintendent was Ray Holmes,

1 H-O-L-M-E-S, I believe.

2 Q At the 199 building?

3 A Yes.

4 Q Is Mr. Holmes still around, to your knowledge?

5 A I don't know, to be honest with you.

6 THE DEPONENT: I'd like to request a
7 two-minute restroom break.

8 Q Let me ask you one more question before you leave,
9 because I want to establish a parameter here, then
10 we'll take a break. At what point chronologically
11 did your responsibilities, if they did, end with
12 regard to chloracne and TCDD and the
13 trichlorophenol process?

14 MR. WAGNER: I object, breadth and
15 vagueness.

16 A I need to hear that one again.

17 (The requested material was read by the
18 reporter.)

19 THE DEPONENT: Did you make your
20 objection?

21 MR. WAGNER: Yes.

22 A Then I can answer. There's no clearcut cutoff
23 time. The way things worked, about 1967 I took on

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D.2290

1 other responsibilities.

2 MR. SCHULER: Okay, let's take a break.

3 (Recess.)

4 BY MR. SCHULER:

5 Q In 1964 was the chemical or the oils that appeared
6 to be causing the chloracne, were they -- was that
7 substance tested on rabbits?

8 MR. WAGNER: I object to the form of the
9 question.

10 Q To your knowledge?

11 A Yes.

12 Q And did it turn out that the concentration of the
13 chemical causing the chloracne was so high in 1964
14 that the rabbits tested by the rabbit ear test
15 died?

16 MR. WAGNER: I object to the form of the
17 question, vague.

18 A Yes.

19 Q Now, prior to your being given the industrial
20 hygiene assignment for the 199 building, among the
21 other responsibilities that you told us you had in
22 connection with the outbreak of chloracne, can you
23 describe for us what the worker safety routine was

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1 in the plant at the time before you made your
2 recommendations?

3 MR. WAGNER: I object to the form of the
4 question, vague.

5 A Only in general terms and with no certainty
6 because that's been a long time. It would be
7 basically skin protection and the use of gloves
8 when working in areas that may be contaminated,
9 plus personal hygiene instructions on washing
10 thoroughly after any action.

11 Q So gloves were used and then washing. What type
12 of gloves were used, do you recall?

13 A I have no idea.

14 Q Any other safety measures that were in use before
15 you made your recommendations?

16 A I don't remember.

17 Q Were there any type of barriers in the plant 199
18 and the manufacture of TCP? When I say barrier, I
19 mean was it done behind walls or anything like
20 that to protect the workers, or was it an open
21 manufacturing process?

22 MR. WAGNER: I object to the form,
23 vague, over broad.

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1 A It was basically a closed process within vessels
2 and piping and such.

3 Q And were there joints in the pipes, or were there
4 places in which the chemical came out, or was it
5 all enclosed in piping and vessels?

6 MR. WAGNER: I object to the form of the
7 question, compound, vague.

8 A I'm not really sure what the question is, here.
9 It was basically closed. There were exits for
10 product and waste streams, and there were joints
11 within the piping, yeah.

12 Q Prior to your prescribing additional measures, did
13 the workers wear any type of protective clothing
14 other than the gloves, other than the normal
15 clothing they might wear?

16 A I honestly don't remember.

17 Q What type of recommendations did you make as far
18 as the worker safety and improving the protection
19 for the workers from the potential for exposure to
20 TCDD?

21 MR. WAGNER: I object, over broad, time
22 frame.

23 A At the time I was safety officer, I required full

2196

D-2293

1 company-supplied clothing from the skin out,
2 required shower time, at least twice a day for
3 lunch break and at the end of the shift, and then
4 respiratory protection at any time there was a
5 risk of airborne material.

6 Q What type of respiratory protection, do you
7 recall?

8 A Two basic forms, depending on the nature of the
9 action the guy was going to take, the cartridge
10 type or air purifying, and in some instances, most
11 of the time it was air supplied self-contained
12 breathing apparatus or air-line respirator.

13 Q What type of company-supplied clothing did you
14 prescribe?

15 A Underwear, shoes, coveralls, gloves.

16 Q The coveralls, were they made from any particular
17 material, if you recall?

18 A Nothing out of the ordinary, no.

19 Q Cotton, if you know?

20 A I don't know.

21 Q Any boots?

22 A Yes, as a matter of fact, I left out that we used
23 a lot of disposal coveralls over the work clothes.

2197

D-2294

1 By disposal, I mean use once and throw away, and
2 that included boots that covered their work shoes.

3 Q Did you put the safety recommendations into the
4 form of writing?

5 A I believe so.

6 Q Who was in charge of follow up to make sure that
7 there was compliance with the safety requirements
8 that you outlined?

9 A I was.

10 Q And would you do this by physical observation at
11 the plant, primarily?

12 MR. WAGNER: I object to the form of the
13 question.

14 A I basically lived at the plant, yes.

15 Q Were the workers provided with double lockers?

16 A To my recollection, yes.

17 Q What was the purpose of that?

18 MR. WAGNER: Did you say double lockers?

19 MR. SCHULER: Right.

20 A The purpose was to separate contaminated work
21 clothes from street clothes.

22 Q Were there any special instructions for washing
23 the contaminated clothing or getting rid of it,

1 one way or the other?

2 A Yes.

3 Q What were the instructions for that?

4 A To the best of my recollection, we instructed
5 Dow's own laundry, which did the work clothes, in
6 special handling to avoid contact with the
7 contaminated clothing they were laundering. As
8 far as the waste disposal, there was an operating
9 waste disposal department, and I do not recollect
10 -- I do not recall any specific interaction with
11 them, to be honest with you.

12 Q I think you said you recommended two showers a
13 day, is that correct?

14 A During a period of time, yes, I did.

15 Q What period of time?

16 A When I was full-time safety officer in the plant.

17 Q And how would that work, it would be a shower on
18 the way in and a shower on the way out, or how
19 would it work?

20 A No. A shower before the lunch break and then a
21 shower at the end of the shift.

22 Q Were there any special instructions for the
23 showering, other than the normal shower with soap

2199

D. 2296

1 and water?

2 A Not that I recall.

3 Q Was the shower and wash time, I think you
4 mentioned this earlier, was that paid time for the
5 employees?

6 A Yes.

7 Q Now, while you were health officer at the
8 particular plant, were there daily safety
9 meetings?

10 A I do not remember specifically.

11 Q How long did you actually serve as health officer
12 for the particular plant, 199?

13 A It was a matter of months, six or seven months, I
14 would guess.

15 Q Then after you stopped serving as health officer
16 for the particular plant, what was your next
17 responsibility, if you recall?

18 A No, I don't, to be honest with you.

19 Q The trichlorophenol that was being manufactured,
20 was that used in the manufacture of 2,4,5-T or
21 Silvex, if you know?

22 A Yes.

23 Q Did you ever serve as health officer for any of

2200

D-2297

1 the plants where the final product was made?

2 MR. WAGNER: Silvex or 2,4,5-T?

3 MR. SCHULER: Yes.

4 A No.

5 Q Are you familiar enough with the chemical process
6 to know or describe for me physically how it was
7 done? In other words, was the trichlorophenol
8 taken in some vat to another building where the
9 2,4,5-T or Silvex was made?

10 MR. WAGNER: I object to the form of the
11 question.

12 A My recollection is it was transported in rail car
13 tanker.

14 Q To another building?

15 A Yes.

16 Q Did you ever witness the final manufacturing
17 process where the trichlorophenol and other
18 elements were combined to make the 2,4,5-T or the
19 Silvex?

20 MR. WAGNER: I object to the form of the
21 question.

22 A I don't remember, to be honest with you. I've got
23 to quit saying that.

1 Q Now, at the time that you first got involved with
2 this process, and the trichlorophenol process and
3 the chloracne outbreak in building 199 in 1964, do
4 you recall what the measurement was for the amount
5 of TCDD in the caustic insoluble oil?

6 A At the time I initially became involved, we didn't
7 know what was in the caustic insoluble oil.

8 Q Do you recall initially -- now, I'm talking about
9 initially when you first got involved -- what the
10 measurement was for the TCDD and the
11 trichlorophenol, the manufactured trichlorophenol?

12 MR. WAGNER: This is not the caustic
13 waste oils, but the TCP, itself?

14 MR. SCHULER: Right.

15 A No.

16 Q At some point were there methods developed for
17 measuring the concentrations of TCDD in the
18 trichlorophenol, for example?

19 A Yes.

20 Q When did that occur, to the best of your
21 recollection?

22 A Early 1965.

23 Q And who developed those methods, if you recall?

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D-2299

1 A The Dow analytical laboratory in Midland.

2 Q Do you remember specifically who was involved in
3 that project?

4 A Harold Gill, G-I-L-L, was the name I recall.

5 Q Is he still around, to your knowledge?

6 A To my knowledge, yes.

7 Q In Midland or elsewhere?

8 A Last I knew it was Midland.

9 Q Is he retired from the company, do you know?

10 A I think so.

11 Q And was the method that he developed the vapor
12 chromatography or gas chromatography method?

13 A Yes.

14 Q And do you recall, back in 1964 or 1965, anything
15 about the measurements that were taken of the
16 finished trichlorophenol as far as the amounts of
17 TCDD that may have been in that particular
18 chemical?

19 A Yes. I'm trying to get a handle on that question.
20 You're asking if I remember any amounts found?

21 Q Yes, if you remember the measurements that were
22 taken, through this gas chromatographic method, of
23 any amounts of TCDD that were in the finished

1 trichlorophenol that was produced back at that
2 time?

3 A Yes, generally undetectable, yeah.

4 Q And when you say undetectable, can you describe
5 that a little more fully for me?

6 A Below the limit of detection of the analytical
7 method at that time.

8 Q And what was the sensitivity, if you know, of the
9 analytical method developed back at that time?

10 A Early on, it was as high as ten parts per million
11 of TCDD.

12 Q And then did that improve, later on, to some
13 lesser amount?

14 A Over a period of time, yes.

15 Q And if you recall, over what period of time did
16 the sensitivity improve and to what level did the
17 sensitivity improve?

18 MR. WAGNER: If you have a recollection.
19 I caution you not to guess because there are
20 people that would have that knowledge, but if you
21 know, please give him the information.

22 A Okay. Over some period of time after the
23 development of the method, it improved in stages

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D-2301

1 to one per million, one-tenth, .01, I think, part
2 per million.

3 Q Do you know whether the final commercial grade
4 product of 2,4,5-T or Silvex was ever tested
5 through the gas chromatographic method to
6 determine the amount of TCDD that may have carried
7 over in the process to the final product?

8 MR. WAGNER: I object as to the breadth.

9 A That's a mouthful. You're asking if I know
10 whether any of the products were tested by the
11 analytical method? Yes.

12 Q And can you tell me, and you can make it specific
13 to point in time, if you would like, what the
14 results were for the testing of the final product?

15 MR. WAGNER: Same objection as to
16 breadth and vagueness.

17 A Generally non-detectable in products.

18 Q At what point in time, if you recall?

19 A Mid sixties.

20 Q And what was the sensitivity level of the
21 detection equipment?

22 A It improved over time.

23 Q Can you tell me what the level was, if you know,

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D-2302

1 at a specific point in time?

2 A It was one part per million at some point in time,
3 yeah.

4 Q Had Dow Chemical determined that there was some
5 safe level of TCDD in its final product that was
6 acceptable to the company?

7 MR. WAGNER: I object to the form,
8 vague, undefined terms, and over broad as to time.

9 A The answer is no.

10 Q Was there ever any manufacture of 2,4,5-T or
11 Silvex that you're aware of, while you were with
12 the company, that was completely devoid of the
13 TCDD contaminant, in other words, a clean product?

14 MR. WAGNER: I object to the form of the
15 question and you cannot detect -- my problem with
16 the form of that is it's impossible to detect the
17 absence of anything in a chemical, so it's
18 unanswerable in its present form.

19 A Give it to me one more time.

20 (The requested material was read by the
21 reporter.)

22 A I have no way of knowing. The answer is I don't
23 know.

2206

D. 2303

1 Q Do you know whether there was testing of the
2 trichlorophenol to determine whether it would
3 carry dioxin, the TCDD dioxin into the final
4 2,4,5-T product?

5 MR. WAGNER: I object to the form of the
6 question, vague.

7 A Yes.

8 Q What was the result of that, what was determined?

9 A Most of the 2,4,5-T contained undetectable amounts
10 of the TCDD.

11 Q Would the same be true for Silvex?

12 A I don't remember.

13 Q What about 2,4-D, was that ever tested, to your
14 knowledge, to determine whether that contained any
15 detectable amounts of TCDD?

16 A I believe it was.

17 Q Do you know what the result of that was at a
18 specific point in time?

19 A No.

20 Q In addition to the manufacturing process, did you
21 also develop lab safety procedures for handling
22 the dioxin TCDD in the laboratory?

23 A Yes.

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D. 2304

1 Q What type of procedures did you institute at what
2 point in time for that?

3 A My recollection is the late sixties I wrote lab
4 safety procedures that basically instructed
5 employees to avoid all contact and to wash
6 thoroughly after any handling, just in case there
7 was contact.

8 Q Were there any other procedures with regard to the
9 wearing of clothing like gloves or boots or
10 coveralls for the lab people?

11 A Yes.

12 Q What specifically do you recall about that?

13 A Gloves.

14 Q Anything else?

15 A Nothing else specifically.

16 Q Were the lab people supposed to wear respirators,
17 also, or wasn't that in the recommendation?

18 A I don't believe it was recommended.

19 MR. WAGNER: Just for your timing
20 purposes, Larry has expressed a desire to go to
21 Max and Irma's, which is across the street, so if
22 you could shoot for a break, about five to 12:00,
23 we'll beat the lunch cRowed.

2208

D. 2305

1 Q Have you had any experience with dioxins other
2 than TCDD that caused chloracne at Dow Chemical
3 Company?

4 MR. WAGNER: I object, no predicate.

5 A Not to my knowledge.

6 Q Do you know whether there were dioxins, other than
7 TCDD, which caused chloracne in the
8 trichlorophenol back in 1964?

9 MR. WAGNER: I object, no predicate.

10 A Not to my knowledge.

11 Q What about other compounds, such as furans, that
12 caused chloracne, in the trichlorophenol back in
13 1964? Are you familiar with whether or not there
14 were any of those in the trichlorophenol?

15 MR. WAGNER: Same objection.

16 A Not to my knowledge.

17 Q Do you know, in the finished product of 2,4,5-T or
18 Silvex, whether those finished products, in your
19 experience, were tested for either furans or other
20 dioxins that were chloracnegenic in the sixties?

21 MR. WAGNER: Same objection.

22 A Not to my knowledge.

23 Q What about in the seventies?

1 A I don't know.

2 Q Do you know who has that information or knowledge?

3 A No, I don't, to be honest with you.

4 Q Was one of the concerns back in the sixties that
5 TCDD might be a problem for customers using the
6 end product Silvex or 2,4,5-T?

7 MR. WAGNER: I object to the form of the
8 question, over broad as to time, vague as to whom
9 he's making reference.

10 A Yes.

11 Q What specifically was the concern regarding the
12 customers using Silvex or 2,4,5-T end products?

13 MR. WAGNER: Same objection.

14 A The concern, as I recall it, was that customers
15 would not be as careful in protecting employees as
16 was Dow Chemical, less controlled conditions for
17 the employees, in other words.

18 Q After the 1964 chloracne outbreak in the
19 trichlorophenol plant, there was a meeting, I
20 believe, that was called by Dow Chemical and some
21 other chemical manufacturers regarding TCDD,
22 correct?

23 MR. WAGNER: I object to the form of the

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D-2307

1 question, and no predicate.

2 A Yes.

3 Q Were any of Dow's customers, in the sense of the
4 chemical companies that Dow sold these products
5 to, Silvex or 2,4,5-T, notified of this problem
6 back in 1964?

7 MR. WAGNER: I object to the form of the
8 question.

9 A The form of your question is -- I think the answer
10 is I don't know.

11 Q Are you aware of any testing that Dow Chemical
12 Company did of any of the end products, 2,4,5-T or
13 Silvex, to determine whether those products were
14 toxic to humans?

15 MR. WAGNER: Contains undefined terms
16 and vague.

17 A I don't know.

18 Q You were not involved in anything like that,
19 correct?

20 A No, I don't believe so.

21 Q You mentioned one part per million contamination
22 level for TCDD. Was that an established level by
23 Dow Chemical Company for Silvex and 2,4,5-T in the

2211

D.2308

1 1960s?

2 MR. WAGNER: I object to the form of the
3 question. It mischaracterizes the prior testimony
4 which was in reference to a detection limit.

5 A Not to my knowledge is the answer.

6 Q As far as the one part per million TCDD in Silvex
7 or 2,4,5-T, was this a detection limit for the
8 equipment back then in the 1960s?

9 A At some time, yeah.

10 Q Was there any testing done to determine whether a
11 contamination level of one part per million of
12 TCDD in Silvex or 2,4,5-T was safe to human
13 beings?

14 MR. WAGNER: I object to the form of the
15 question, undefined terms, not enough there to
16 meaningfully answer.

17 A I do not know.

18 Q Do you know what the detection limit was for TCDD
19 in end product 2,4,5-T or Silvex in 1975?

20 A I do not know.

21 Q Do you know who would know that?

22 A No.

23 Q Do you know what division in the company was

2212

D.2309

1 responsible for determining that?

2 A Probably agricultural products division.

3 Q Do you know who the head of agricultural products
4 was back in 1975?

5 A No, I don't.

6 Q Did you work with anyone in that division,
7 agricultural products, in the 1974-75 time period?

8 A Not that I recall.

9 Q Would the product quality control people, who had
10 tested the final product, be in that division,
11 agricultural products division, is that what
12 you're saying to me?

13 A I believe so.

14 Q Was the agricultural products division located in
15 Midland in 1974-75, the headquarters of it?

16 A I believe so.

17 Q And we're sitting here today in some buildings
18 that have DowElanco on the front of it. Do you
19 know the relationship between DowElanco and Dow
20 Chemical Company?

21 A No is a good answer to that.

22 Q Do you know, at some point in time, was there a
23 division of Dow Chemical that was here in

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D-2310

1 Indianapolis that was renamed DowElanco, if you
2 know?

3 A I really don't know.

4 MR. WAGNER: He really doesn't know.
5 Off the record.

6 (Discussion held off the record.)

7 MR. SCHULER: Let's go back on the
8 record.

9 Q So I'm clear about this, the testing of the final
10 product Silvex and 2,4,5-T for any contaminants
11 back in 1974 and '75, let's say, would have been
12 done someplace in Midland, Michigan, if you know?

13 A I just have to guess, yes. I wasn't involved.

14 MR. WAGNER: Your role is not to guess.

15 THE DEPONENT: Thank you, sir. I got
16 tired of hearing myself say I don't know.

17 Q Was there, again, going back to '74 and '75, but
18 even earlier, if you know, did Dow have a
19 government affairs division?

20 MR. WAGNER: Over broad as to time.

21 A I don't remember.

22 Q Did you know a fellow by the name of Andrew
23 Anderson?

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D.2311

1 A I don't remember.

2 Q Did you know an A.P. Beutel, B-E-U-T-E-L?

3 A I believe so.

4 Q Do you know what Mr. Beutel's role?

5 A My recollection of A.P. Beutel is general manager
6 of the Texas division when I started work at Dow
7 and for many years afterward.

8 Q You mentioned the Texas division earlier. What
9 was the Texas division responsible for, what kind
10 of manufacturing?

11 MR. WAGNER: I object as to breadth,
12 time frame.

13 A Basic industrial chemicals.

14 Q Including agricultural chemicals?

15 A Not to my knowledge.

16 Q If I understand you correctly, you do not know who
17 Andrew Anderson is, correct, you don't recognize
18 the name?

19 A The name is vaguely familiar, but I have no
20 recollection of the gentleman or what he did.

21 Q And Mr. Beutel, you said you remembered for his
22 being the manager of the Texas division at some
23 point in time?

2215

D. 2312

1 A Yes.

2 Q But that's about all you know about him?

3 A That's all I remember about him, yeah.

4 Q Did you know a Dr. Hoerger, H-O-E-R-G-E-R? I'm
5 probably mangling that name, also.

6 A I remember the name, yes.

7 Q Do you know what his role was at Dow Chemical, to
8 your knowledge?

9 A My only recollection of him is as a chemist
10 research scientist.

11 Q Did he have anything to do with 2,4,5-T, Silvex or
12 2,4-D, to your knowledge?

13 A I don't remember him having any involvement.

14 Q Was there a group called the product stewardship
15 group?

16 MR. WAGNER: I object as to the breadth,
17 time frame.

18 A Not in the sixties.

19 Q When did that come about, if you know?

20 A I have no idea.

21 Q Do you recall such a group, or you just don't have
22 any recollection?

23 A I have no recollection.

2216

D.2313

- 1 Q Do you know a Dr. Hinman, H-I-N-M-A-N?
- 2 A Yeah.
- 3 Q Who is Dr. Hinman?
- 4 A For some period of time he was director of the
- 5 biochemical research lab.
- 6 Q Do you know approximately what point in time?
- 7 A No. It would be guessing.
- 8 Q Sixties or seventies, can you be that specific?
- 9 A Late sixties.
- 10 Q Do you know whether he did any research with
- 11 regard to 2,4-D, 2,4,5-T or Silvex?
- 12 A I have no knowledge of that at all.
- 13 Q Was there ever a 2,4-D task force set up within
- 14 Dow Chemical Company, to your knowledge?
- 15 A No.
- 16 Q Did you know a fellow by the name of Chet Otis,
- 17 O-T-I-S?
- 18 A I remember Chet Otis, yes.
- 19 Q And what was his position at the company?
- 20 A I don't know his official position in the company.
- 21 Q Dr. Rowe mentioned in his deposition that at some
- 22 point in the fifties there was a visit from a
- 23 fellow from a German chemical company, by the name

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D. 2314

1 of Oettel, O-E-T-T-E-L. Do you recall meeting
2 with this gentleman?

3 MR. WAGNER: I object to the form of the
4 question.

5 A No.

6 Q Do you know a J.D. Doedens, D-O-E-D-E-N-S?

7 A I remember the name.

8 Q Do you know what his role with the company?

9 A I remember nothing more about him.

10 Q When you were involved with the trichlorophenol
11 process back in 1964 and sought to determine
12 exposure levels, was the process of doing that the
13 taking of the wipe tests and the air samples, is
14 that how you did it?

15 MR. WAGNER: I object to the form of the
16 question.

17 A Yes.

18 Q Were there any other ways that you determined
19 exposure levels other than that?

20 A Observation.

21 Q Physical observation at the plant, itself?

22 A Yes.

23 Q Do you recall any specific recommendations with

1 regard to correcting operating procedures or
2 changing operating procedures as far as the
3 manufacture of trichlorophenol is concerned in '64
4 and '65?

5 MR. WAGNER: I object to the form of the
6 question, as far as operating procedures is
7 undefined and vague.

8 A I can't recall any specifics.

9 Q Who did you primarily deal with in the '64-65 time
10 period in the toxicology department?

11 MR. WAGNER: I object, no predicate.

12 A V.K. Rowe, the director, Dr. Kenneth Olson,
13 toxicologist.

14 Q What about the medical department, who did you
15 deal with primarily there?

16 A Dr. Benjamin Holder.

17 Q And what about in production, who did you deal
18 with primarily there?

19 A That's too broad a question, I'm sorry.

20 Q Specifically with regard to the production of
21 trichlorophenol, who did you deal with?

22 A Ray Holmes, the superintendent, and Al Lueck, the
23 assistant superintendent.

2219

D.2316

1 Q How do you spell his last name?

2 A L-U-E-C-K, I believe.

3 Q Did you deal with anyone specifically that was
4 involved in the production of 2,4,5-T, the end
5 product, or Silvex?

6 A Not that I recall.

7 Q Do you know who would have been involved in
8 working on the process to reduce the content of
9 dioxins in the final product after 1964?

10 MR. WAGNER: I object, no predicate.

11 A No, I really don't.

12 Q Was there a specific file on dioxin at Dow
13 Chemical Company that information was fed into, to
14 your knowledge?

15 MR. WAGNER: I object as to the breadth.

16 A Not to my knowledge.

17 Q Were there specific, to your knowledge, toxicology
18 files on the different chemicals, 2,4-D, Silvex,
19 2,4,5-T?

20 A Yes.

21 Q And where were those kept, if you know?

22 A In the building where toxicology was located,
23 biochemical research department.

1 Q Prior to today, has your deposition been taken in
2 any other cases involving allegations that either
3 2,4-D or Silvex or 2,4,5-T caused physical injury?

4 A Not to my knowledge.

5 Q And when I say any other cases, I'm talking about
6 any other civil cases, other than that one?

7 A Not to my knowledge, is the answer.

8 Q Was your deposition taken at all in the, for lack
9 of a better term, Agent Orange group of cases?

10 MR. WAGNER: I object to the form of the
11 question.

12 A Yes.

13 Q Once or more than once?

14 A I don't remember.

15 Q Do you recall at what point in time it may have
16 been taken? Was it back in the early eighties or
17 late seventies?

18 A Early eighties.

19 Q And do you recall who may have taken your
20 deposition back then?

21 A No, I do not.

22 Q Was it taken in Midland or some other place?

23 A It was taken in Long Island, somewhere.

1 Q Other than that deposition, has your deposition
2 been taken before in context with any claimed
3 allegations of defects in the 2,4-D or 2,4,5-T or
4 Silvex products?

5 MR. WAGNER: I object to the form of the
6 question.

7 A I just do not remember.

8 Q Did you know an F.D. Axe, A-X-E?

9 A Yes.

10 Q Was he an industrial hygienist?

11 A Yes.

12 Q I don't remember him being named in the group that
13 you named earlier, but do you recall when he was
14 with the company?

15 A He's been with the company for a lot of years,
16 mostly in the western division. He spent some
17 time in the industrial hygiene group in Midland.
18 Timing is vague in my memory.

19 Q When you say western division, what are you
20 talking about?

21 A There is a production division at Pittsburg,
22 California, and research lab, also, and Rick was
23 the industrial hygienist out there most of the

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D-2319

1 time he was with Dow Chemical.

2 Q Pittsburg, California, is that right?

3 A Yes, with no H.

4 Q Was that division involved in manufacturing either
5 2,4-D or 2,4,5-T or Silvex, to your knowledge?

6 A Not to my knowledge.

7 Q Did you have any input into labeling of 2,4-D or
8 2,4,5-T or Silvex?

9 A No.

10 Q Do you know who was responsible for that?

11 A No.

12 Q When you would submit your reports regarding
13 contamination of trichlorophenol or the caustic
14 insoluble oil involved in the trichlorophenol
15 process as a by-product, would your reports
16 generally be submitted to the toxicology section,
17 Dr. Rowe and those folks?

18 MR. WAGNER: I object as to the breadth.

19 A Yes.

20 Q Would the reports be submitted to any type of
21 governmental affairs section or anything like that
22 at Dow Chemical?

23 MR. WAGNER: Same objection.

1 A I don't remember.

2 Q Do you know Marguerite Leng, L-E-N-G?

3 A Yes.

4 MR. WAGNER: Did you say Marguerite?

5 Q Marguerite. Who is Marguerite Leng?

6 A She was a scientist. My recollection of her was
7 as a member of the toxicology lab for some period
8 of time. Vague recollection that she spent some
9 time in agricultural research department at Dow in
10 Midland.

11 Q Do you know what her role was with either the
12 toxicology lab or agricultural research?

13 A I really do not remember.

14 Q Did Dow, if you know, have any specific department
15 or division or group of people that were involved
16 with the registration of agricultural pesticides?

17 MR. WAGNER: I object as to the breadth,
18 time period.

19 A I was aware that they did, yeah.

20 Q Did you ever deal with any of those folks
21 yourself?

22 A Not that I remember.

23 Q Do you know who the head of that department was or

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D. 2321

1 anybody in that department?

2 MR. WAGNER: Same objection.

3 A No.

4 Q Do you know whether Marguerite Leng has anything
5 to do with that?

6 A She may have, but I don't know for sure.

7 MR. SCHULER: You want to take a break?
8 It's five to 12:00.

9 MR. WAGNER: Sure.

10 (Recess.)

11 MR. SCHULER: Back on the record.

12 Q Mr. Silverstein, let me ask you initially, as we
13 begin this afternoon, did you review anything
14 before your deposition here today of a documentary
15 nature?

16 MR. WAGNER: That's a yes or a no.

17 A Yes.

18 Q What did you review, sir?

19 MR. WAGNER: To the extent you reviewed
20 things with me, I instruct the witness not to
21 answer. If you reviewed things on your own, feel
22 free to tell him.

23 MR. SCHULER: If you reviewed documents

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1 of the company, I think it's included. Just
2 because you handed them to him --

3 MR. WAGNER: His discussions or
4 preparations with me before this deposition, the
5 substance of that is work product.

6 MR. SCHULER: I'm not asking for
7 discussions. I'm asking if he reviewed documents.

8 MR. WAGNER: It's work product.

9 Q What have you reviewed, sir?

10 MR. WAGNER: I'll instruct you not to
11 answer.

12 MR. SCHULER: All right, we'll be back
13 on that one, I'll guarantee you that.

14 Q Have you reviewed any depositions, sir?

15 A No.

16 Q Have you reviewed any Dow Chemical Company
17 documents?

18 A Yes.

19 Q What have you reviewed that are Dow Chemical
20 Company documents?

21 MR. WAGNER: Same instruction.

22 Q I want to be clear for the purpose of the record,
23 so when we come back at your expense, that I'm not

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D. 2323

1 asking if you have reviewed anything prepared by
2 any attorneys of any shape or form whatsoever.
3 I'm asking you if you reviewed any Dow Chemical
4 Company documents, not prepared by any lawyers?

5 MR. WAGNER: Same instruction.

6 Q Have you reviewed anything else in preparation for
7 your deposition here today, sir?

8 MR. WAGNER: To the extent that you
9 reviewed things with me, I instruct the witness
10 not to answer. If you did things apart from me --

11 A No, I haven't.

12 Q So your testimony here today is that you haven't
13 reviewed any documents that were not handed to you
14 by a lawyer, I guess, is that fair enough?

15 MR. WAGNER: You can answer that.

16 A Yes.

17 Q Let me ask you if you have spoken with anybody
18 other than the attorneys, regarding preparation
19 for your deposition here today?

20 A No.

21 Q Have you ever testified before the Environmental
22 Protection Agency or any of its subcommittees?

23 A No.

1 Q Since leaving Dow in 1979, I believe you said, is
2 that correct?

3 A That's correct.

4 Q Do you maintain, either personally or through your
5 company, any consulting arrangements with Dow?

6 A No, sir.

7 Q When I say Dow, I mean any of its divisions like
8 DowElanco or any subsidiaries or anything of that
9 nature?

10 A No.

11 Q Do you maintain contact, and when I say maintain
12 contact with, either on a professional or personal
13 level, with anyone you worked with at the company,
14 Dow?

15 A Yes.

16 Q Who particularly do you maintain contact with?

17 A Primarily in the industrial hygiene and toxicology
18 areas, a number of folks.

19 Q And give me the names of three or four of those.

20 A Dr. Larry Rampy, Gordon Ingdol.

21 Q Who is Dr. Rampy?

22 A He was, at the time, the director of industrial
23 hygiene, Dow Chemical U.S.A., I believe.

1 Q And during what years did he hold that position?
2 I gather from what you're saying he doesn't hold
3 it anymore?

4 A No. He recently got a new job that I don't know
5 about, but I don't know, '75 to '90 or '91, or
6 '92, somewhere in that range.

7 Q Where is he working now?

8 A He's still at Dow, but I don't know his new
9 position.

10 Q Still in Midland?

11 A As far as I know.

12 Q And Rumpy, R-A-M-P-E?

13 A R-A-M-P-Y.

14 Q What other folks do you still maintain contact
15 with?

16 A Bruce Houhman, manager of industrial hygiene for
17 DowElanco. Greg Socha is radiation safety officer
18 here. They're friends from Midland.

19 Q How do you spell the last name?

20 A S-O-C-H-A.

21 Q Any others?

22 A Patty Houhman, worked for me at Dow Corning when I
23 was manager.

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D.2326

1 Q How do you spell her name?

2 A I think it's officially Patricia, H-O-U-H-M-A-N.

3 Q What was her position when she was working with
4 you?

5 A She was an industrial hygienist at Dow Corning.

6 Q Is she still there?

7 A No.

8 Q Where is she located now?

9 A Physically here in the Indianapolis area.

10 Q Is she with another company?

11 A No.

12 Q Still with Dow?

13 A She doesn't work full time to my knowledge.

14 Q She doesn't work with Dow any longer or part time
15 or --

16 A Last I knew she was part time with Dow Corning,
17 industrial hygiene.

18 Q In 1964, when you were called in to help evaluate
19 the chloracne problem in the trichlorophenol
20 process, and in the course of your involvement
21 with that, did you ever communicate to any
22 governmental agencies the fact that there was a
23 substance in the trichlorophenol process that was

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D. 2327

1 causing chloracne in Dow workers?

2 A No.

3 MR. WAGNER: I object as to the
4 predicate.

5 Q Did you ever communicate that fact to any
6 scientific organizations?

7 MR. WAGNER: I object on the predicate.

8 A Not that I remember.

9 Q Did you ever communicate that fact publicly
10 outside the company in any way?

11 A Not that I remember.

12 Q Do you know if there were any claims by workers,
13 as a result of the 1964 chloracne outbreak,
14 against Dow?

15 A No.

16 Q You don't know one way or the other?

17 A I don't know one way or the other.

18 Q Have you ever testified in any case or proceeding
19 involving any claim by any worker who got
20 chloracne as a result of working at Dow, whether
21 it was 1964 or any other time?

22 A No.

23 Q I asked you earlier if you testified in any civil

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D.2328

1 cases where there were allegations of personal
2 injury from exposure to a Dow product. Have you
3 testified in any cases whatsoever, civil cases,
4 where Dow Chemical Company was a defendant?

5 A No.

6 Q Let me show you some documents that I have here,
7 and most of these, if not all of them, were marked
8 as exhibits to the deposition of Dr. Rowe. This
9 particular one happens to be Deposition Exhibit 10
10 to that deposition, and I'll ask you, first of
11 all, if you can identify that particular document?

12 A To the extent that it is, you know, entitled, and
13 obviously I wrote it, yes, I can identify it.

14 Q What is the document? Just give me a general
15 identification for the purpose of the record.

16 A It is a description of the part played by my
17 department, the biochemical research department,
18 in Dow's chloracne problem.

19 MR. SCHULER: And we'll just go ahead
20 and mark that as Exhibit 1 to this deposition.

21 MR. LUTZ: What exhibit was it to Rowe's
22 deposition?

23 MR. SCHULER: 10.

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D. 2329

1 (Plaintiff's Exhibit 1 was marked for
2 identification.)

3 Q Looking at Plaintiff's Exhibit 1, it's entitled
4 the Chloracne Problem, Biochem's Contribution.
5 Who asked you to prepare this document, do you
6 recall, Mr. Silverstein?

7 A I don't recall specifically.

8 Q At the top, in handwritten letters, it says
9 Mr. Lynn, and then there's some handwriting that
10 says early history of -- early Dow history of, is
11 that your handwriting?

12 A This, I don't think is. I'm pretty sure that
13 isn't, and I know that isn't. That and the date
14 look like my handwriting.

15 Q Do you know whose handwriting this would be at the
16 top that's not yours?

17 A I don't recognize that, no.

18 Q In the first paragraph of Plaintiff's Exhibit 1,
19 you make the comment there's evidence that other
20 compounds, than the one already isolated and
21 identified and studied, are capable of producing
22 trichlorophenol, and I've highlighted those words
23 there. Can you tell me what other compounds you

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D. 2330

1 were referring to?

2 A At that time there was nonspecific analytical
3 evidence that there was a whole series of things
4 in that waste oil, and those are the other
5 compounds I would be referring to.

6 Q But they were not specifically identified at that
7 point in time, is that what you're saying?

8 A At that point in time, this is March 11th, '65.

9 Q I'm looking at page 2 of Plaintiff's Exhibit 1,
10 and the second full paragraph, and I'll show this
11 to you, I only have one copy, but it says, this
12 compound, referring to what appears to be the
13 TCDD, do you see that?

14 A Yes.

15 Q And others, which have been shown to cause
16 chloracne, have also been shown by animal tests
17 and some human experience in other companies to
18 produce liver damage if the exposure is more
19 extensive. Again, do you know what those other
20 compounds are? Can you identify them at this
21 point in time?

22 A They would be the families that I was then aware
23 of that had caused chloracne in humans, such as in

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D-2331

1 the thirties, the chlorinated naphthalenes, and
2 earlier Dow experience, before I came there, with
3 materials they suspected, you know, of being the
4 culprits, the chlorinated furans and that type of
5 thing, yes.

6 Q But you're not referring there to other compounds
7 in the trichlorophenol waste oil?

8 A I don't remember if that was meant to do that or
9 not, to be honest with you.

10 Q You refer in the last sentence to some European
11 experience with chloracne. Can you tell me who
12 you're referring to there?

13 A Well, there were, as I remember, three big
14 companies in Europe that had had accidents in
15 their plant that had caused some employees to have
16 the chloracne and also some liver damage in other,
17 you know, some of their employees. That's about
18 all I remember of it.

19 Q Do you remember the names of the companies?

20 A The one was Boehringer Chemical in Germany. I do
21 not remember the one in the Netherlands, and I
22 don't remember the one in France, either.

23 Q You mention on page 3, and I'll show you this

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D.2332

1 section of Plaintiff's Exhibit 1, that
2 folliculitis in rabbits appears to be produced,
3 regardless of the severity of exposure. Do you
4 see that there?

5 A Yes, this part that you've highlighted?

6 Q Yes.

7 A All right, let me read the whole sentence here.

8 Q Go ahead.

9 A Yes, okay.

10 Q Do you recall where you got that information from?

11 A It had to be from toxicology, our toxicology
12 department.

13 MR. WAGNER: For purposes of the record,
14 if this is ever offered at trial, this document, I
15 want to object to the highlighting of it and would
16 want a clean copy submitted, as opposed --

17 MR. SCHULER: You'll certainly get a
18 clean copy.

19 Q In the next sentence you indicate there's evidence
20 that unknowns, it looks like acnegens, may produce
21 folliculitis in rabbits with a shorter induction
22 period. Can you tell me what you are referring to
23 there?

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D. 2333

1 A I have no idea what that refers to.

2 Q Are you referring to --

3 A I don't recall.

4 Q I didn't mean to cut you off. Are you referring
5 to the contents or contaminants of the
6 trichlorophenol waste oil?

7 A I just don't know whether I was or not.

8 Q I'm looking at the last paragraph on page 3 of
9 Plaintiff's Exhibit 1, where you're talking about,
10 you start off talking about some 1944 research,
11 and I can't make out the last sentence, the word
12 that was inserted there. It says the something
13 product was shown to be inactive by animal tests.
14 Do you know what that says, can you make that out
15 for me?

16 A The handwritten insertion appears to be the word
17 phenate.

18 Q Is that your writing or was that someone else's?

19 A I can't tell. It's too indistinct.

20 Q Can you make out the handwritten scratches that
21 are crossed out at the bottom, or at least tell me
22 if that's your writing?

23 A I can't make out what it says, except for the last

2237
D. 2334

1 word which is obviously experience, and it is not
2 my writing.

3 Q Do you know whose writing it is?

4 A No. I don't recognize that writing.

5 Q You mention at the top of page 4 in Plaintiff's
6 Exhibit 1, that in 1955 a number of German
7 manufacturers of trichlorophenol and at least one
8 French company had human experience with chloracne
9 that caused them to shut down production plants
10 and to study the problem. Are those the same
11 companies you referred to earlier, Boehringer, and
12 you couldn't remember the names of the other two?

13 A I believe so.

14 Q On page 4 of Plaintiff's Exhibit 1, you talk about
15 something that happened in 1957 historically in
16 the 199 and 349 buildings, that there were process
17 samples tested on animals, and the caustic
18 insoluble oil and coil reactor product in 199 were
19 active and that tar from color stills in 349 was
20 also active.

21 Are you referring to rabbit testing
22 there?

23 A Yes.

2238

D. 2335

1 Q And when you say active, are you referring to
2 causing chloracne?

3 A No.

4 Q What are you referring to?

5 A To cause folliculitis in the animal, or the rabbit
6 ear, and there's a technical difference between
7 that and chloracne.

8 Q What is the difference between folliculitis and
9 chloracne?

10 A I'm not a medical person, so I really just as soon
11 not give you an answer, if that's all right.

12 Q If you can't answer it, if you don't feel
13 qualified to answer something, tell me that you
14 don't feel qualified to answer that.

15 A I think that's a good answer, I don't feel
16 qualified.

17 Q You mention in the next sentence, page 4 of
18 Plaintiff's Exhibit 1, that over the years some
19 samples of end products, such as Silvex, and I
20 can't make out the next name, it's handwritten
21 over, can you make out the next one?

22 A Where are we?

23 Q That last highlighted sentence.

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D.2336

1 A Over the years?

2 Q Right.

3 MR. WAGNER: Are you asking what that
4 word is?

5 MR. SCHULER: Yes.

6 A Looks like Ronnel, R-O-N-N-E-L.

7 Q What is Ronnel, do you know?

8 A It's a agricultural product, but I could not give
9 you the chemical components, okay?

10 Q Okay. You mention that Ronnel, Silvex and 2,4,5-T
11 had been tested on animals and in no case was
12 chloracne activity detected in these products.
13 Where did you get that information?

14 A Probably from toxicology.

15 Q At Dow Chemical Company?

16 A Yes.

17 Q In the next sentence you mention in 1962 there was
18 additional testing of samples from the then
19 existing process from the pilot run with a
20 decrease in the caustic concentration, and to
21 follow on the next page, those samples were tested
22 in animals and that certain insoluble oil was
23 found to be active. Are you referring to causing

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D.2337

1 chloracne there or some other problem?

2 A I'm referring to causing folliculitis in the
3 animal tests, specifically.

4 Q The next paragraph, then, in your history you
5 refer to the outbreak that occurred in 1964 of
6 chloracne and that the two samples of the oil that
7 were tested were dramatically different than those
8 tested before. Let me show you that and ask you
9 what you mean by that?

10 MR. WAGNER: I object to the form.

11 A Well, as it says, the samples killed the rabbits
12 in the test, in contrast to earlier tests where
13 the rabbits did not die.

14 Q You're referring to the strength of the
15 contaminant there?

16 MR. WAGNER: I object to the form of the
17 question.

18 A Simply the end result.

19 Q Okay, the fact that the rabbits died?

20 A Yes.

21 Q And you subsequently refer, in the next couple of
22 sentences that I'll show you on page 5 of
23 Plaintiff's Exhibit 1, that the concentration of

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D-2338

1 the caustic insoluble oils had to be diluted from
2 the usual 10 percent to .1 percent concentration
3 before the animals survived, do you see that?

4 A Yes.

5 Q Where did you get that information from?

6 A Toxicology.

7 Q Do you know who was conducting these tests at this
8 time in 1964?

9 A To the best of my knowledge, it was Dr. Kenneth
10 Olson.

11 Q He was a toxicologist with the company at that
12 time?

13 A Yes.

14 Q You mention at the bottom of the first full
15 paragraph on page 5 of Plaintiff's Exhibit 1 that
16 the tests had been repeated periodically, to the
17 extent that over 600 animal tests directly related
18 to the chloracne problem had been run since July,
19 and there's a date that's cut off there. Do you
20 see that last sentence?

21 A Yes, I see it.

22 Q Was that information you got from toxicology,
23 also?

1 A Yes.

2 Q And would that have been Dr. Olson, as well, that
3 was doing that testing?

4 MR. WAGNER: I object, the predicate.

5 Q The circle around the sentence with the insertion
6 of the phrase in that particular sentence, is that
7 something that you did, or did somebody else edit
8 this?

9 A I --

10 MR. WAGNER: I object to the form of the
11 question.

12 A I honestly don't remember.

13 Q There is a reference in the last paragraph to a
14 Mr. Skelly. Was he one of the toxicologists in
15 the analytical lab?

16 A No.

17 Q What was Mr. Skelly?

18 A Analytical chemist.

19 Q And what division or department was he in?

20 A Analytical laboratories.

21 Q Is that part of the biochemical research lab?

22 A No.

23 Q Separate?

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D.2340

1 A Yes, separate.

2 Q You mention in that same sentence that Skelly
3 isolated a number of fractions and among them was
4 the TCDD. Was he the first one in the company to
5 identify that by-product?

6 A May I see the reference?

7 Q Sure.

8 A Your question again, please?

9 Q Was Mr. Skelly the first one at Dow Chemical to
10 isolate the TCDD, to your knowledge?

11 A I don't know the answer.

12 Q Again, there's some editing of the last paragraph.
13 Do you know if that was yours or someone else's?

14 A That doesn't look like my handwriting. I don't
15 know whose it is.

16 Q In the next sentence you refer to two materials
17 that were identical from infrared melting point
18 analysis. Do you know what you're referring to
19 there?

20 A I don't know what that refers to.

21 Q Was Harold Gill in the analytical laboratory also?

22 A Yes.

23 Q Was he the head of it?

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D.2341

1 A Not to my knowledge.

2 Q You mention on page 6 of Plaintiff's Exhibit 1
3 that the vapor phase chromatography, I guess it
4 was called, sensitivity at that time was
5 sensitive, could detect samples -- I guess of the
6 TCDD, down to one part per million by weight, do
7 you see that there?

8 A Yes.

9 Q And there is a subsequent statement that the
10 rabbits are sensitive to the TCDD down to
11 approximately five parts per billion by weight, do
12 you see that next sentence there?

13 A Yes.

14 Q Where did you get that information, from
15 toxicology also?

16 A The part relating to the rabbits from toxicology,
17 and the other from analytical.

18 Q With respect to those two measurements, if the
19 machines were only sensitive to a measurement of
20 one part per million, how could it be detected,
21 and again, if you're not qualified or can't tell
22 me how they arrived at this, but how could you
23 arrive at the conclusion that the rabbits were

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D-2342

1 sensitive down to five parts per billion?

2 THE DEPONENT: Okay to answer?

3 MR. WAGNER: Sure.

4 A Because the analytical samples, process samples
5 had lots of interferences. Starting with pure
6 material we could accurately dilute down to five
7 parts per billion and test on the animals, so
8 that's what what we did.

9 Q So you took the pure and diluted the pure to five
10 parts per billion? You worked up instead of down,
11 if you will?

12 A I don't remember which way we went.

13 Q Who would have done that research, do you know?

14 A Probably toxicology -- well, I know it was.

15 Q Would that have been Dr. Olson again?

16 A To the best of my recollection, yes, Dr. Olson.

17 Q There's a lot of editing that went on on page 6
18 here of Plaintiff's Exhibit 1. Again, do you know
19 whether you did that or that was somebody else?

20 A Just about impossible to tell, but I don't think I
21 did it.

22 Q And you don't know who did, correct?

23 A No. I can't recognize that handwriting.

1 Q Referring to the last highlighted sentence here on
2 page 6 of Plaintiff's Exhibit 1, you make the
3 comment that wipe samples with no detectable TCDD
4 but varying amounts of unknowns have shown more
5 activity on the animals than can be accounted for
6 by the low level of TCDD which may be present.
7 Can you tell me where you got that information?

8 THE DEPONENT: Okay?

9 MR. WAGNER: Okay.

10 A My wipe test samples were tested on the rabbit ear
11 because of its great sensitivity. At the same
12 time we had them analyzed by the analytical lab
13 for the materials they could find on it, and that
14 statement arose because wipe samples that showed
15 very little or no TCDD by analytical analysis did
16 produce an effect on the animals.

17 Q And so, I'm not sure I understood you, in other
18 words, the wipe samples were analyzed chemically
19 and then they were also tested on the rabbits?

20 A Yes.

21 Q And in the chemical analysis, even if there was no
22 TCDD collected, they might still be bio-reactive
23 on the animals, is that what you are saying?

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D.2344

1 A That's correct.

2 Q And the chemical analysis was done with the vapor
3 phase chromatography?

4 A Yes.

5 Q At that time down to a sensitivity of one part per
6 million measurement?

7 MR. WAGNER: I object, no predicate.

8 A To the best of my recollection.

9 Q There's a sentence scratched out at the end that
10 talks about the chlorinated dibenzofurans were
11 tested on animals many years ago and shown to be
12 quite active. Do you recall where that
13 information came from?

14 MR. WAGNER: I object to the form of the
15 question.

16 A Somewhere in the files.

17 Q Toxicology again?

18 A Yes.

19 Q And in the next sentence that was scratched out,
20 it says research was abandoned on these products
21 because of their high acnegenic reactivity. Do
22 you recall what products you were referring to
23 there?

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D. 2345

1 A No, I don't.

2 Q There's a handwritten page 6, is that in your
3 handwriting?

4 A That appears to be my handwriting.

5 Q That highlighted sentence, could you read into the
6 record for me?

7 A Peaks coincided with some unknowns which were seen
8 in wipe samples and process samples. Both the
9 biochem lab and the Germans have reported animal
10 tests with these compounds which showed acnegenic
11 activity.

12 Q What compounds are you referring to there?

13 A Well, let me see, I think it goes back to the
14 impure chlorinated dibenzofurans that I didn't
15 read. I just read the highlighted.

16 THE DEPONENT: Can I take a break?

17 MR. SCHULER: Sure.

18 (Recess.)

19 BY MR. SCHULER:

20 Q Let me show you page 7 of Plaintiff's Exhibit 1,
21 and I'll ask you to read that first highlighted
22 portion there.

23 A The analytical laboratory and the toxicology

1 laboratory are presently conducting a project to
2 determine the analytical and animal test limits of
3 sensitivity for TCBD in various Dow products, I
4 think the word is made, M-A-D-E, from
5 trichlorophenol. This project is aimed at
6 developing a quality control specification for
7 TCBD in consumer products.

8 Q Do you know who was in charge of that project?

9 A No.

10 Q Do you know what standard was ultimately
11 developed?

12 A During the time I was involved, our standard was
13 nothing detectable in the material.

14 Q And I think in one of these other documents we'll
15 get to the various measurements, but in the period
16 of the 1960s, up until 1969, what was the limit of
17 detection, if you know?

18 A I don't remember.

19 Q You have a section here in Plaintiff's Exhibit 1,
20 starting at page 7, that deals with the 199
21 building and talks about an animal test that was
22 done, conducted in 1945, which showed the caustic
23 insoluble oil to be active. Do you know what

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D.2347

1 precautions were recommended back at that time? I
2 know that was before you were with the company,
3 but you referred to precautions.

4 A I don't remember specifically.

5 Q What about 1957, do you know what precautions were
6 recommended at that time?

7 A I do not remember specifics.

8 Q On page 8 of Plaintiff's Exhibit 1, you refer to
9 the Boehringer Sohn Company in Germany asking for
10 information from a Givaudan, G-I-V-A-U-D-A-N,
11 Corporation. Do you know where that company was
12 located and whether or not Dow Chemical had an
13 interest in it?

14 A I have no recollection of that company, Givaudan.

15 Q You mention in the next sentence on page 8 that a
16 letter describing the hazards and precautions for
17 safe handling of 2,4,5-Trichlorophenol was sent to
18 Boehringer with a data sheet from biochem. Did
19 you author that letter?

20 A No.

21 Q Do you know who did?

22 A No.

23 Q It mentions that the letter answered seven

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D.2348

1 specific questions regarding our own plant
2 experience. Do you recall what those questions
3 were?

4 A I do not.

5 Q On page 9 of Plaintiff's Exhibit 1, you refer to a
6 January 1964 first medical report of a case of
7 chloracne, initiated a survey by the environmental
8 research laboratory. Do you know who was involved
9 in doing that survey?

10 A That was my assignment to the plant being referred
11 to there.

12 Q And that was, I forget the fellow's name, who was
13 your boss?

14 A Harold Hoyle.

15 Q Hoyle, okay. And where you refer to the
16 operator's job being studied closely and a report
17 being issued on February 5th, 1964, recommending
18 changes in the procedure and the personal hygiene
19 habits, that was your report?

20 A I presume so.

21 Q You mention a company by the name of Phoenix
22 Sprinkler as the company that came in to change
23 some of the equipment on the 199 building. Was

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D.2349

1 that a company separate from Dow Chemical, a
2 subcontractor?

3 A To my knowledge, yes.

4 Q And you mention that apparently some of their
5 workers developed chloracne in the process of
6 changing some of this equipment. Do you recall
7 how many?

8 A No, I don't.

9 Q Did you ever meet those men that developed
10 chloracne that were employed by Phoenix Sprinkler?

11 A Not to my knowledge.

12 Q How did you find out about that?

13 A I was told by someone.

14 Q At your company, Dow Chemical?

15 A I would guess so, yeah.

16 MR. WAGNER: Don't guess.

17 THE DEPONENT: You are right.

18 MR. LUTZ: Does that mean you are
19 changing your last answer to you don't recall?

20 THE DEPONENT: I'll change my last
21 answer to I don't recall.

22 MR. LUTZ: I had to say something.

23 Q You mention at the top of page 10 of Plaintiff's

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D.2350

1 Exhibit 1 that very stringent safety precautions
2 were instituted at the 199 building. Those were
3 the ones we discussed earlier in your deposition
4 here?

5 A Yes.

6 Q You say these include a full-time health
7 supervisor. Do you recall who that was?

8 A Yes.

9 Q Who?

10 A Myself.

11 Q Was there anyone that followed you in that
12 position?

13 A Yes.

14 Q Who?

15 A I don't recall the name.

16 Q Was that a full-time position after you left it,
17 that was permanently maintained at that building?

18 A No.

19 Q How many followed you, one other person or more,
20 if you remember?

21 A I don't remember.

22 Q The closures that you refer to on page 10 that
23 were put up around parts of the process and that

2254

D. 2351

1 you refer to being put up in November and December
2 of 1964, what type of closures were they, do you
3 recall?

4 A It was basically a very large, metal, rectangular
5 structure around the main process equipment.

6 Q Kind of a wall that was put up around it?

7 A A wall, yeah.

8 Q Was it completely self-contained, did it
9 completely enclose the process equipment, or was
10 it open at some point?

11 A It was a closure, as I stated, enclosing the
12 process, yes.

13 Q Was it completely enclosed, or was it open at the
14 top or one of the sides?

15 A It was open only to let pipes and such things
16 through it, yeah.

17 Q Do you remember what material it was made out of?

18 A No.

19 Q On page 11 there's some comment and criticisms, I
20 guess, of the language here. Do you recall who
21 may have written that?

22 MR. WAGNER: I object to the form of the
23 question.

2255
D. 2352

1 Q Either the insertions up here or the word out
2 here, that says poor?

3 MR. WAGNER: Same objection.

4 A I don't know who critiqued or edited it, no.

5 Q The 349 building that you refer to on page 11 of
6 Plaintiff's Exhibit 1, you talk about contaminated
7 phenate being processed in that building. Is that
8 a chemical which is a component of any of the
9 herbicides 2,4-D, 2,4,5-T or Silvex?

10 MR. WAGNER: Phenate?

11 MR. SCHULER: Phenate.

12 A Can I see the reference?

13 Q The last --

14 A Oh, the one that was poor, uh-huh. I'm really not
15 sure is the answer.

16 Q You refer to a building superintendent at 349 by
17 the name of Clare Bailey. Is that a man or a
18 woman, if you know?

19 A It was a man.

20 Q Is he still employed by Dow?

21 A I don't know.

22 Q You mention at the top of page 12 of Plaintiff's
23 Exhibit 1 that there were objections by workmen to

2256

D.2353

1 working in 349, which caused the adoption of
2 full-scale protective measures in that building in
3 regard to the trichlorophenol process. Were any
4 of those objections in written form, if you
5 recall?

6 A I do not recall.

7 Q Do you remember the names of any people who would
8 have objected, any of the workmen?

9 A I wouldn't know any names of the folks.

10 Q You mention in paragraph two of page 12 of
11 Plaintiff's Exhibit 1 that a health supervisor is
12 now stationed at the 349 building. Do you recall
13 who that was?

14 A No, I don't.

15 Q At the top of page 13 in the first full paragraph
16 you discussed Dowicide 3. Do you know what the
17 components were of that particular chemical?

18 A No, I don't.

19 Q In the 267 building, on page 13 of Plaintiff's
20 Exhibit 1, you mention that that is the building
21 where the trichlorophenol from 349 is processed to
22 2,4,5-T acid and 2,4,5-T esters, and you mention
23 that in 1965, samples taken from that building

2257

D. 2354

1 showed no activity with one exception, and that is
2 the residue from the sodium salt filter press
3 showed slight activity on the rabbit ear. Do you
4 know what activity was shown on the rabbit ear
5 that you're referring to there?

6 A Where the heck are we here?

7 Q Here.

8 A That's not what --

9 Q Right here, I'm sorry.

10 A That's the folliculitis activity.

11 Q You distributed this March 10th, 1965, memorandum
12 that we marked as Plaintiff's Exhibit 1. There is
13 a handwritten statement at the end that says unit
14 index. Can you tell me what that is?

15 MR. WAGNER: I object to the form of the
16 question.

17 A That was an indexing method used in the lab,
18 meaning write out, you know, the key word so that
19 it could be retrieved, presumably.

20 Q For filing purposes?

21 A Filing purposes, strictly.

22 Q Was there computerization of these things back in
23 1965, or was it manual?

2258

D-2355

1 MR. WAGNER: I object to the form of the
2 question.

3 A I don't remember.

4 Q Can you tell me who these people are at the end in
5 the chain of distribution?

6 MR. WAGNER: I object to the form of the
7 question.

8 Q Is that your handwriting, first of all?

9 A I don't think that's my handwriting.

10 Q Can you read the names there that are listed?

11 A Under distribution is Hutchenreuther.

12 Q And where was he located at the time?

13 A He was a manager in the Midland plant at the time.
14 Goergea, same as Hutchenreuther, G-O-E-R-G-E-A;
15 Staehling, S-T-A-E-H-L-I-N-G, another major
16 manager. I can't read -- oh, Amstutz,
17 A-M-S-T-U-T-Z; J. Kelly, parentheses, W, period,
18 disposal; Shannon, ditto marks under disposal, and
19 Leuck, L-U-E-C-K; Bailey, B-A-I-L-E-Y, and
20 Sculati, S-C-U-L-A-T-I.

21 Q It mentions a J. Kelly. It says something
22 disposal. Who is that individual?

23 A I don't remember Mr. Kelly.

1 Q And Mr. Staehling, where is he located?

2 A He was manager in the Midland plant at that time.

3 Q Mr. Leuck?

4 A He was assistant superintendent at 199 building at
5 the time.

6 Q And I think Bailey we have covered. And the last
7 name --

8 A Sculati.

9 Q What was his position?

10 A He was plant superintendent, but I don't remember
11 where.

12 Q At one of the buildings?

13 A Yeah.

14 Q Let me show you this document and ask you if you
15 can identify that?

16 A Yes.

17 Q What is it, first of all?

18 A It is the, a report of a meeting held at the
19 biochemical research laboratory.

20 Q What is the date?

21 A Memo is dated March 29th, 1965.

22 MR. SCHULER: We'll mark that as Exhibit
23 2.

2260
D.2357

1 (Plaintiff's Exhibit 2 was marked for
2 identification.)

3 Q Plaintiff's Exhibit 2 is a report authored by you,
4 Mr. Silverstein?

5 A If you referring to the document we just looked
6 at, yes.

7 Q And what was the purpose of this report,
8 Plaintiff's Exhibit 2?

9 A To document a meeting that was held at the
10 biochemical research laboratory on the date
11 indicated.

12 Q There is some handwriting at the top, it says copy
13 to a Bill something or other, I can't make out the
14 name. Is that your handwriting?

15 A No, it isn't.

16 Q Do you recognize the name, can you make it out?

17 A Yes, Bill Haberstoh.

18 Q Better spell that one.

19 A H-A-B-E-R-S-T-O-H. That appears to be V.K.R.,
20 V.K. Rowe.

21 Q Who is Mr. Haberstoh?

22 A I don't remember.

23 Q You were present at that meeting of the various

1 representatives of the chemical companies,
2 correct?

3 A Yes.

4 Q And you mention in your report that Mr. Rowe
5 referred to evidence for unknown acnegens, and you
6 can take a look at that, if you want. Again, I'll
7 ask you, do you know what he was referring to in
8 the context of that meeting?

9 MR. WAGNER: I object to the form of the
10 question.

11 A The number of other compounds in the caustic
12 insoluble oil.

13 Q Other than the TCDD?

14 A Yes.

15 Q Was the location of this meeting at the
16 biochemical research laboratory, 1701 building, or
17 was it someplace else?

18 A I don't remember which building it was in.

19 Q But it was on the Dow premises?

20 A Yes.

21 Q On page 2 of Plaintiff's Exhibit 2, you mention
22 that Dr. Holder reviewed the medical side of the
23 Dow experience. He was the fellow that you

1 referred to earlier that was head of the medical
2 division?

3 A I didn't say he was head of the medical division.
4 He was the gentleman I dealt with at the medical
5 department, yes.

6 Q Sorry. And you refer to the fact that he said we
7 now have approximately 60 to 70 cases of
8 individuals with chloracne, ranging from two
9 severe cases to some very mild cases that were
10 difficult to diagnose. Are you referring to,
11 there, just the cases from the 199 building?

12 A I couldn't tell you.

13 MR. WAGNER: I object to the form of the
14 question.

15 A I couldn't tell you what Dr. Holder was referring
16 to at the time.

17 Q You mention that he showed slides of the more
18 dramatic cases. Did you have a chance to observe
19 the slides yourself?

20 A Yes.

21 Q Did he put them in a slide projector and put them
22 up on a screen, is that the way he did that?

23 A Yes.

1 Q Do you remember how many slides there are that he
2 showed?

3 A No.

4 Q You mention that he reviewed clinical studies that
5 were being made on these people with emphasis on
6 the liver function tests. Do you recall what he
7 said about the impact of these unknown acnegens
8 and the TCDD on liver functions?

9 A I do not recall what he said.

10 Q You mention that Dr. Holder also discussed or
11 mentioned the incidence of fatigue among the
12 afflicted people. Do you recall what he said
13 about that?

14 A No.

15 Q Do you recall Dr. Holder's discussion of what
16 topical treatments were tried on the
17 chloracnogenic condition of these folks?

18 A I do not.

19 Q You mention a doctor in the first full paragraph,
20 a Dr. Sadek, S-A-D-E-K, showed slides of ears and
21 livers of rabbits that had been exposed to TCDD.
22 Who is Dr. Sadek?

23 A He was, at that time, a veterinary pathologist in

1 the toxicology lab.

2 Q With Dow Chemical Company?

3 A Yes.

4 Q You also made a presentation at that meeting, is
5 that correct?

6 A I don't remember.

7 Q It mentions, here at the bottom of page 2 of
8 Plaintiff's Exhibit 2, that Silverstein described
9 the plant study on washing of contamination of
10 tools and surfaces. Does that refresh your
11 recollection?

12 A Yes.

13 Q And you can look at this to further refresh your
14 recollection, if you would like. It's at the very
15 bottom of page 2 of Plaintiff's Exhibit 2. Was it
16 your experience with contamination that in order
17 to remove it from tools and other objects, that
18 you either had to use the chemicals referenced in
19 that paragraph there or proceed with vigorous
20 scrubbing with soap and water to do that?

21 MR. WAGNER: I object to the form of the
22 question.

23 A I need a rerun of the question because it got a

1 little long.

2 Q Okay. Was it your experience with the
3 contamination of tools and other objects with this
4 foreign material that you either had to use the
5 substances you outlined to remove it or to use
6 soapy water, soap and water with vigorous
7 scrubbing?

8 MR. WAGNER: I object to the form of the
9 question.

10 A Yes.

11 Q Did you feel, and having looked at this now, that
12 washing with water alone would be sufficient to
13 remove the contamination?

14 MR. WAGNER: I object, no predicate.

15 A My recollection is it could be done.

16 Q With water alone?

17 A Mm-hmm -- yes. I'm sorry, you said water alone?

18 Q Yes.

19 A Water, detergents and vigorous scrubbing was
20 required.

21 Q The question, though, is, did you feel that the
22 use of water alone would be insufficient without
23 detergent?

1 A I think I missed a word in there, a key word.

2 Q Did you feel that water alone without detergent
3 would be insufficient?

4 MR. WAGNER: I object to the form of the
5 question.

6 A Yes.

7 Q You mention in the next paragraph on page 3 of
8 Plaintiff's Exhibit 2 that Harold Gill discussed
9 the analysis by vapor phase chromatography, and at
10 that time he referred to a limit of one part per
11 million for trichlorophenol and for 2,4,5-T acid,
12 either acetic or propionic. Is that your
13 recollection of the limit of detection of the
14 machinery at that time?

15 A At the time --

16 MR. WAGNER: I object to the form of the
17 question, since the paragraph refers to two limits
18 of detection.

19 A My recollection at the time, for the sentence
20 highlighted, yeah.

21 Q You mention, at the bottom of page 4 of
22 Plaintiff's Exhibit 2, some concern, and we
23 discussed earlier, about as a group, that we could

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1 not afford to sell contaminated products. Was
2 that because of the concern that the customers
3 would not be using the products under the same
4 conditions of health control and hygiene as your
5 workers would be?

6 MR. WAGNER: I object to the form of the
7 question, over broad and vague.

8 A I honestly can't remember that.

9 Q Do you have any independent recollection of the
10 comments of any of the other manufacturers'
11 representatives at this meeting with regard to
12 Dow's disclosure of this contaminant in both
13 trichlorophenol and potentially in its end
14 products?

15 MR. WAGNER: I object to the form of the
16 question.

17 A I have no recollection of any comments by anyone
18 at the meeting at this time.

19 Q Do you have any recollection of what the reaction
20 of the other manufacturers' representatives were
21 from your observation, standpoint?

22 A I don't remember.

23 Q At this point in time, I'm referring to the date

2268

D.2365

1 of this meeting, which was on March 24th, 1965,
2 had Dow developed the technology to attempt to
3 reduce the contamination of TCDD or other
4 chloracnogens in its end products or its
5 trichlorophenol?

6 MR. WAGNER: I object to the form of the
7 question.

8 A I honestly do not recall time frames that well.

9 Q You mention on page 5 of Plaintiff's Exhibit 2
10 that even if the vapor phase chromatography does
11 not detect TCDD, an animal response may still
12 occur. Where did you get that information?

13 A I didn't say that.

14 Q My question is, where did you get that
15 information?

16 A It would have come probably from toxicology. I
17 was just reporting what Jack Peterson said at that
18 point.

19 Q Who is Jack Peterson?

20 A He was an industrial hygienist in the same group
21 in biochemical research with myself at the time.

22 Q Is he still with Dow?

23 A No.

1 Q Do you know where he's located now?

2 A I believe he's in San Diego in retirement.

3 Q You mention in the next to last paragraph on page
4 5 of Plaintiff's Exhibit 2 that some air samples
5 have shown activity on the animals. Were those
6 air samples that you collected?

7 A Yes.

8 Q And were they collected from the 199 building, is
9 that what you're referring to?

10 A I'm not sure, at this point, where they were
11 collected.

12 Q There is a postscript on Plaintiff's Exhibit 2,
13 that's page 6. Is that a postscript from Dr.
14 Rowe, or is that something that you wrote?

15 A The V.K.R. was his standard way of initializing
16 things, so I would interpret that to be from V.K.
17 Rowe.

18 Q The last paragraph on page 6?

19 A Yes.

20 THE DEPONENT: While you are collecting
21 your thoughts, let's take a break.

22 (Recess.)

23 BY MR. SCHULER:

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D. 2367

1 Q Let me show you this document. This doesn't
2 appear to have been one that was marked to Rowe's
3 deposition, either.

4 MR. WAGNER: Before you move on to that
5 document, I've asked Mr. Silverstein about the
6 individual who he recalls having chloracne, and
7 with your agreement that he -- I will let him
8 identify that person without waiving the right to
9 object to others, revealing others' names, with
10 your agreement, if the court approves, that I can
11 still seek to expunge this individual's name from
12 this record so it's not public record if he later
13 agrees with me or the judge later changes his
14 mind.

15 MR. SCHULER: I agree, that, you know,
16 you've objected to it, and the judge has overruled
17 it, and you certainly have the right to appeal or
18 petition for certiori, but I'm not going to
19 stipulate to another objection. The judge ruled
20 on it.

21 MR. WAGNER: I didn't say that. I don't
22 want to, by letting him give you a name, let that
23 serve as a springboard for you saying, well, I've

1 waived it for everybody else; I can't object. I
2 can't go to the 5th D.C.A. I don't want it to be
3 a waiver in any other context.

4 MR. SCHULER: In other words, the fact
5 that he discloses the name will not prevent you
6 from taking the appeal?

7 MR. WAGNER: Correct.

8 MR. SCHULER: I'll agree to that.

9 MR. WAGNER: Go ahead.

10 MR. LUTZ: The mystery guest.

11 Q Let me restate the question.

12 A I wish you would.

13 Q I asked you to identify any of those people that
14 you remembered that had sustained chloracne as a
15 result of exposure to chloracnegens in your
16 experience at Dow Chemical, and you thought for a
17 minute, and I think your answer was you remembered
18 one person, and I'll ask you the name of the
19 person.

20 A I remember only one name, Rose, R-O-S-E.

21 Q A man or a woman?

22 A That's a man.

23 Q Do you remember the first name?

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D. 2369

1 A No, I don't know.

2 Q Still alive?

3 A I have no idea.

4 Q Do you know where Mr. Rose worked, in what part of
5 the company? Did he work in the 199 building?

6 A Only that he worked had 199 building, yeah.

7 Q Do you know what his job function was?

8 A I do not remember it.

9 Q How did it come about that you met him or remember
10 him?

11 A I have no idea.

12 Q Was there something significant about him that was
13 different than the others, that's why you remember
14 him?

15 A Only that I was acquainted with him.

16 Q Was his case of chloracne worse than the others?

17 A I don't remember.

18 Q And this would have been about 1964 that you met
19 him?

20 A Yes.

21 Q You don't have any idea at this point whether he's
22 still with the company or still in Midland or not?

23 A No, I do not.

2273

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1 Q Okay. I handed you a document, and I'll ask you
2 to review that particular document, if you
3 wouldn't mind.

4 A You want me to read the entire thing or --

5 Q Just look at it to familiarize yourself with it.

6 A Okay.

7 Q Do you recognize that as being a document that you
8 authored?

9 A Yes.

10 Q Let's go ahead and -- is there a date on that?

11 A On the last page.

12 Q What is the date?

13 A February 24th, 1976.

14 (Plaintiff's Exhibit 3 was marked for
15 identification.)

16 Q Before I ask you some questions about Plaintiff's
17 Exhibit 3, Mr. Silverstein, do you know anything
18 about the facts of this case, Moyer versus Dow
19 Chemical, et al, case?

20 MR. WAGNER: To the extent you may have
21 been told anything by me, I instruct you not to
22 answer. If you've heard about it from a source
23 other than a lawyer, feel free to give him that.

2274

D.2371

1 A The answer is no.

2 Q So you haven't looked at any depositions of
3 witnesses or parties or experts outside of what
4 the lawyer for Dow Chemical communicated to you,
5 you would have no knowledge of any of the facts of
6 this case?

7 A That is correct.

8 Q Plaintiff's Exhibit 3 appears to be a document
9 that you identified, and it's entitled, quote,
10 Chloracne in the Dow Trichlorophenol plant, close
11 quote, Circa, 1964, correct?

12 A Correct.

13 Q And it's broken down into various sections. It
14 says dictated February 24th, 1976, as you
15 testified earlier. Why was this dictated on
16 February 24th, 1976, do you recall?

17 MR. WAGNER: I object to the form of the
18 question.

19 A Yes, I do recall. It's because I was about to
20 transfer to Dow Badische --

21 Q Which we spelled earlier, I think.

22 A -- in Williamsburg, and wanted that done before I
23 left.

2275

D-2372

1 Q Was this document, Plaintiff's Exhibit 3,
2 requested by someone, or was this done by you for
3 your own summary purposes?

4 A I don't remember.

5 Q Why did you want it done before you left?

6 A It would be strictly conjecture to answer that.

7 Q You have no clear recollection at this point in
8 time, is that correct?

9 A That's correct.

10 Q Do you know what file this was put into upon your
11 leaving?

12 A No, I don't.

13 Q This document appears to have been marked with
14 exhibit numbers from other litigation. Were you
15 ever questioned about this particular document in
16 other cases?

17 A I don't remember specifically.

18 Q There appear to be some edit marks at various
19 points in this document. Do you know whether you
20 edited the document or whether it was edited by
21 someone else?

22 A I don't know.

23 Q Do you know whether this document was used for any

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1 purpose outside of keeping it in your own file
2 within the company?

3 A I do not know.

4 Q Do you know whether this document was used for any
5 purpose outside of the company?

6 A I don't know that.

7 Q On page 5 of Plaintiff's Exhibit 3 you mention
8 that in February of 1964, the plant assistant
9 superintendent and some operators were examined by
10 the medical department and were found to have
11 chloracne. My question to you is, do you recall
12 the name of the assistant plant superintendent
13 that you were referring to there?

14 A Yes.

15 Q Who was that, sir?

16 MR. WAGNER: Same understanding with
17 referring to identifying the person's name?

18 MR. SCHULER: Yes.

19 A I can answer? Al Lueck, L-U-E-C-K.

20 Q And that is the Mr. Lueck who I think appeared on
21 the routing slips for some of the other memoranda?

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

2277

D.2374

- 1 A Yes.
- 2 Q Do you recall whether Mr. Lueck had a severe, mild
3 or moderate case of chloracne?
- 4 A I don't recall that.
- 5 Q Do you know where Mr. Lueck is located now?
- 6 A No.
- 7 Q Do you know if he's still employed with Dow
8 Chemical Company?
- 9 A To my knowledge, yes.
- 10 Q At Midland someplace?
- 11 A As far as I know, that's why I said no earlier.
- 12 Q Do you remember the names of any of the operators,
13 who you referred to on page 5, who reported to the
14 medical department or were examined by the medical
15 department and were found to have chloracne?
- 16 A No.
- 17 Q When you say operators, do you recall how many
18 there were in the plant, or is that just a generic
19 description for the people who worked in the
20 process in the plant?
- 21 A Yes.
- 22 Q The latter?
- 23 A The latter, yeah.

2278

D. 2375

1 Q You mention on page 7 that you, Larry Silverstein,
2 were the first full-time safety officer. Are you
3 referring to in any of the plants or this
4 particular building 199?

5 A Referring to 199.

6 Q Were there other safety officers for other
7 manufacturing buildings?

8 A I do not know.

9 Q You mention on page 8 of Plaintiff's Exhibit 3
10 that thorough safety training indoctrinations for
11 all persons working in that plant were held. Do
12 you recall the frequency of those safety training
13 indoctrinations?

14 A I don't.

15 Q Were those meetings that you conducted?

16 A I don't remember.

17 Q Did you have any assistants that helped you to or
18 that would have conducted meetings like that?

19 MR. WAGNER: I object to the form of the
20 question.

21 A Repeat the question.

22 Q Were there any assistants that would have
23 conducted these safety training indoctrinations

1 for persons working at the plants?

2 A No.

3 Q You mention on page 10 of Plaintiff's Exhibit 3
4 that you were one of the persons who went to
5 Europe, in late 1964, to talk to companies who had
6 experienced a similar problem and claimed to have
7 found answers to it, and you mention the one
8 French company and a German company. Does that
9 help refresh your recollection at all about who
10 the companies may have been?

11 A Well, I think I've mentioned Boehringer in
12 Germany.

13 Q Do you recall the French company or the other --

14 A I think the French is Progil, P-R-O-G-I-L.

15 Q You mention on page 11 of Plaintiff's Exhibit 3
16 that while the caustic insoluble oil in the new
17 process still contains a few parts per million of
18 the known acnegen that caused our trouble in the
19 old plant, it is orders of magnitude less than was
20 found to be in the old plant's CI oil. With
21 regard to that statement, are you referring to the
22 new process as being that process that was
23 purchased, if you will, from the German company

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1 and that was installed at Midland sometime after
2 1964?

3 A Yes.

4 Q And you mention that the contaminant was orders of
5 magnitude less than was found in the old CI oil.
6 Do you recall what the numbers were?

7 A No.

8 Q Now, I'm going to jump over to page 14 of your
9 memorandum we have marked as Plaintiff's Exhibit
10 3, and you mention that your recollection was, at
11 the beginning of the company's quality control
12 guideline, was that the product must contain less
13 than one part per million by weight of TCDD. Does
14 that comport with your recollection today?

15 MR. WAGNER: Object to the form of the
16 question.

17 A Yes.

18 Q And then you go on to say that improvements in the
19 analytical method came about so that this quality
20 control limit was reduced to .05, and now stands,
21 you said, I believe, at .01 parts per million in
22 the final product. Is that the limit or the
23 standard that existed, to your recollection, when

1 you did this memorandum in February of 1976?

2 MR. WAGNER: I object to the form,
3 compound.

4 A To the best of my recollection, yes.

5 Q And when you mention that the standard was .01
6 parts per million in the final product, are you
7 referring to the Silvex and 2,4,5-T?

8 A I do not recall.

9 Q In the next sentence you mention that all of this
10 quality control analysis data for the production
11 from the new plant has been retained by plant
12 supervision and is available if needed or desired.
13 What type of data, as you recall, would be kept by
14 plant supervision?

15 MR. WAGNER: I object to the form of the
16 question.

17 A I honestly couldn't answer that.

18 Q When you refer to plant supervision, what are you
19 referring to?

20 A Plant superintendent.

21 Q For that particular building?

22 A Yes.

23 Q In other words, if I wanted to get -- if I wanted

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D.2379

1 to look at that documentation or data, to the best
2 of your recollection, anyway, back in 1976, that
3 data would have been located in some file at the
4 plant, itself, 199?

5 A Yes.

6 Q You mention in the next paragraph that there was
7 instituted, although not quite so rigid, quality
8 controls by analysis backed up by animal testing
9 for the end product into which the trichlorophenol
10 went, namely the esters, and so there was quality
11 control data available on that, as well. Are you
12 referring there to the end product, to the esters
13 2,4,5-T?

14 A Let me see the statement.

15 Q Sure.

16 A It would refer to the esters specifically, as I
17 read it.

18 Q The esters of 2,4,5-T?

19 A If you're -- if you're using 2,4,5-T to denote the
20 trichlorophenol, yes.

21 Q What I'm referring to is the end product --

22 A Yeah.

23 Q -- that the trichlorophenol was a component of?

2283

D-2380

1 A Mm-hmm.

2 Q The esters of 2,4,5-T?

3 MR. WAGNER: Object to the form of the
4 question.

5 A Yes.

6 Q What about the amine form, do you know if there
7 was information, the same information in the amine
8 form?

9 A By amine, do you mean A-M-I-N-E --

10 Q Yes, of --

11 A -- meaning the amine?

12 Q Right.

13 A I do not know.

14 Q You mention, on page 15, that you prepared a
15 safety precautions brochure of five or six pages
16 regarding the handling or laboratory handling of
17 the TCDD. Do you know where that would be located
18 within the company?

19 MR. WAGNER: It's the one he provided to
20 the government?

21 MR. SCHULER: Yes.

22 Q Do you know where that would be in the company?

23 A No, I don't.

1 Q Going back to page 13, you mentioned that there
2 was also developed a list of known
3 acnegen-producing materials by the company. Do
4 you know where that would be kept?

5 MR. WAGNER: Object to the form.

6 A No.

7 Q There's an insertion here, regarding human
8 testing, after page 13, is that in your
9 handwriting?

10 A Unfortunately it appears to be, yes.

11 Q That human testing that you're referring to, does
12 that refer to the testing that was done on jail
13 inmates, I think it was the Harrisburg prison?

14 A I don't know at what prison, but it says the
15 consulting dermatologist, yes.

16 Q Do you recall the name of the doctor who did that?

17 A Kligman.

18 Q So you're referring to the Kligman testing here on
19 page, the handwritten page 13?

20 A Yes.

21 Q There's a graph here that deals with response of
22 rabbits and humans to TCDD. Is that something you
23 prepared, or was that prepared somewhere else?

2285

D. 2382

1 A I prepared this originally, yes.

2 Q And where did you get the information to prepare
3 this from?

4 A The human data came from Kligman's report. The
5 animal data came from Dow toxicology.

6 Q Back in 1976, when you prepared this report, was
7 it your understanding that the Kligman work was a
8 valid scientific experiment?

9 MR. WAGNER: Object to the form of the
10 question; undefined terms, vague and over broad.

11 A At the time it was considered, I believe, to be
12 valid information.

13 Q And would you have gotten the information
14 regarding the Kligman prisoner experiments from
15 the toxicology department?

16 A Yes.

17 Q To your knowledge, were any follow-up studies done
18 of those Dow workers that were exposed to TCDD in
19 1964 and who showed evidence of chloracne?

20 A Yes.

21 Q Can you tell me who conducted those follow-up
22 studies?

23 A Epidemiology section of the same laboratory.

2286

D-2383

1 Q Of the toxicology laboratory?

2 A Well, toxicology, epidemiology, industrial hygiene
3 were all in health and environmental research back
4 then.

5 Q Do you recall the name of the individual or
6 individuals who conducted the follow-up studies?

7 A Dr. Ralph Cook, M.D., was the head of
8 epidemiology.

9 Q Was anyone else involved besides Dr. Cook?

10 A Yeah, a number of folks.

11 Q Do you recall any of the other names?

12 A Not for that time period.

13 Q Do you recall for how long the follow-up studies
14 were done?

15 MR. WAGNER: Object to the form of the
16 question.

17 A I don't understand your question. Do I --

18 Q How long were the workers followed after 1964?

19 A I really don't know the answer. There's a
20 publication on it, but I don't remember when it
21 came out.

22 Q Do you remember what decade it came out, the
23 sixties, seventies, eighties?

2287

D-2384

1 A I think it was the seventies, but even that is
2 vague.

3 Q Do you recall the results of the follow-up study?

4 A To my recollection, there was no excess of any
5 disease found, and they were looking especially
6 for cancer and found no statistical significance
7 in terms of the fate of those people who passed
8 on.

9 Q Do you recall whether the study was published in a
10 scientific journal or not?

11 A Yes.

12 Q Do you recall what journal it was published in?

13 A I believe it was the Journal of Occupational
14 Medicine.

15 Q And indirectly I asked you this before, but do you
16 recall what year it may have been published?

17 A I don't remember the year.

18 Q As far as your responsibility is concerned, I take
19 it from what you're telling me that you did not
20 participate in the follow-up study, is that
21 right --

22 A No, that's not --

23 Q -- as an industrial hygienist?

2288

D-2385

1 A No.

2 MR. WAGNER: Object to the form.

3 Q Did you?

4 A Yes.

5 Q What did you do?

6 A I estimated the categories of exposure for the
7 workers being studied.

8 Q Were your results committed to writing?

9 MR. WAGNER: In a form other than the
10 article that was published?

11 MR. SCHULER: Yes.

12 A I don't recall.

13 Q Do you remember what the results were of your
14 estimation of the exposure?

15 A No, sir.

16 Q And I say that, I mean, can you give me a range?

17 A Not a numerical range.

18 Q But that information would be in the article?

19 A In the article, correct, yeah.

20 Q Did you do anything else other than estimate
21 exposures in connection with the follow-up study
22 of the 1964 workers?

23 A Not to my recollection.

2289

D.2386

1 Q To your knowledge, and this was an in-house Dow
2 study, correct?

3 MR. WAGNER: Object to the form of the
4 question. Let me ask a clarifying question. Do
5 you mean all the authors were Dow employees?

6 MR. SCHULER: Correct.

7 MR. WAGNER: Okay.

8 A Yes.

9 Q And there wasn't anybody brought in from the
10 outside, any independent laboratory or scholars or
11 anybody to take part in the study?

12 MR. WAGNER: Object to the form of the
13 question.

14 A No.

15 Q Do you know whether there was anyone in that study
16 that died from cancer?

17 A I don't remember.

18 Q Well, you wouldn't remember then if there was
19 anyone that died from a specific type of cancer,
20 then, I assume?

21 A That's correct, I would not.

22 Q Have you participated in any other epidemiological
23 studies done within the Dow Chemical Company with

1 regard to exposure to TCDD in humans?

2 A Not that I recall.

3 Q Is that the only one that you're aware of, the
4 1964 group?

5 A Yes.

6 Q Do you know whether anyone was included in that
7 study that did not evidence chloracne?

8 MR. WAGNER: I object to the form.

9 A I don't know.

10 Q Let me show you this document, and I'll ask you if
11 you can identify that, and it's been marked as
12 Exhibit Number 17 to the deposition of Row.

13 THE DEPONENT: You guys have the worst
14 copying machines in the world.

15 MR. SCHULER: We got it from Dow
16 originally.

17 MR. WAGNER: It's not all his fault.

18 Q Would you identify that for the record, please?

19 A The document is a memo with a date that is
20 illegible, entitled the Hazard of Monsanto T Acid,
21 by L.G. Silverstein. Is that March 14th? I can't
22 tell.

23 (Plaintiff's Exhibit 4 was marked for

1 identification.)

2 Q This was a memo that you had done regarding some
3 245T acid that Dow had purchased from Monsanto,
4 correct?

5 A That's correct.

6 Q And the material purchased from Monsanto was found
7 to contain TCDD in concentrations averaging about
8 ten parts per million, according to this, correct?

9 MR. WAGNER: Object to the form of the
10 question.

11 A I'd like to see it, here.

12 Q It's the bottom of the first paragraph.

13 A Yes.

14 Q And you were concerned because this product
15 constituted a hazard, is that correct?

16 MR. WAGNER: Object to the form of the
17 question.

18 Q In your opinion?

19 A That's correct.

20 Q And product was sold to Riverdale and Woodbury at
21 some point, correct?

22 A My recollection --

23 MR. WAGNER: Object to the form of the

2292

D.2389

1 question.

2 A -- was that it was proposed to be transferred to
3 some other place, and those two names sound
4 familiar. I do not recall that it happened.

5 Q Well, look at the memorandum and see if the
6 memorandum refreshes your recollection. As a
7 predicate question, Woodbury and Riverdale are
8 what type of companies?

9 A I have no idea.

10 Q Don't you state in page 4 that the product was
11 already sold to those two companies?

12 MR. WAGNER: Object to the form of the
13 question.

14 A No, I don't read it that way, but I see in
15 paragraph two, I'm talking about the requirements
16 if we processed it in 199 and 349, and my
17 recollection is that's what we planned to do with
18 it when we got it, and it says Dow's involvement
19 in shipping this material to Riverdale concerns
20 me. It doesn't say we shipped it. I don't
21 remember it being shipped. I don't know. I just
22 don't know what happened to it.

23 Q Did Dow, in the 1970s, to your knowledge, purchase

2293

D.2390

1 2,4,5-T or 2,4-D from any other manufacturers for
2 resale to chemical suppliers?

3 MR. WAGNER: Object to the form, over
4 broad, vague.

5 A I do not know.

6 Q Who would know about something like that?

7 A I don't know that either.

8 Q Do you know whether there was any follow up from
9 this memorandum, looks like of March -- you're
10 right, it's hard to make out, it looks like March
11 15th, 1965, do you know whether there was any
12 follow up from this memorandum we marked as
13 Plaintiff's Exhibit 4?

14 A My recollection is that the material in question
15 was reprocessed within Dow Chemical until it was
16 non-detectable by analysis, and then it was
17 processed, but that's strictly my recollection at
18 this point.

19 Q Do you know who would have been responsible for
20 the reprocessing?

21 A No.

22 Q Do you recall any complaints from Dow customers
23 from, say, 1964 through 1976, regarding any

2294

D-2391

1 chloracne from any of the 2,4-D or 2,4,5-T or
2 Silvex products sold by Dow?

3 MR. WAGNER: Object to the form of the
4 question.

5 A No.

6 Q If there were some complaints, would you be
7 involved in responding to those?

8 A No.

9 Q Do you know who would be involved in responding to
10 complaints from customers?

11 A No.

12 Q Do you recall any complaints from any Dow
13 customers or end users of 2,4,5-T or 2,4-D or
14 Silvex from 1964 through 1975, regarding it
15 causing -- the causing of cancer in any users of
16 2,4-D, 2,4,5-T or Silvex?

17 MR. WAGNER: Object to the form of the
18 question, vague, over broad as to time, as well.

19 A No.

20 Q And I assume your answer would be the same if
21 there were such complaints, you would not be
22 involved in responding to them, correct?

23 A That's correct.

2295

D. 2392

1 Q Are you being paid for your time in testifying in
2 this case today?

3 A Yes.

4 Q And what's the compensation understanding that you
5 have regarding your time for the preparation or
6 time in deposition here for this case?

7 A My present employer is being paid for my time
8 spent here, and I will receive my normal
9 compensation from him.

10 Q That is Farlow Environmental Engineers, Inc.?

11 A That's correct.

12 Q And what is your understanding of the compensation
13 arrangement to Farlow Environmental Engineers,
14 Inc., for your time involved in the preparation or
15 testimony in this case?

16 A For my services in legal areas, it's \$150 an hour.

17 Q And that's for preparation and deposition time?

18 A Yes.

19 Q And is it your understanding that Dow Chemical
20 Company is paying that amount to Farlow?

21 A My understanding that Dow Elanco will pay Farlow,
22 yes.

23 Q And Dow Elanco is, to the best of your knowledge,

2296

D.2393

1 a division or a part of Dow Chemical Company?

2 MR. WAGNER: Object to the form of the
3 question.

4 A In some way, yes.

5 Q Are you getting any portion of that \$150 directly,
6 or do you get paid a salary as your compensation?

7 A I am paid a salary, yes.

8 Q Do you get any type of credit for that billing?

9 A No.

10 Q In other words, you hire your time out, your
11 employer charges for your time, and you get paid a
12 straight salary?

13 MR. WAGNER: Object to the form of the
14 question.

15 A That's correct.

16 Q And I assume the salary is based to some extent on
17 what you produce?

18 MR. WAGNER: I object.

19 A I didn't understand.

20 Q I assume your salary is based to some extent on
21 what you produce in terms of billing?

22 MR. WAGNER: Same objection.

23 A It's a straight salary, annual compensation, at

2297

D. 2394

1 this point.

2 Q I understand that, but I assume that it's based,
3 to some extent, on what you produce for the
4 company, billing-wise, right?

5 MR. WAGNER: Object to the form of the
6 question.

7 A That is not correct.

8 Q Do you know who J.E. Johnson was at Dow Chemical
9 Company back in 1969?

10 A There was a Julius Johnson who was a vice
11 president for research, I think.

12 Q Let me show you this document that's been marked
13 as Exhibit 24 to the deposition of Row, and I'll
14 ask you if you've ever seen it before?

15 A I have never seen this before, to my knowledge.

16 MR. SCHULER: So we have a record here,
17 let's mark this.

18 (Plaintiff's Exhibit 5 was marked for
19 identification.)

20 Q As part of Plaintiff's Exhibit 5, there's a
21 handwritten memorandum here, appears to be three
22 pages. Do you recognize who may have prepared
23 that?

2298

D.2395

1 MR. WAGNER: Object to the form of the
2 question, calls for speculation.

3 A The answer is no, I don't recognize that.

4 Q And you've never seen that handwritten memorandum
5 before?

6 A That's right, I have not.

7 Q Let me show you this document that's already
8 marked as Exhibit 20 to Row's deposition, and I'll
9 ask you if you've seen that before?

10 A I don't remember if I've ever seen it before.

11 (Plaintiff's Exhibit 6 was marked for
12 identification.)

13 Q In Plaintiff's Exhibit 6 -- before I get into
14 that, Mr. Axe signs this as a member of the safety
15 department, I think you testified earlier, and I
16 mentioned his name, that he was a member of the
17 same department that you were a member of, is that
18 correct?

19 A For a period of time, yes.

20 Q And he was also an industrial hygienist?

21 A Yes.

22 Q He mentions in Plaintiff's Exhibit 6 that there
23 was some reports of chloracne from what's called a

2299

D. 2376

1 Tordon, T-O-R-D-O-N, plant. Are you familiar with
2 the chemical, Tordon?

3 A In a general sense, yes.

4 Q Does Tordon contain 2,4-D?

5 A I don't know.

6 Q Do you know of any of the chemical components of
7 Tordon?

8 A I couldn't name one of them, for you, no, I'm
9 sorry.

10 Q Are you familiar with a product named Kuron?

11 A No, I'm not.

12 Q How about Estron?

13 A A vague familiarity with that term.

14 Q Do you know whether either Kuron or Estron
15 contained 2,4,5-T or Silvex?

16 A I do not know.

17 Q In your assignment in connection with the 199
18 building, did you have occasion to deal with any
19 governmental entities regarding workers' safety in
20 1964, '65 or '66?

21 A No.

22 Q How about later years?

23 A No.

1 Q Did you, yourself, Mr. Silverstein, ever contract
2 a case of chloracne?

3 A No.

4 Q Did you participate at all in the decision by the
5 Dow Chemical Company to withdraw 2,4,5-T or Silvex
6 from the market?

7 A No, sir.

8 Q Were you aware that that decision process was
9 going on at Dow Chemical Company at any point in
10 time?

11 MR. WAGNER: Object to the form of the
12 question.

13 A No.

14 Q Have you participated in any groups or, I'm not
15 talking about just in connection with your
16 employment with the Dow Chemical Company, but even
17 since your employment at 1979, participated in any
18 groups that have studied safety of 2,4-D as a
19 herbicide?

20 A No.

21 Q Do you belong to any professional organizations,
22 you told me what your educational background was,
23 but do you belong to any professional

2301

D.2398

1 organizations or have you in the past belonged to
2 any professional organizations in connection with
3 your employment?

4 A Yes.

5 Q What organizations?

6 A The American Industrial Hygiene Association and
7 the Health Physics Society, and State chapters of
8 the Industrial Hygiene Association.

9 Q Have you held any positions with those
10 organizations at one time or another?

11 A Yes.

12 Q What type of positions have you held?

13 A Well, I was a member of, chairman of the
14 Laboratory Accreditation Committee for the
15 Industrial Hygiene Association.

16 Q How long ago was that?

17 A 15 years ago. Let's see, I can tell you, 1975,
18 '76, '77.

19 Q Any other positions?

20 A I was president of the now defunct Northeast
21 Michigan section of the American Industrial
22 Hygiene Association. That's it, I believe.

23 Q Do you have a curriculum vitae that you maintain,

2302

D.2399

1 listing your educational background and various
2 organizations that you belong to?

3 A Yes.

4 Q Do you have a copy of that with you?

5 MR. WAGNER: I haven't seen it. I'll be
6 happy to get one for you.

7 MR. SCHULER: I think I asked for that
8 to be produced. If I don't have it, I can't ask
9 any questions about it.

10 MR. WAGNER: I didn't recall that,
11 frankly, but you may have. Have you got one here?

12 THE DEPONENT: All right, if we're going
13 into this, I need to take a break.

14 MR. SCHULER: That's fine.

15 (Recess.)

16 MR. SCHULER: Okay, let's go back on the
17 record.

18 Q Let me show you this document that you handed me,
19 Mr. Silverstein. If that wasn't intended to go
20 with it, you can take it off, if you want.

21 A You want the document?

22 Q I'm asking you to identify it for the record.

23 A I'm sorry, I see -- I didn't realize we were going

1 on the record. This is a letter describing the
2 industrial hygiene services offered by Farlow
3 Environmental Engineers, Incorporated.

4 (Plaintiff's Exhibit 7 was marked for
5 identification.)

6 Q And this document here, if you would identify
7 that, please, sir.

8 A This is my resume', that of Lawrence G.
9 Silverstein, most recent copy, to my knowledge.

10 (Plaintiff's Exhibit 8 was marked for
11 identification.)

12 Q Looking at your resume' that we have had marked as
13 Plaintiff's Exhibit 8, you make the statement in
14 here that you have routinely worked with attorneys
15 on cases involving real or perceived injuries
16 related to exposure to hazardous materials in the
17 workplace. And my question to you is what kind of
18 numbers are we talking about here where you work
19 routinely with attorneys for real or perceived
20 injuries related to exposure to hazardous
21 materials?

22 A My draft of the document you are holding said
23 occasionally, or words to that effect, that

2304

D-2401

1 routinely is a word substituted by my present
2 supervisor, when he revised my resume'. I have
3 done it occasionally, is more accurate.

4 Q Tell me about your occasional experience, then, at
5 working with attorneys in personal injury, toxic
6 tort cases?

7 A It's been --

8 MR. WAGNER: Let me see it for a second,
9 excuse me.

10 Now, the question said the word toxic
11 tort, and I object to the form. The resume'
12 doesn't say that.

13 A I was going to say --

14 MR. WAGNER: Listen to the question, and
15 I object to the form of the question. It's
16 undefined as to what toxic tort is.

17 Q How long have you been a gun for hire, that's what
18 I'm asking?

19 MR. WAGNER: I object to the form. You
20 don't have to answer that one.

21 Q How long have you been working with attorneys in
22 cases involving injuries from exposure to
23 hazardous substances, as you so eloquently worded

2305

D.2402

1 it here?

2 MR. WAGNER: Object to the form of the
3 question.

4 A I'm trying to recall my first such event. I
5 believe it was in the mid-seventies, and the only
6 occasions on which I have worked with attorneys
7 since the mid-seventies were involved with cases
8 having to do with Dow Chemical Company.

9 Q And can you give me some idea of the numbers of
10 cases that you've been involved in since the
11 mid-seventies?

12 A Less than half a dozen.

13 Q And can you tell me what types of chemicals were
14 involved in the half a dozen cases?

15 MR. WAGNER: Object to the form of the
16 question.

17 A In all but one instance it involved the dioxins.

18 Q Can you give me the names of some of the cases?

19 A That, I cannot do. I don't remember.

20 Q Would the bulk of your being involved with
21 attorneys have been on Dow Chemical Company's
22 behalf?

23 MR. WAGNER: Object to the form of the

2306

D-2403

1 question.

2 A Yes.

3 Q I assume an attorney wouldn't hire you to testify
4 against a dioxin manufacturer while you were
5 working for Dow Chemical Company, or maybe I'm
6 wrong. Has that ever happened?

7 MR. WAGNER: Object to the form of the
8 question.

9 A Was there a question?

10 (The requested material was read by the
11 reporter.)

12 MR. WAGNER: Same objection, I object to
13 the form.

14 A I don't know.

15 Q You don't know?

16 A I don't know. You asked, has that ever happened?
17 That's a whole big universe.

18 Q Six cases doesn't sound like an universe to me.
19 What attorneys have you worked with who have hired
20 your services in the past?

21 A Give me the question again, please.

22 (The requested material was read by the
23 reporter.)

2307
D.2404

1 A I'd like to question the wording of the question.
2 You said, hired me. I've never been paid by an
3 attorney, to my knowledge, for anything.

4 Q Well, let me explore that a little bit. You said
5 that you've routinely worked with attorneys on
6 cases involving real or perceived injuries related
7 to exposure to hazardous materials in the
8 workplace, and let me ask you what attorneys
9 you've worked with in that context?

10 MR. WAGNER: Object to the form of the
11 question.

12 A I have worked with attorneys representing the Dow
13 Chemical Company exclusively.

14 Q And I assume in the past that was probably the
15 Rivkin, Radler law firm for the time period you're
16 talking about from the mid-seventies?

17 A I don't know for sure.

18 Q Do you remember the names of any of the lawyers
19 that you worked with?

20 A Yes.

21 Q Who were they, the ones that you remember?

22 A I remember one by the name of Sam Pierce.

23 Q Maybe I can shorten this up by asking you, have

1 you been hired by any lawyers other than lawyers
2 representing Dow Chemical Company to work on this
3 type of case?

4 MR. WAGNER: Object to the form of the
5 question.

6 A No.

7 Q Since you left Dow Chemical Company in 1979, have
8 you or your firm been retained, other than this
9 case, have you or your firm been retained by any
10 other attorneys for Dow Chemical Company other
11 than the attorneys in this case?

12 MR. WAGNER: Object to the form of the
13 question, no predicate.

14 A I don't even understand the question. It was
15 confusing to me.

16 Q Okay. Have you ever testified in trial,
17 Mr. Silverstein, on behalf of Dow Chemical Company
18 in any case?

19 A No.

20 Q In your list of publications, you list or you make
21 the statement you co-authored an epidemiological
22 study on dioxin-exposed workers. Was that the
23 study we referred to earlier of the 1964 workers

1 at Dow Chemical?

2 A Yes.

3 Q And your name is on that study?

4 A Yes.

5 Q Other than the case that we have at hand here, the
6 Moyer case, is your company, Farlow, being paid by
7 DowElanco or Dow Chemical in any other cases,
8 presently?

9 MR. WAGNER: Object to the form of the
10 question.

11 A I don't know.

12 Q No other ones that you're involved in?

13 A None to my knowledge, sir.

14 Q You mention, also, in your resume, here, that you
15 are a senior IH, I assume that's industrial
16 hygienist, for dioxin, and then in Agent Orange
17 investigations. Is that in connection with the
18 1964 incident that we've discussed here, or is
19 that some other position that you held at the
20 company?

21 A The former.

22 Q When you have dioxin here, and then parentheses,
23 agent orange, are you equating the two?

1 A No, sir.

2 Q Why did you put the agent orange in parentheses?

3 A Because to the lay people, agent orange is more
4 familiar than dioxin, presumably.

5 Q When you state manager of industrial hygiene
6 research and AIHA accredited laboratory, what does
7 the AIHA mean?

8 A American Industrial Hygiene Association.

9 Q Is that the laboratory that you're referring to,
10 was that the laboratory at Dow Chemical?

11 A Yes.

12 Q In connection with your work at Dow Corning
13 Corporation, I think you said you started there in
14 1979, have you testified in any lawsuits?

15 A No.

16 Q Do you consider dioxin to be a hazardous material?

17 MR. WAGNER: Object to the form of the
18 question.

19 A Yes.

20 Q You mention in this letter describing your
21 industrial hygiene services that you were the
22 first manager of industrial hygiene and safety for
23 the Dow Midland plant. Are you referring to that

1 199 building or the combination of buildings
2 there?

3 A It refers to the Midland production division.

4 Q And you mention in the next sentence that this
5 facility was claimed to be the largest chemical
6 production plant at one site at that time. What
7 I'm trying to get at here is, you're referring to
8 the production of all chemicals generically that
9 were done at that location at Midland, or specific
10 types of chemicals?

11 MR. WAGNER: Object to the form of the
12 question.

13 A I don't understand your question, but --

14 Q Let me make it clearer, then. I'm trying to get
15 at, were you the safety officer for the overall
16 production facilities for Dow?

17 A Yes.

18 Q Okay.

19 A In Midland.

20 Q And that encompassed, I assume, the production of
21 many different types of chemicals?

22 A Yes.

23 Q Not just trichlorophenol or 2,4,5-T or Silvex or

1 2,4-D, but other chemicals, as well?

2 A Yes.

3 Q How many chemicals, do you know, did you ever get
4 a count?

5 A I have no idea.

6 Q In the hundreds?

7 A Easily.

8 Q Did you ever have any input into the writing of
9 any standards through OSHA or NIOSH, for example,
10 for dioxin or any related materials?

11 A I didn't understand your question. I missed a key
12 word someplace.

13 Q Let me repeat it. Did you ever have any input
14 into the writing of any OSHA or NIOSH standards
15 for dioxin or related materials?

16 A No.

17 Q Now, I've asked for some additional documentation,
18 here in the notice of deposition, that had to do
19 with documents that you produced or were produced
20 at your direction in the course of your employment
21 with Dow Chemical Company that pertain to
22 research, analysis, formulation, study or
23 production of 2,4-D, 2,4,5-T, Silvex or any

1 product containing those chemicals. Do we have
2 any of those documents here today?

3 MR. WAGNER: He didn't have any, no.

4 MR. LUTZ: Not today, or he didn't have
5 any period?

6 MR. WAGNER: He didn't have any
7 documents responsive to the subpoena.

8 MR. SCHULER: You're not saying Dow
9 doesn't have the documents; you're saying he
10 doesn't have the documents?

11 MR. WAGNER: That's correct, it was a
12 subpoena to him.

13 Q You don't maintain any documents, is that correct,
14 Mr. Silverstein, you don't have any copies of
15 documents you generated at Dow Chemical Company?

16 A That's correct, I do not have copies.

17 Q You don't keep any files at home with any of your
18 work product from that, what was it, 20-year
19 employment history?

20 A No, I don't.

21 Q Do you have copies of the article that you
22 published on the epidemiological study?

23 A I believe I do have a copy of that.

1 Q Do you have it with you here today?

2 A No, I don't.

3 Q That would also fit the description of what I have
4 requested here.

5 MR. WAGNER: I didn't know that you had
6 that -- I asked -- I think I've got a copy.

7 THE DEPONENT: Did you ask me if I had a
8 copy of that?

9 MR. WAGNER: Yes.

10 THE DEPONENT: No. I have it at home,
11 but not here.

12 MR. WAGNER: I've got a copy.

13 Q Let me show you, before I read further, let me
14 show you this particular document that your lawyer
15 has given to me, and I'll ask you to identify it.

16 A It is a copy of a published article. You want the
17 precise title?

18 Q Yes, please.

19 A Mortality Experience of Employees Exposed to
20 2,3,7,8-Tetrachlorodibenzo-para-dioxin,
21 parentheses, TCDD.

22 (Plaintiff's Exhibit 9 was marked for
23 identification.)

2315

D-2412

1 Q Incidentally, let me just go back, to digress for
2 a minute, with regard to Farlow, how many
3 employees are in Farlow?

4 A About 20.

5 Q And it's located here in Indianapolis?

6 A Yes.

7 Q And in the organization of the company, you
8 mention that you're director-industrial hygiene
9 safety and training. How is the company broken
10 down? Are there other specific sections of the
11 company?

12 A Well, there's an engineering group. That's pretty
13 much the rest of the company, except for
14 administration.

15 Q How many people are in the industrial hygiene
16 safety and training area?

17 A Three total.

18 Q And yourself, and who are the others?

19 A An industrial hygienist and an instructor,
20 training specialist.

21 Q What are the names of the other two people
22 involved?

23 THE DEPONENT: Is this all pertinent?

2316

D.2413

1 MR. SCHULER: Sure.

2 A Linda Jackowiac is the industrial hygienist.
3 Russell Farlow is the training specialist.

4 Q Do you hold any officialship in the company,
5 president or vice president, treasurer, anything
6 like that?

7 A No.

8 Q Do you have any stock in the company?

9 A No.

10 Q Looking at this article we have marked as
11 Plaintiff's Exhibit 9, the mortality study done on
12 the 61 workers involved in the 1964 chloracne
13 incident, it's mentioned in the head note to the
14 article that there were three deaths attributed to
15 cancer out of the group, with 1.6 expected. Can
16 you tell me, and you can look at this --

17 MR. WAGNER: What kind? It says what
18 kind at the very end.

19 MR. SCHULER: That's what I'm looking
20 for.

21 Q I know you told me earlier, but usually it tells
22 you what the journal is at the top. I don't see
23 that on this. Can you tell me again what journal

2317

D.2414

1 this was published in?

2 A I believe it was the Journal of Occupational
3 Medicine.

4 Q Can you tell me the year of publication
5 approximately?

6 A Somewhere in the seventies, I think.

7 Q Is there continued follow up of this group, if you
8 know?

9 A I do not know.

10 Q But you haven't participated in it, if there has
11 been?

12 A I have not participated, correct.

13 Q You mention that you were involved in calculating
14 the exposures, and I'm trying to read an obviously
15 very technical --

16 MR. WAGNER: I think he said
17 characterizing, not calculating.

18 Q Okay, let me ask you to -- it looks like a table
19 that you may have done. Let me ask you to just
20 take a look at that and tell me how you
21 characterize the exposure.

22 A You're referring to this table?

23 Q Well, whatever you need to refer to answer the

2318

D.2415

1 question.

2 A From memory, I characterized the exposure based on
3 my familiarity with the plant environment,
4 physical layout and that type of thing, plus the
5 data in terms of wipe tests and air samples taken
6 through the event. And with all that information,
7 I could -- I did the best I could in judging high
8 versus low exposure, in essence.

9 Q Did you quantify it all or just put it in
10 categories, high, low?

11 A Not quantified, no.

12 Q So based on what you just said, if I understood
13 you correctly, through using the wipe tests and
14 the air sampling, and what was the third thing,
15 observing the workers, also?

16 A Yes.

17 Q You just kind of put them in groups of high or low
18 exposure?

19 A That's correct.

20 Q Other than to the characterization of the
21 exposure, I assume that the other conclusions in
22 the study were those of Dr. Cook, essentially?

23 MR. WAGNER: Object to the form of the

2319

D.2416

1 question.

2 Q Would that be a fair statement?

3 A Yes.

4 Q Is Dr. Cook still with Dow?

5 A No.

6 Q Is he still around, still alive?

7 A Yes.

8 Q Where is he located now, if you know?

9 A Yes.

10 Q Where?

11 A Dow Corning Corporation.

12 Q Also in Midland?

13 A Yes.

14 Q How many hours, if you know, has your company
15 billed for your time so far in this matter?

16 A None.

17 Q How many hours have you accumulated to date in
18 this matter?

19 A I haven't really calculated yet.

20 Q Can you give me an estimate?

21 A Okay, hang on just a minute. 15 maybe.

22 Q Other than this article that's now been produced
23 as Plaintiff's Exhibit 9, do you have any other

2320

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1 documents in your possession, including reports,
2 articles, or transcripts relating to any opinion
3 you have ever formed regarding the cause of soft
4 tissue sarcoma or the toxicology or health effects
5 of exposure to 2,4-D, 2,4,5-T, Silvex, 2,4,5-T or
6 any product or substance containing any of these
7 chemicals?

8 A No. You asked if I have any documents pertaining
9 to all that, right?

10 Q That's correct.

11 A The answer is no, I do not.

12 Q Do you have any documents in your possession
13 relating to any instance since 1981 that you have
14 been employed by a party or his attorney in
15 connection with or related to litigation involving
16 personal injury or the risk of personal injury
17 allegedly cause by exposure to a pesticide,
18 herbicide or other chemical or substance?

19 A Oh, boy, I have, in my files at home, a statement
20 I made. I don't think it was even a deposition.
21 I do not know what case. I do not know for sure
22 if it's involved with your materials or not, but
23 that's the only thing I can remember, and I do not

1 have a copy of that with me. When I say at home,
2 I mean at home in Midland, Michigan, because I
3 didn't move it down here.

4 Q A statement made in connection with litigation?

5 A Yes, but I have no recollection of what case, what
6 materials.

7 Q When you say a statement, are you talking about a
8 deposition or --

9 A I don't even know if it was a deposition, to be
10 honest with you. I believe it was a statement
11 made, and I was asked to review it for accuracy
12 and sign it if I agreed it was accurate.

13 MR. SCHULER: I would ask that that
14 statement be produced, as well, since you have
15 that in your possession.

16 MR. WAGNER: I haven't seen it, so I'll
17 have to get it. I don't know if it's a work
18 product statement or not.

19 A I just have no idea what it relates to, but in the
20 interest of outright honesty, I had to tell you
21 I've got it. I don't know what it is.

22 MR. WAGNER: I'll have to look at it. I
23 need to make a telephone call.

2322

D.2419

1 (Recess.)

2 BY MR. SCHULER:

3 Q Let's go back to where we were. You had mentioned
4 that you had some type of statement or affidavit
5 or something along those lines in your records,
6 Mr. Silverstein, at home?

7 MR. WAGNER: In Midland.

8 Q On some other case?

9 A Yes.

10 Q Do you still have a home there?

11 A Yes.

12 Q And I've requested that be produced. Obviously
13 I'm in a whipsaw here, because I can't ask you any
14 questions about it.

15 MR. WAGNER: In the break I tried to get
16 in touch with a Dow lawyer to find out -- it's the
17 first I heard of the statement, and I tried in the
18 quick break to find out whether or not it is a
19 work product statement or what it is, and I was
20 unsuccessful in tracking down the lawyer I need to
21 talk with.

22 THE DEPONENT: I'm certain it's not a
23 deposition. That, I know.

2323

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1 MR. SCHULER: But, I mean, my position
2 for the record is I'm obviously here, I've
3 requested that certain documents be produced, and
4 if that document fits the subpoena and was not
5 produced, I can't ask any questions about it
6 without seeing it.

7 THE DEPONENT: You do understand it's a
8 copy?

9 MR. SCHULER: I understand. Copies are
10 not an issue here. The issue is the statement,
11 itself. And I reserve the right to question this
12 witness on any items that are not produced that
13 fit the description of the subpoena that he may
14 have.

15 Q Let me go down the remaining documents here. The
16 next request was for all documents relating to
17 every instance since 1981 that you have been
18 employed by a party or his attorney in connection
19 with or related to litigation involving personal
20 injury or the risk of personal injury allegedly
21 caused by exposure to a pesticide, herbicide or
22 other chemical or substance. Other than the
23 document you mentioned, do you have any other

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D.2421

1 documents that would fit that description?

2 A No.

3 Q The next request was for all documents relating to
4 any opinion you have communicated or formed since
5 1981 in connection with any employment or
6 professional services rendered as an expert
7 witness or consultant, including but not limited
8 to deposition transcripts, contracts, reports,
9 trial transcripts, correspondence, or documents
10 summarizing any opinion formed and the grounds for
11 your opinion. Do you have any documents that fit
12 that description?

13 A No, sir.

14 Q Do you have any documents in your possession that
15 you obtained from the defendants in this case or
16 their attorneys, through either this lawsuit or
17 other lawsuits?

18 A No, sir.

19 Q Do you maintain files at home with regard to the
20 cases in which you have consulted attorneys in
21 other lawsuits?

22 A No.

23 Q This statement or affidavit or whatever it is that

2325

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1 you do have, what kind of a file do you keep that
2 in?

3 A Miscellaneous.

4 Q In that miscellaneous file folder, is there any
5 other documents that pertain to litigation
6 concerning Dow Chemical Company or any other
7 company, for that matter?

8 A No.

9 Q Have you ever been retained or testified on behalf
10 of a plaintiff injured as a result of exposure to
11 a chemical or toxic substance?

12 A No.

13 Q In your connection with your employment with Dow
14 Chemical Company and subsequent employment with
15 Dow Corning and your subsequent employment with,
16 as a consultant with Farlow Environmental
17 Engineers, do you have an opinion as to whether or
18 not there is any safe level of exposure to TCDD?

19 MR. WAGNER: Object to the form of the
20 question.

21 A No, I do not.

22 MR. SCHULER: That's all I've got.

23 Thank you.

2326

D.2423

1 MR. LUTZ: No questions.

2 MR. WAGNER: He'll read it.

3 AND FURTHER THE DEPONENT SAYETH NOT

4

5

LAWRENCE G. SILVERSTEIN

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D.2424

1 STATE OF INDIANA)
) ss:
2 COUNTY OF MARION)

3 I, Aprille Rigsbee Lucas, RPR, Notary
4 Public in and for the County of Marion, State of
5 Indiana, do hereby certify that the deponent
6 herein was by me first duly sworn to tell the
7 truth, the whole truth and nothing but the truth,
8 in the aforementioned matter;

9 That the foregoing deposition was taken
10 on behalf of the Plaintiff;

11 That said deposition was taken at the
12 time and place heretofore mentioned between the
13 hours of 8:00 a.m. and 6:00 p.m;

14 That said deposition was taken down in
15 stenograph notes and afterwards reduced to
16 typewriting under my direction and thereafter
17 presented to said witness for signature; that this
18 certificate does not purport to acknowledge or
19 verify the signature hereto of the deponent;

20 I do further certify that I am a
21 disinterested person in this cause of action; that
22 I am not a relative or attorney of any of the
23 parties, or otherwise interested in the event of

2328

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IN WITNESS WHEREOF, I have hereunto set
my hand and affixed my notarial seal this 15th day
of March, 1993.

Aprille Riggsbee Lucas, RPR

My Commission Expires:
September 21, 1996

1 UNITED STATES DISTRICT COURT
2 EASTERN DISTRICT OF ARKANSAS, WESTERN DIVISION
3

4 JERRY KEISTER, et al.,)
5 Plaintiffs,)
6 -vs-)
7 THE DOW CHEMICAL COMPANY,)
8 et al.,)
9 Defendants.)

10
11 DEPOSITION OF LAWRENCE G. SILVERSTEIN
12 Taken by the Plaintiff on the 18th day of July,
13 1990, at Sheraton Fashion Square Hotel, 4960
14 Towne Centre Road, Saginaw, Michigan, at 9:00 a.m.

15 APPEARANCES:

16 For the Plaintiffs: MR. GARY DAVIS
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25

GENERAL REPORTING SERVICE, INC.

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D. 2427

1 UNITED STATES DISTRICT COURT
2 EASTERN DISTRICT OF ARKANSAS, WESTERN DIVISION
3

4 JERRY KEISTER, et al.,
5 Plaintiffs,
6 -vs-
7 THE DOW CHEMICAL COMPANY,
8 et al.,
9 Defendants.

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15 APPEARANCES:

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 10 -oOo-

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LAWRENCE G. SILVERSTEIN

HAVING BEEN CALLED BY THE PLAINTIFF AND SWORN:

EXAMINATION

BY MR. DAVIS:

Q Mr. Silverstein, my name is Gary Davis and I represent a group of workers and their families from Jacksonville, Arkansas, and one of the defendants in this case is Dow Chemical. I'm here to ask you some questions today. Have you been in a deposition before?

A Yes, sir.

MR. PIERCE: Mr. Davis, would you indicate on

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1 the record why we're starting at this time, please?

2 MR. DAVIS: Sure. I apologize to all
3 concerned that someone dropped the ball in our office
4 and we did not have a court reporter show up at the
5 appointed hour and we're starting approximately an hour
6 late.

7 MR. PIERCE: And let me indicate to you that
8 the witness has a hearing problem, he has hearing aids,
9 and if you could please speak up and also the rattling
10 of paper sometimes causes difficulty.

11 MS. JONES: Gary, --

12 MR. DAVIS: Can you hear us?

13 MS. JONES: You guys were cut off there for a
14 minute.

15 MR. DAVIS: I don't understand what's going on
16 here.

17 MS. JONES: I think it has something to do
18 with your speaker because it's cutting in and out.

19 MR. DAVIS: I don't know what to do, LeeAnn,
20 we got a speaker phone here. Can you hear now?

21 MS. JONES: Yes, I can hear you fine now.

22 MR. DAVIS: We'll go on.

23 Q (By Mr. Davis, continuing): Mr. Silverstein, if you
24 are unable to hear me at any point during the
25 deposition please let me know or if you don't

1 understand my question because I haven't phrased it
2 well enough, please let me know about that.

3 A I will.

4 Q Okay. Thanks. Can you state your full name, please?

5 A Lawrence Gordon Silverstein.

6 Q And where do you live?

7 A Midland, Michigan.

8 Q Okay. Can you give me your address, please?

9 A 5409 Mason Street.

10 MS. JONES: Gary, you guys are gone again.

11 (Conference off the record.)

12 Q Mr. Silverstein, you were giving me your address.

13 A 5409 Mason Street in Midland, Michigan 48640.

14 Q Thank you. Are you currently employed?

15 A Yes, sir.

16 Q And who are you employed with?

17 A The Dow Corning Corporation, Midland, Michigan.

18 Q Okay. And how long have you been with Dow Corning?

19 A Ten years, round figures.

20 Q Before you were with the Dow Corning Corporation were
21 you with The Dow Chemical Company?

22 A Yes, sir.

23 Q And where was that?

24 A Primarily Midland, Michigan.

25 Q When did you first start working for Dow Chemical?

GENERAL REPORTING SERVICE, INC.

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1 A September 1st, 1955.

2 Q What was your position at that time?

3 A I was an industrial hygienist.

4 Q In which particular plant did you work?

5 MR. PIERCE: Objection to the form of the
6 question. You go ahead and answer.

7 A Mostly the Midland, Michigan production plant.

8 Q So you started in 1955 in Midland. Can you tell me
9 what the Midland production plant is? Is that the
10 major production facility of The Dow Chemical Company?

11 MR. PIERCE: Objection to the form of the
12 question.

13 A I don't know for sure. I was told it was at that time.

14 MR. DAVIS: Off the record just a second.

15 (Conference off the record.)

16 Q (By Mr. Davis, continuing): The Midland, Michigan
17 plant for Dow Chemical, do you know approximately how
18 many employees it has?

19 A No, I don't. Not at this time.

20 Q How about at the time you were working there?

21 A I don't remember.

22 Q Thousands?

23 MR. PIERCE: Objection to the form of the
24 question. The man answered he doesn't know.

25 Q Was it in the thousands as far as you know?

GENERAL REPORTING SERVICE, INC.

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1 A As far as I know.

2 Q And is Dow's headquarters in Midland, Michigan?

3 A Yes.

4 Q Which particular production units did you have
5 responsibility for when you started in 1955?

6 MR. PIERCE: Objection to the form of the
7 question.

8 A No assignment to a particular plant at that time.

9 Q Okay. When were you first involved in the production
10 units that made trichlorophenol and 2,4,5-T at the Dow
11 plant?

12 MR. PIERCE: Objection to the form. No
13 foundation.

14 A To the best of my recollection, about 1964.

15 Q Okay. You were aware that Dow had been making
16 trichlorophenol all the way back to 1946, weren't you?

17 MR. PIERCE: Objection to the form of the
18 question.

19 Q You may answer.

20 A I became aware of that fact, yes.

21 Q And that Dow was making 2,4,5-T as an herbicide prior
22 to 1964?

23 MR. PIERCE: Objection to the form of the
24 question.

25 A I really couldn't, you know, speak accurately on that.

GENERAL REPORTING SERVICE, INC.

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1 Q Okay. You knew that Dow was making 2,4,5-T before you
2 started working in the production unit that made those
3 products, didn't you?

4 MR. PIERCE: Objection to the form. Asked and
5 answered.

6 A The best of my recollection, yes.

7 Q And that Dow was also making 2,4-D?

8 A Yes.

9 MR. PIERCE: Objection to the form of the
10 question, if that is a question.

11 MR. DAVIS: Let's do one thing for the judge
12 right now which is I think I'm entitled to ask leading
13 questions here. It's a witness who has been an
14 employee of The Dow Chemical Company, now works for Dow
15 Corning. If your objections are to leading then they
16 have no foundation.

17 MR. PIERCE: I am also objecting to the form
18 of the question and that last one in particular was not
19 even a question.

20 Q You're aware that Dow made Agent Orange during the Viet
21 Nam war?

22 A No, sir.

23 MR. PIERCE: Objection to the form.

24 Q You are aware today of that, aren't you?

25 A What I think I know is they made ingredients for it. I

GENERAL REPORTING SERVICE, INC.

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1 never heard the term until long after.

2 Q Dow's 2,4,5-T and Dow's 2,4-D were blended to make
3 Agent Orange as far as you know?

4 MR. PIERCE: Objection to the form of the
5 question. Not only leading, but argumentative. The
6 man has answered as to his knowledge.

7 MR. DAVIS: It's going to be a long day, Stan.

8 MR. PIERCE: It is.

9 Q Let's talk about your involvement with the
10 trichlorophenol plant at the Dow Midland plant. What
11 was the 199 Building?

12 MR. PIERCE: Objection to the form. Want to
13 give us a time frame?

14 Q Do you know what the 199 Building was, Mr. Silverstein?

15 A Yes, sir.

16 Q What was done there?

17 MR. PIERCE: Objection to the form.

18 A I'm sorry. Two major products were made there.

19 Q What were those?

20 A Aniline and trichlorophenol.

21 Q And at the time that you became involved with the 199
22 Building trichlorophenol was being made there, right?

23 A Yes.

24 Q And was this in approximately 1964 when you first
25 became involved in the production of trichlorophenol?

GENERAL REPORTING SERVICE, INC.

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- 1 MR. PIERCE: Objection to the form of the
2 question. The witness has not indicated he was
3 involved in the production of trichlorophenol.
- 4 Q You were involved in the trichlorophenol production
5 unit, is that correct, not that you produced it
6 yourself but that you had some involvement as an
7 industrial hygienist, correct?
- 8 A Yes, sir.
- 9 Q And that began in 1964?
- 10 A To the best of my recollection, yes.
- 11 Q I want to show you a memorandum or a letter and let me
12 just go ahead and have this marked as Exhibit 1.
- 13 (DepX#1 marked.)
- 14 Q What we have is a memorandum from Ray Holmes to Mr. H.
15 R. Hoyle on Dow stationery dated July 30th, 1964, with
16 some writing at the top of it and Mr. Silverstein, if I
17 can ask you if the writing at the top indicates that
18 you were familiar with this memo at the time. You may
19 review it.
- 20 You had this in your possession back in 1964?
- 21 A I don't remember for sure that it was in my possession.
- 22 Q Your name is indicated at the top of this memo, isn't
23 it, in handwriting?
- 24 A It looks like mine.
- 25 MR. PIERCE: Where is that? I'm sorry. Mr.

GENERAL REPORTING SERVICE, INC.

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1 Davis, if you could show me.

2 Q Just so that the record's clear, on Exhibit 1 the
3 handwriting at the top looks to me like it says Larry
4 on the left-hand side. You were known by Larry, were
5 you not?

6 A Yes, sir.

7 Q And then it says: "Alex, please return this to me.
8 Larry S." Is that the way you read this?

9 A Yes, sir.

10 Q And you're Larry S., is that right?

11 MR. PIERCE: Objection to the form.

12 Q You presume that this was yours, is that correct?

13 MR. PIERCE: Why should he presume it's his?
14 He gave you the answer to your question. But go ahead
15 and answer it.

16 MR. DAVIS: He did until you suggested
17 otherwise.

18 A Is there a question?

19 Q The question you have already answered, I was just
20 responding to Mr. Pierce's question about what this
21 said.

22 A Okay.

23 Q In the 199 Building Dow made trichlorophenol by using
24 tetrachlorobenzene, methanol and caustic, is that
25 correct?

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1 MR. PIERCE: I just like to indicate that
2 certainly the witness is not an expert on production
3 but go ahead and answer to the best of your ability.

4 Q That was your understanding of how the process worked,
5 correct?

6 A To my recollection, yes, sir.

7 Q Okay. And you can refresh your memory with Exhibit 1
8 if you care to at any time. Do you recall that in the
9 production of trichlorophenol in this Building 199 that
10 there was a -- an oil material from the trichlorophenol
11 reactor which was called a caustic insoluble oil? Do
12 you recall that?

13 A I remember the term, yes.

14 Q Do you know if it was also called a non-saponifiable
15 fraction?

16 A That doesn't strike a note of familiarity, no.

17 Q What was this oil that -- what was your understanding
18 about how this oil originated from the trichlorophenol
19 production process?

20 MR. PIERCE: His understanding as he sits
21 here?

22 MR. DAVIS: Yes.

23 A It was a waste stream from the process that was my
24 knowledge, my understanding.

25 Q And do you remember what Dow would do with this oil

1 would be to separate it in the 199 Building from the
2 trichlorophenol product and incinerate it?

3 MR. PIERCE: Objection to the form of the
4 question. It's compound, it's leading.

5 Q You recall that, don't you, Mr. Silverstein?

6 A Would you give me the question part of that, please?

7 Q Okay. Dow would take this oil in the 199 Building
8 that was part of the trichlorophenol product and would
9 separate the oil and incinerate it? You recall that,
10 don't you?

11 MR. PIERCE: Continue the objection.

12 A I'm not sure I hear a question. Are you asking me to
13 verify that?

14 Q I'm asking you if that statement is a correct
15 statement?

16 A I don't know for sure.

17 Q Have you reviewed Exhibit 1? Would you disagree with
18 the statement in Exhibit 1 that the oil was separated
19 and incinerated?

20 MR. PIERCE: Wait. Mr. Davis, let's have a
21 clarification. You indicated to the witness before he
22 could use the document to refresh his recollection.
23 Are you now asking him if the document
24 refreshes his recollection or if he's going to argue
25 that the language in the document speaks -- which

1 speaks for itself says otherwise? I mean I don't
2 understand what you are really asking this witness to
3 do.

4 Q If you don't recall you may use Exhibit 1 to refresh
5 your recollection.

6 MR. PIERCE: If it can do that.

7 Q Please --

8 A I didn't read it all because part of it is very
9 difficult to read and I just didn't want to take the
10 time but if you want me to I will read it, okay?

11 Q I appreciate it.

12 A Some of it is still illegible but I have read it.

13 Q All right. Does it refresh your recollection about the
14 caustic insoluble oil fraction from the trichlorophenol
15 process?

16 A Yes, I guess.

17 Q And you now remember that it was incinerated and --
18 separated from the trichlorophenol and incinerated?

19 MR. PIERCE: Objection to the form of the
20 question.

21 A That was my understanding at the time, yes, sir.

22 Q And this memo in Exhibit 1 also talks about a chloracne
23 incident in 1964, is that correct?

24 MR. PIERCE: The document speaks for itself.

25 Q You remember that incident, don't you?

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1 A Yes, sir.

2 Q And you recall that the Dow trichlorophenol plant
3 was pushing production in 1963 and that's what led to
4 the chloracne incident in '64?

5 MR. PIERCE: I believe that the witness has
6 already testified he was not involved in 1963.

7 Q Do you recall from reading this memo, and I can show
8 you some other documents if need be to refresh your
9 recollection?

10 MR. PIERCE: Objection to the form of the
11 question.

12 Q Do you recall that?

13 A I'd like to know what the question is again, you know.

14 Q It's unfortunate but we keep losing the question after
15 all the objections. But we'll try to persevere. You
16 do recall that the chloracne incident in '64 was as a
17 result of Dow pushing production in '63 and some
18 process changes that occurred?

19 MR. PIERCE: Objection to the form of the
20 question.

21 A My recollection is the process changes were believed to
22 have contributed to the thing, yes.

23 Q Okay. And you know that pushing production to the
24 limit had something to do with it as well?

25 MR. PIERCE: Objection. Asked and answered.

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1 A No, I don't know that.

2 Q The chloracne was first noticed in approximately

3 January or February of 1964, do you recall that?

4 MR. PIERCE: Objection to the form.

5 A I read it in the memo. My recollection was it was

6 later than that but that shows how memory goes.

7 MR. DAVIS: Let me go ahead and introduce

8 Exhibit 2. Let's mark this.

9 (DepX#2 marked.)

10 MR. DAVIS: You want to look at it?

11 MR. PIERCE: Sure. Gary, there appear to be

12 two documents clipped together. You want to take a

13 look and make sure? I don't know if that's the way

14 you want it or --

15 MR. DAVIS: Let me just state for the record

16 that what we have is a document, Exhibit 2, which is

17 entitled "The Chloracne Problem, Biochem's

18 Contribution", dated 3-11-65.

19 MR. PIERCE: I just want to point out you

20 seem to have Exhibit 1 attached to it as well.

21 MR. DAVIS: That is correct. I kept that

22 attached since they were in that form when we got the

23 documents and the Dow Bates stamp numbers are

24 consecutive among these. So let me just show this to

25 Mr. Silverstein.

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1 MR. PIERCE: All right. And then there
2 appears to be yet another document after Exhibit 1. Is
3 that in the form that you wish to present it to us?

4 MR. DAVIS: That is correct. That appears to
5 be the form in which this document was copied.

6 Q Mr. Silverstein, have you ever seen Exhibit 2 before?

7 A It looks like something I have seen before, yes, sir.

8 Q You're the author of the first part of Exhibit 2, the
9 document entitled "The Chloracne Problem", is that
10 correct?

11 MR. PIERCE: Objection to the form. I think
12 it's really confusing. But go ahead.

13 Q You're the author of this document?

14 MR. PIERCE: By "this document", what do you
15 mean?

16 MR. DAVIS: I one I just described that says
17 "The Chloracne Problem, Biochem's Contribution", dated
18 3-11 '65.

19 Q You're the author of that, is that correct?

20 MR. PIERCE: Just to clarify, you don't mean
21 the entire exhibit, is that correct?

22 MR. DAVIS: I thought we made that clear.

23 MR. PIERCE: Okay.

24 A It looks like something I remember writing but I can't
25 verify it's accurate because I did not read every word

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1 and I couldn't remember it anyway if I had after 25
2 years.

3 Q I understand it's been a long time. Did you review any
4 documents in preparation for this deposition?

5 A No, sir.

6 Q Okay. Well, I'm going to give you an opportunity to
7 review Exhibit 2 for a few minutes and see if it
8 refreshes your recollection about some things, okay?

9 A I will need a few minutes to read through it because
10 again I did not look at every word.

11 I would like to request a restroom break.

12 MR. DAVIS: Certainly.

13 (DepX#3 through DepX#21 marked.)

14 (Recess)

15 MR. DAVIS: Let's go back on the record.

16 Q (By Mr. Davis, continuing): Mr. Silverstein, I learned
17 how to pronounce your name correctly during the break.
18 I apologize.

19 Have you had an opportunity to review Exhibit 2?

20 A Yes, sir.

21 Q Okay. And you once again were the author of Exhibit 2?

22 MR. PIERCE: Objection to the form. There are
23 three, at least three different documents.

24 Q Let's clarify that now for the record. Let me just
25 have your copy of Exhibit 2. I am going to take what

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1 is attached to Exhibit 2 and I am going to pull it off
2 and can you verify first of all that the first document
3 attached to Exhibit 2 is a copy of what has already
4 been marked as Exhibit 1?

5 A This is versus that?

6 MR. PIERCE: The document speaks for itself.

7 Q Is that the same document as Exhibit 1?

8 A It appears to be.

9 Q Okay.

10 A Without reading word for word.

11 Q That's all I need. Let me mark this as Exhibit 2-A
12 which is another document that was attached to Exhibit
13 2.

14 (DepX#2-A marked.)

15 Q Exhibit 2-A is titled "Chloracne Status Report - July
16 to September, 1964", from A. F. Lueck -- is that how
17 you say it?

18 A Yes, sir.

19 Q L-u-e-c-k. September 28th, 1964. We'll just leave
20 that with you. Right now let me ask you first of all
21 about Exhibit 2. What was biochem that's referred to?

22 A It was the biochemical research laboratory of The Dow
23 Chemical Company.

24 Q Okay. Is that where you worked?

25 A Yes, sir, initially.

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1 Q Okay. And after reviewing Exhibit 2 do you recall that
2 the chloracne that we have talked about that occurred
3 in the 199 Building was mostly due to exposure to the
4 caustic insoluble oils?

5 MR. PIERCE: Objection to the form.

6 A It was the primary source as I recall it, yes.

7 Q Okay. If you can maybe speak up a little bit?

8 A Oh, yes. I'm sorry. I'll try better.

9 Q And --

10 A Or try harder.

11 Q What do you recall about how that chloracne looked in
12 the workers who worked in the plant, in the 199
13 Building?

14 MR. PIERCE: Objection to the form.

15 A Visual appearance?

16 Q Yes.

17 A Blackheads like teen-age acne.

18 Q How many workers suffered from chloracne at that time?

19 MR. PIERCE: Objection to the form.

20 A I don't remember other than what's in the document.
21 Somewhere in the 40 range, I think.

22 Q Okay. Now, Dow had had experience with chloracne
23 before, is that right, before 1964?

24 A I was told that, yes.

25 Q And Dow knew that certain chlorinated organic compounds

1 caused chloracne as early as 1941?

2 MR. PIERCE: Objection to the form.

3 A I know that only from being told or reading, yes.

4 Q And you wrote that in your memo on page 3, is that
5 correct, of Exhibit 2?

6 A Would you restate the question? I lost track of it.

7 Q Okay. The question was Dow knew as early as 1941 that
8 certain chlorinated organic compounds caused chloracne?

9 MR. PIERCE: Are you asking him does he recall
10 that now or --

11 MR. DAVIS: That was my first question and he
12 said he was told that and I said and you wrote that in
13 your memo, particularly concerning the V. K. Rowe paper
14 that's mentioned in here.

15 MR. PIERCE: Objection.

16 A Sorry. Well, that paper as I remember it described a
17 test but I do not recall what compounds were involved
18 in the test to be honest with you, sir.

19 Q Okay. Fair enough. This test that you're referring
20 to was a test that was reported by Adams, Irish,
21 Spencer and Rowe in 1941 which was a test on rabbit
22 ears, is that right?

23 A That is true.

24 Q And describe how that test worked, if you recall?

25 MR. PIERCE: How that test worked in 1941?

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- 1 MR. DAVIS: Or any time that it was used.
- 2 A I'm not a toxicologist but I will describe my
- 3 understanding of the test, okay?
- 4 Q Okay.
- 5 A The test material was applied to the inner ear of a
- 6 rabbit and after a period of time, minimum 7 days as I
- 7 remember being told, the follicles of the ear either
- 8 did or did not appear more prominent than normal. And
- 9 this was an indication of something in the test
- 10 material that could produce the folliculitis on the
- 11 animal's ear and that was the basis or the extent of
- 12 the test actually.
- 13 Q By folliculitis you mean a skin reaction, is that what
- 14 you were looking for?
- 15 A The hair follicles inside the rabbit's ear where the
- 16 material had been placed were affected, yes.
- 17 Q And you also recall, don't you, that a Dow lab
- 18 researcher in 1944 had experienced chloracne and had at
- 19 least tentatively identified the type of compound that
- 20 could cause chloracne?
- 21 MR. PIERCE: Objection to the form of the
- 22 question.
- 23 A I don't remember his having chloracne but apparently he
- 24 did find some materials and I don't know what they
- 25 were, as indicated on page 3.

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1 Q Let me ask you if you have ever seen Exhibit 4 before
2 which we have previously marked.

3 MR. PIERCE: I just like to indicate that the
4 first page is at least to me illegible but --

5 Q Appears to be a -- some sort of handwritten notes from
6 a laboratory and if you can -- if the first page is
7 unreadable please look at the rest?

8 MR. PIERCE: Let me just object to the
9 characterization but please, go ahead and read it.

10 A I have never seen this before, sir.

11 Q Okay. Where did you get the information about the 1944
12 research that's reported on Exhibit 3 of -- I'm sorry,
13 page 3 of Exhibit 2?

14 A From Dow employees at the time who were still active.

15 Q In around 1945 -- 1944 or '45 Dow first tested the
16 caustic insoluble oil portion of the trichlorophenol
17 production on rabbit ears, you recall that?

18 MR. PIERCE: Objection to the form.

19 A I was told that and I was not with Dow at the time.

20 Q Okay. And you've -- strike that.

21 A I can hear you from here, sir, if you want to keep
22 going.

23 A I don't think she can hear your answers.

24 MR. PIERCE: What do you need, this one?

25 MR. DAVIS: Yes.

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1 Q And you recall Dow knowing in 1955 that the Germans had
2 had problems with chloracne in the production of
3 trichlorophenol?

4 MR. PIERCE: Objection to the form of the
5 question.

6 A I don't recall it that early, no.

7 Q You have written that in Exhibit 2, correct, on page 4?

8 A What appears to be my document, I did write it, but I
9 don't recall it.

10 Q And the Germans actually identified the compound as
11 being the compound responsible for chloracne as being
12 the tetrachlorodibenzodioxin, is that correct?

13 MR. PIERCE: Objection to the form and the
14 witness has already testified he has no recall.

15 A What I recall is they proposed that this may be it.
16 They hadn't identified it.

17 Q This was around 1957?

18 A To the best --

19 MR. PIERCE: Objection to the form of the
20 question.

21 Q You may answer.

22 A To the best of my recollection, yes.

23 Q And Dow had been taking precautions in handling those
24 caustic insoluble oils since 1945, is that right?

25 A That's what I was told. Remember, I wasn't there until

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1 '55.

2 Q That's right. Okay. But did you become involved in
3 the trichlorophenol building in 1957 when Dow was
4 looking at the caustic insoluble oils?

5 MR. PIERCE: Objection to the form of the
6 question.

7 A Not to my recollection, no.

8 Q Okay. So did someone tell you that Dow was looking at
9 the caustic insoluble oils for chloracne potential in
10 1957?

11 A Yes. Long after the fact, yes.

12 Q Let me go ahead and ask you to look at what's been
13 marked as Exhibit 5 and let's just -- since you have
14 the document right now, if you'll please read the title
15 of the document first?

16 A "Chloracne in the Dow Trichlorophenol Plant Circa 1964".

17 Q And what's the date of this document?

18 MR. PIERCE: If you know the date.

19 A In the upper right corner, 2-24-76.

20 Q Are you the author of what's been marked as Exhibit 5?

21 A I did dictate a document and it looks like the one,
22 yes. I can't verify every word, of course.

23 Q Why did you dictate Exhibit 5?

24 A Why?

25 Q Yes. What was the purpose of this document?

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1 A I honestly do not recall. I have been trying.

2 Q Okay. Can I ask you the same question about Exhibit 2,
3 do you recall why you wrote it?

4 A The same answer, I do not recall to be honest.

5 Q Once the chloracne outbreak occurred in 1964 in the
6 trichlorophenol building at Dow, Dow determined that
7 the compound likely responsible was
8 tetrachlorodibenzodioxin, correct?

9 MR. PIERCE: Objection to the form of the
10 question.

11 A And the question's a bit vague because there are more
12 than one such material.

13 Q Okay.

14 A And I don't think I know what you're really asking.

15 Q Let's try to be as precise as we can then and maybe we
16 can use a shorthand notation as well. What I'm
17 referring to is the tetrachlorodibenzo-para-dioxin
18 which is often called TCBD and if we can just refer to
19 it as TCBD, would you be agreeable to that?

20 A I guess so. I have used it before.

21 Q Okay. Now, did Dow determine that TCBD was the
22 contaminant in the trichlorophenol process that was
23 responsible for the chloracne outbreak in Building 199
24 in 1964?

25 MR. PIERCE: Objection to the form of the

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1 question.

2 A My recollection is we determined it was the primary
3 culprit.

4 Q Okay. And do you also recall that Dow tested TCBD and
5 found that it was the most potent chemical ever tested
6 in its toxicological laboratory?

7 MS. JONES: Object to that question.

8 MR. PIERCE: Objection. This is outside this
9 witness's scope of knowledge. But go ahead and answer
10 it to the best of your ability.

11 A Once again I'm not a toxicologist but I did hear that,
12 certainly.

13 Q And if you'll please turn to Exhibit 5, page 8. You
14 also wrote that on page 8 of Exhibit 5, correct?

15 MS. JONES: Gary, could you tell me what
16 Exhibit 5 is?

17 MR. DAVIS: Sure. Off the record.

18 (Conference off the record.)

19 A I don't see that statement on page 8.

20 Q I'm sorry, I misspoke. It was on page 9.

21 MR. PIERCE: I'd just like to object in that
22 the document speaks for itself. If it says that it
23 does.

24 And could we have the question read back, please?

25 (Requested portion read back.)

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1 MR. PIERCE: I'd like to object to the
2 characterization of what the document states. I think
3 it is taken out of context and further that the document
4 speaks for itself.

5 Q Okay. You may answer the question about whether you
6 wrote that in Exhibit 5?

7 A It appears that I did, yes.

8 Q Okay. What -- how did your involvement start in
9 Building 199 with the trichlorophenol where the
10 trichlorophenol process was, do you recall that?

11 A My recollection is that I was told there was a problem
12 there and that my assignment was to find out what
13 exposures the workers may have been receiving or to
14 look at the situation.

15 Q Were you appointed as a full-time safety person for
16 Building 199 in the trichlorophenol process?

17 A Not at that time.

18 MR. PIERCE: Objection to the form of the
19 question.

20 A Not at that time.

21 Q When were you appointed as such?

22 A Sometime later. I don't remember exactly.

23 Q Okay. What precautions were you aware of that Dow took
24 to prevent exposure to workers from the compound that
25 caused chloracne in the trichlorophenol process?

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D.2455

1 MR. PIERCE: In what time frame?

2 Q In any time frame.

3 MR. PIERCE: You mean now?

4 MS. JONES: I'd object to that question in
5 that it's overly broad.

6 Q I'll try to be more specific then.

7 A Please.

8 Q You're aware that in 1957 the Boehringer Company, a
9 German chemical manufacturing company, sent a letter to
10 Dow and all other known trichlorophenol manufacturers
11 on how to avoid generating the chemical that causes
12 chloracne in the trichlorophenol process?

13 MR. PIERCE: Object to the form of the
14 question and I believe that has been previously
15 answered.

16 A I have seen such a letter.

17 Q Let me show you Exhibit 6 which has been previously
18 marked and ask if this is the letter?

19 MR. PIERCE: What do you mean by is this the
20 letter?

21 MR. DAVIS: The letter he just referred to.

22 MR. PIERCE: Are you asking him if he has seen
23 this letter?

24 MR. DAVIS: He just said he did.

25 MS. JONES: Gary, could I ask you guys since I

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1 can't see the document, when you refer to an exhibit
2 give me the date of the exhibit and something that will
3 identify it.

4 MR. DAVIS: We will do that.

5 MS. JONES: Thanks.

6 MR. PIERCE: LeeAnn, this is a document dated
7 February 11th, 1967 --

8 MR. DAVIS: '57.

9 MR. PIERCE: '57, which purports to be a
10 letter from -- signed Weyland, W-e-y-l-a-n-d, and it is
11 apparently addressed to The Dow Chemical Company.

12 MS. JONES: Thanks.

13 Q Mr. Silverstein, this is the letter from the German
14 chemical company Boehringer that you saw before
15 relating to measures to prevent chloracne?

16 MR. PIERCE: Objection to the form. I think
17 it's a mischaracterization of his previous testimony.
18 But answer it if you have seen it before.

19 A This appears to be an extremely poor copy of a letter I
20 remember but I can not speak to the -- you know, each
21 and every word. I can't even read them.

22 Q It is a poor copy, I will agree. One of the items that
23 Dow was aware of as a result of this letter is that the
24 temperature of the trichlorophenol process was
25 important in preventing the generation of the compound

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1 that causes chloracne, right?

2 MR. PIERCE: Are you asking him in terms of
3 awareness of The Dow Chemical Company or are you asking
4 him that's what the letter speaks to? I mean I object
5 to the question but answer it to the best of your
6 ability.

7 A I really don't know what the question is here. Would
8 you please rephrase it?

9 Q As a result of this letter which has been marked as
10 Exhibit 6, was Dow aware that the temperature of the
11 trichlorophenol reaction was an important factor in
12 preventing the generation of the chemical that causes
13 chloracne?

14 MR. PIERCE: Objection to the form. I don't
15 think this witness is qualified to answer as to Dow's
16 awareness or to the basis of Dow's awareness, but you
17 can answer the question the best you can.

18 A Please understand I'm not a chemical engineer or a
19 process engineer and I certainly can't speak to Dow
20 Chemical Company's awareness. The letter mentions a
21 temperature in the content and that's all I can really
22 speak to with accuracy at this point.

23 Q Okay. That temperature was 150 degrees Centigrade?

24 MR. PIERCE: You mean that's what the letter
25 says?

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1 MR. DAVIS: Yes. In Exhibit 6.

2 MR. PIERCE: Well, of course I object that the
3 letter speaks for itself but go ahead and take a look
4 at it.

5 Q Actually that might have been marked out of this
6 letter. Back in Exhibit 2 on page 8, which is right
7 here --

8 A Page, sir?

9 Q 8, please.

10 A Page 8. Yes, sir.

11 Q 150 degrees Centigrade is the temperature that was
12 emphasized by the German chemical company Boehringer as
13 being a necessary temperature to minimize the threat of
14 chloracne?

15 MR. PIERCE: Are you asking the witness if
16 that's his present recall or if something to that
17 effect is written on page 8 of the exhibit?

18 Q Do you recall that at present?

19 A In all candor I recall it and page 8 confirms that that
20 was the number.

21 Q Okay. Now, what were some of the process changes that
22 were made at Building 199 where the trichlorophenol was
23 made in 1964 to prevent a recurrence of chloracne among
24 the workers?

25 MR. PIERCE: Objection to the form and it's

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D. 2459

1 outside this person's scope of knowledge but you can
2 answer it to the best of your ability.

3 Q If you recall.

4 A From my standpoint as an industrial hygienist basically
5 the process was even closed more so than previously,
6 leak points, process equipment primarily were tightened
7 up or replaced in order to minimize leakage and a
8 couple of procedural changes to avoid sample taking
9 which was a potential exposure point.

10 Q And this was particularly with regard to the caustic
11 insoluble oils?

12 A No, sir.

13 Q What about the -- was there something called a decanter
14 in the process that you recall where the caustic
15 insoluble oils would be drawn off?

16 A I recall that and I said no, sir a moment ago because
17 it wasn't aimed only at the caustic oil.

18 Q Okay. Let me ask you to look at what's been marked as
19 Exhibit 3.

20 MR. PIERCE: Gary, I think the witness has
21 already indicated that he is certainly not the person
22 expert in the process but for whatever you want to use
23 that for, please.

24 A Okay.

25 Q My question is does this look from your memory like it

1 was the Dow process in use at that time in 1964-65?

2 MR. PIERCE: You mean is this document the
3 Dow process, number 3?

4 Q Is this a drawing that represents the Dow process?

5 A I don't remember ever seeing that drawing before and at
6 this late date I couldn't say that it even remotely
7 resembled it to be honest with you.

8 Q Okay. That's fine. The purpose of the changes in the
9 trichlorophenol process were to minimize the worker
10 exposure to the compound that could cause chloracne, is
11 that right?

12 A Yes, sir.

13 Q And at that point in time in 1964 when you got involved
14 did you cause some rabbit ear tests to be made of the
15 caustic insoluble oils from the trichlorophenol
16 process?

17 MR. PIERCE: Objection to the form and the use
18 of the term "caustic insoluble oils".

19 A In conjunction with my industrial hygiene efforts a
20 number of tests were run on many different things, yes.

21 Q Were some of those run on the caustic insoluble
22 oils?

23 A As I recall, yes.

24 Q And what happened to the rabbits that were tested with
25 those oils in 1964?

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D. 2461

1 MR. PIERCE: I'm sorry, but that's not a clear
2 question, honestly.

3 Q Was the concentration of the chemical that caused the
4 chloracne in the caustic insoluble oils so high in
5 1964 that the rabbits tested for the rabbit ear test
6 died?

7 MR. PIERCE: Objection to the form of the
8 question.

9 A To my recollection there was an instance in which that
10 happened, yes.

11 Q Did Dow consider shutting down the Building 199 process
12 in the 1964 time frame?

13 A To the best of my recollection it was considered, yes.

14 Q And sometime in the 1964 or '65 time frame you were
15 appointed full-time safety officer for that plant?

16 A Yes, sir.

17 Q Were wipe samples taken around the buildings that
18 were responsible for the production of
19 trichlorophenol?

20 A Yes, sir.

21 Q What were wipe samples, can you describe those?

22 A A wipe sample is a technique adapted from radiation
23 safety of simply wiping a surface with a filter paper
24 or absorbent paper and subsequently analyzing the paper
25 for the material being tested for.

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1 Q Okay. And describe how that was done in the
2 trichlorophenol process? What kinds of surfaces would
3 you sample?

4 MR. PIERCE: Objection to the form. Could we
5 have a time frame here?

6 Q In the 1964-65 time frame.

7 A Primarily work surfaces that might be contacted by
8 employees. They were the focal point of the wipe test.

9 Q What would you then do with the filter paper or paper
10 that was used to wipe the surface, how would you test
11 it?

12 A I didn't personally test them, sir.

13 Q Do you know how they were tested though?

14 A Yes. In the beginning they were submitted to
15 toxicology for the animal test that's been previously
16 discussed.

17 Q The rabbit ear test?

18 A Yes.

19 Q And was there -- at a later time frame was there
20 another type of test done on those wipe samples?

21 A Eventually in a machine. An analytical method was
22 developed and used.

23 Q And was the purpose of the wipe test to determine the
24 levels of TCBD or dioxin on surfaces in the plant?

25 MR. PIERCE: Objection to the form of the

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1 question.

2 A Well, the rabbit ear test didn't identify materials,
3 just said whether there was a material that was capable
4 of causing a response. When the analytical method came
5 along we were able to identify the specific material we
6 were looking for, yes.

7 Q And the rabbit ear test was even more sensitive than
8 the analytical method that came along in determining
9 whether there was a material present that caused
10 chloracne, is that right?

11 A Initially, yes. I don't know what the situation is
12 now.

13 Q What did you find when you took those wipe samples and
14 had them analyzed in 1964?

15 A Well, that's a very broad question. I found all kinds
16 of results, you know, good and bad.

17 Q Did you find that the Building 199 was extensively
18 contaminated with the compound that causes chloracne?

19 MR. PIERCE: Objection to the form of the
20 question. Objection to the use of the term
21 "extensively" which has no definition.

22 Q You may answer.

23 A To my best recollection early on I found positive
24 samples in the 199 Building.

25 Q If you will turn to page 9 of Exhibit 2, please. And

1 towards the middle of the page you stated that the
2 building was found to be extensively contaminated, is
3 that right?

4 A The statement is there, yes.

5 Q And what did you do once you found that contamination
6 or what did you request to be done with regard to
7 removing that contamination from the building?

8 A I reported it to the, you know, responsible people and
9 recommended that clean-up be done promptly and to my
10 recollection it was done quite promptly.

11 Q How was the building cleaned?

12 A Oh, basically by high pressure water hose treatment.
13 That's my recollection.

14 Q Okay. Were there workers wiping the surfaces at the
15 same time or --

16 MR. PIERCE: Objection to the form of the
17 question.

18 A If you are indicating wipe testing, no.

19 Q No, I mean in terms of the actual cleaning, was it by
20 hand or was it just the water hose?

21 A Wow, I honestly don't remember.

22 Q Let me show you two documents that have been previously
23 marked as Exhibits 7 and 8 and take a few minutes to
24 review those, please.

25 MR. DAVIS: Off the record.

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(Recess)

MR. PIERCE: Okay. I believe the witness has completed his review.

Q (By Mr. Davis, continuing): What I want to ask you first about Exhibits 7 and 8, Mr. Silverstein, is are these Dow documents that describe the steps to be taken to eliminate exposure to the chloracne in Building 199 or the trichlorophenol process?

MR. PIERCE: Objection to the vagueness of the question and the characterization of the documents.

Q You may answer.

A They appear to be such documents but I don't recall them.

Q Do they refresh your recollection in any way on the steps that were taken in 1964 and '65?

A In a general way a number of the steps come through as familiar because of my involvement but on specifics, no.

MR. DAVIS: Let me see those.

MR. PIERCE: Sure.

Q Let's just go ahead and identify these for the record. Exhibit 7 is entitled "Aniline Section, Equipment" and then it says "TCP Chloracne Completed Changes November 13th, 1964".

Item 12 on page 1 of Exhibit 7 discusses -- or

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1 I'll read the statement and let me ask you a question
2 about it. It says: "November 13th - Reactor room 100
3 feet by 180 feet washed down with detergent and painted
4 with aluminum."

5 Is that the clean-up that you were describing?

6 MR. PIERCE: Objection to the form that you
7 are reading from a document not identified. But go
8 ahead and answer the question.

9 A I don't believe so, no, it doesn't sound like it.

10 Q Do you recall what that item would have referred to?

11 A I have no recollection of that specific item, no.

12 Q What is the reactor room? Does that ring a bell to
13 you?

14 A I believe we referred to the enclosure of the process
15 equipment as the reactor room but that was an addition
16 to minimize exposure.

17 Q When you say the reactor, you mean the trichlorophenol
18 reactor?

19 MR. PIERCE: Objection to the form.

20 A I believe so.

21 Q What hygiene precautions did you recommend that the
22 workers take to minimize chloracne and to minimize
23 their exposure to TCBD or dioxin?

24 MR. PIERCE: Objection to the form of the
25 question. You may answer.

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1 A Okay. Strictly from memory, the basic precautions
2 were to use skin protection, namely gloves for routine,
3 and full suits when anything more in the way of
4 possible exposure might occur. And in addition extreme
5 personal hygiene in terms of washing thoroughly after
6 any possible contact, even with the protection, and
7 showers frequently, required beginning and end of a
8 shift and required any time a person had to get into a
9 full suit -- that's immediately after the job, excuse
10 me.

11 Q So you required showers twice a day --

12 MR. PIERCE: Objection to the form.

13 Q -- for the workers that worked with trichlorophenol?

14 MR. PIERCE: That is not -- that's a
15 mischaracterization of what he just indicated to you.

16 Q I am asking another question. You required showers
17 twice a day for the workers that worked with
18 trichlorophenol?

19 MR. PIERCE: Objection to the form. I think --
20 well, go ahead. I'm sorry.

21 A Again to the best of my recollection at least at lunch
22 break and end of their shift, twice a day, and any time
23 they took a smoke break or otherwise, if they had had
24 any reason to get into the full protective equipment.

25 Q Let me show you what's been marked as Exhibit 10 and

1 I'll go ahead and read the title of it. "Safety
2 Precautions For Trichlorophenol Operators, L. G.
3 Silverstein, October 9th, 1964".

4 A Judas Priest.

5 Q This is a difficult one to read, it's a bad copy I
6 realize.

7 A Boy, I can't read --

8 MR. PIERCE: Gary, let me just indicate that
9 the witness has indicated to me that he is having
10 substantial trouble in reading this and I think
11 especially in certain parts it's almost illegible.

12 Q Just do the best that you can. The second page is a
13 little easier to read.

14 A Okay. Let's try it.

15 Q Okay. Does that refresh your recollection about the
16 showering, for instance?

17 MR. PIERCE: Objection to the form.

18 A Not really because it's so illegible.

19 Q You can read page 2, can't you?

20 A Yes. You're right, page 2 is reasonably legible and
21 you said refresh my memory and I think I remembered it
22 without this.

23 Q Also you recommended in Exhibit 10 that plastic booties
24 are worn whenever the operators were walking around in
25 the area of the trichlorophenol production?

1 MR. PIERCE: If you are going to speak from
2 the document, please be specific as to the area and not
3 use generalities which the document does not contain.

4 Q What does the document tell you about the use of
5 plastic booties?

6 A All I can read with some assurance is plastic booties
7 must be worn -- illegible -- oil -- illegible -- the
8 stripper column I believe it says pumps.

9 Q Do you recall anything, having attempted to read that,
10 about where plastic booties were required?

11 A Again, from memory rather than this, we did require
12 plastic booties where there was a possibility of shoe
13 contamination, yes.

14 Q And this was to keep the workers from tracking the
15 dioxin --

16 Off the record.

17 (Conference off the record.)

18 MR. DAVIS: Back on the record.

19 (Question read back.)

20 Q Okay. Out of the process area?

21 MR. PIERCE: Objection to the form.

22 A That's correct.

23 Q Did the workers at the Dow trichlorophenol plant wear
24 their work shoes home?

25 MR. PIERCE: You mean in -- anywhere in the

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1 plant?

2 Q In the trichlorophenol plant in the '64-65 time frame.

3 A After implementation of the added precautions the
4 answer is no.

5 Q You also provided boots for them to wear to work in
6 that time frame, is that right?

7 A In the process area, yes.

8 Q And did you provide double lockers for the workers in
9 the trichlorophenol process?

10 A Yes, sir.

11 Q Describe what a double locker is and why you would use
12 that?

13 A The term is used to describe two lockers assigned to a
14 given employee so that he can place his street clothes
15 in the locker called the clean locker, proceed to get
16 his work clothes out of the other locker and then go
17 into work. On leaving work he leaves his work clothes
18 in a locker and then proceeds through the shower to his
19 street clothes.

20 Q And is that to prevent his work clothes from
21 contaminating his street clothes?

22 MR. PIERCE: Objection to the form.

23 A Yes.

24 Q And did you also require the workers to shower after
25 dealing with the caustic insoluble oils in their

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1 job?

2 A Yes, sir, after implementation of these controls.

3 MS. JONES: Mr. Silverstein, could I ask you
4 to speak up a little bit?

5 A I'm very sorry. I keep forgetting that you are relying
6 on the speaker. You're the only nice one here so I'll
7 try harder.

8 MS. JONES: Thank you.

9 Q Was the shower time for the -- let me strike that just
10 a minute. Mr. Silverstein, am I not being nice to you
11 in this deposition?

12 MR. PIERCE: I don't think he wants you to
13 answer that.

14 Q If any of my questions offend you, please let me know
15 and I'll try to rephrase them.

16 A I'm not taking it personally.

17 Q Was the shower and wash time for the employees who were
18 required to take two showers a day paid time?

19 A Yes, sir.

20 Q Is that important in encouraging the employees to
21 actually take those showers that you have required?

22 MR. PIERCE: Objection to the form of the
23 question.

24 A I believe so.

25 Q Were there also daily safety meetings in the

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1 trichlorophenol process area, particularly at the time
2 when you were trying to implement these precautions?

3 A To the best of my recollection while I was health
4 officer the answer is yes.

5 Q How long were you health officer in that process?

6 MR. PIERCE: Objection to form of the
7 question.

8 A It was a matter of months, approaching a year the best
9 I can recall.

10 Q We were talking earlier about the analytical methods
11 for determining the presence of the dioxin or the
12 chloracnegen in process materials or in wipe samples.
13 We talked about the rabbit ear test. Are you familiar
14 with the other type of test that Dow implemented as an
15 analytical method for determining the presence of
16 dioxin or TCBD?

17 MR. PIERCE: Objection to the form. No
18 foundation. Go ahead and answer.

19 A I'm generally familiar with what was then called the
20 VPC method, vapor phase chromatography.

21 Q Is that sometimes also called a gas chromatograph?

22 A Yes.

23 Q And when was a method developed for analyzing for
24 dioxin or TCBD in the process materials from the
25 trichlorophenol process at Dow?

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1 MR. PIERCE: Objection to the form of the
2 question.

3 A You asked when?

4 Q Yes.

5 A To the best of my recollection about 1965, I think.

6 Q Okay. Now, was the method, that gas chromatograph or
7 the VPC method as you referred to it, capable of
8 detecting the dioxin in the caustic insoluble oil
9 fraction?

10 MR. PIERCE: You realize that the witness is
11 here in his capacity -- I assume you are asking him as
12 industrial hygienist. If you have a misconception that
13 he is an analytic chemist left me say he's not but to
14 the best of your knowledge give him an answer, please.

15 A Okay. As an industrial hygienist I need to know if a
16 method is sensitive enough to tell me amounts in
17 relation to what I want to control to. The answer to
18 your question is that initially, no. The GC method
19 wasn't sensitive enough.

20 Q But the GC method could detect the presence of dioxin
21 at some level in the caustic insoluble oils even in
22 1964, correct?

23 MR. PIERCE: If you know?

24 A Not to my knowledge.

25 Q I know it's been a long, long time since then and I'm

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1 not trying to contradict your answer but I do want to
2 show you Exhibit 9 and see if this refreshes your
3 recollection.

4 A Okay.

5 Q Does Exhibit 9 refresh your recollection about the
6 analysis of the caustic insoluble oil fraction?

7 A I remember having seen such a document, yes.

8 Q Okay. And was the gas chromatograph analytical
9 procedure also used for testing trichlorophenol samples
10 for the presence of dioxin?

11 A Eventually in the time period, yes.

12 Q Okay. You recall that there were -- there was testing
13 of the trichlorophenol to determine whether it would
14 carry dioxin on into the 2,4,5-T product, don't you?

15 A I don't remember it that specifically.

16 Q Okay. Let me show you Exhibit 4 and let me go ahead
17 and note for the record what it is. That it's a memo
18 addressed to several people, including L. G.
19 Silverstein, dated May 4th, 1965, from Richard C.
20 Hoff, Quality Services Supervisor, Chemicals
21 Production Department, on Dow stationery, regarding
22 "2,4,5-Trichlorophenol and 2,4,5-Trichlorophenoxyacetic
23 Acid Analysis for 2,3,7,8-Tetrachlorodibenzodioxin".

24 Does this refresh your recollection about the
25 analyses of the trichlorophenol for the presence of

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1 dioxin as it was put forward in the process of making
2 2,4,5-T at Dow?

3 MR. PIERCE: Objection to the form and
4 objection to the perception that he required refreshing
5 as to the question you have now asked as opposed to the
6 question you previously asked. But in any event,
7 answer.

8 Q You may answer.

9 A My recollection is that we applied quality control to
10 the product for purposes of assuring no transfer of the
11 material from its production plant to anyplace.

12 Q Okay. So you tried to prevent the transfer of any
13 dioxin from the trichlorophenol plant to the production
14 of 2,4,5-T acid, that was one of the --

15 A That was one of the destinations, yes.

16 Q Then you tried to prevent the transfer of dioxin from
17 the plant in the 2,4,5-T acid product?

18 MR. PIERCE: Objection to the form.

19 A Yes.

20 Q Using the gas chromatograph analysis?

21 A I believe so, yes.

22 Q Was it evident to you that the tars or oils from the
23 trichlorophenol process that were either by-products or
24 waste streams were where dioxin would accumulate?

25 MR. PIERCE: Objection to the question.

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1 Compound, ambiguous, vague. Go ahead and answer.

2 A With the knowledge we had at the time we believed this
3 to be the case.

4 Q In the 1964-65 time frame?

5 A Yes, sir.

6 Q Did you ever determine anything that contradicted that?

7 A I'm not sure I understand the question. Sorry.

8 Q You said with the knowledge you had at the time you
9 believed that to be the case. Did you ever find out
10 anything differently?

11 A Wow. Well, we knew a lot beyond that, I believe is the
12 truth, you know, that it wasn't only in there. That
13 was the primary.

14 Q Did you develop laboratory safety procedures for the
15 handling of dioxin in the laboratory?

16 A Yes, I did.

17 Q Let me show you Exhibit 12 and ask if these are those
18 procedures and let's off the record read this to
19 LeeAnn.

20 (Conference off the record.)

21 Q (By Mr. Davis, continuing): The document that was
22 just shown you is Exhibit 12. Is this the -- at least
23 one version of the safety procedures that you developed
24 for handling of dioxin in the laboratory?

25 A This appears to be a copy of procedures I wrote, yes,

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1 sir.

2 Q When did you first write those procedures?

3 A Latter part of the 1960's is my recollection.

4 Q Okay. Would you know whether or not Exhibit 12 is the
5 first written version or is it a subsequent draft?

6 A I wouldn't know for a fact which it is.

7 Q Okay. In Exhibit 12 you talked about the safe handling
8 of even small quantities of dioxin. Do you liken the
9 hazards of dioxin to the hazards of radioactive
10 materials?

11 MR. PIERCE: Objection to the form of the
12 question and the handling relates to laboratory and --
13 go ahead and answer it to the best of your ability.

14 A Well, in the sense that precautions to be taken with
15 handling the material are very similar with those
16 taken handling radioactive materials will protect
17 people, yes.

18 Q Do you know who Exhibit 12 was sent to, if anyone?

19 A In my recollection it was sent to persons who requested
20 it from outside Dow Chemical or within, either.

21 Q You don't know of any particular persons who it was
22 sent to then?

23 A I do not recall any specific recipients, no, sir.

24 Q Okay. Why would you recommend that persons using
25 dioxin in a laboratory throw away plastic gloves

1 without contacting the exterior surfaces of the gloves?

2 MR. PIERCE: Are you referring now to the
3 document or --

4 Q Yes. Referring to Exhibit 12.

5 A Because unless employees are instructed on a proper
6 method of removing contaminated gloves they unwittingly
7 may contact the contaminated outside. You have to
8 show them how to do it properly.

9 Q What type of gloves did you require the employees in
10 the trichlorophenol process to wear?

11 MR. PIERCE: Objection to the form. A
12 mischaracterization of his earlier testimony and by
13 using generalization as to the trichlorophenol process.
14 But go ahead and answer.

15 A The basic requirement was impervious and the actual
16 glove depended on the operation to the best of my
17 recollection.

18 Q What about the employees that were actually handling
19 the caustic insoluble oils in some fashion?

20 A Probably a specific rubber glove that we had in the
21 plant.

22 Q Did you ever require any of those employees to wear an
23 air hood when they were dealing with the caustic
24 insoluble oils?

25 A Yes.

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1 Q What's an air hood?

2 A It's properly called an air-supplied hood and it is a
3 covering over the head with breathing air brought to
4 the hood either from an outside line of breathing air
5 or from a self-contained oxygen or air tank that the
6 person wears on the back.

7 Q What was the purpose of requiring such a breathing
8 hood?

9 A Because we didn't know if the person -- we didn't know
10 whether the person might be exposed to an airborne
11 material.

12 Q By the airborne material you mean the material that
13 caused the chloracne, the dioxin in the process?

14 MR. PIERCE: Objection to the form. Asked and
15 answered.

16 A That and other materials, yes.

17 Q What were the employees actually doing, what activity
18 were they performing where you required the air hood in
19 handling caustic insoluble oils?

20 MS. JONES: Objection if that's not limited to
21 any particular time period.

22 Q You may mention any time period you care to.

23 A Well, during the time period of the middle '60s when I
24 was health officer. My recollection is that in
25 relation to the oil the employees were required to wear

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1 the hood if they took a sample of the material or when
2 they filled the Dempster, the receptacle for the
3 material.

4 Q Okay. Do you recall what the employees would then do
5 with the Dempster, the material in the Dempster?

6 A It was carted away from the building.

7 Q And where did it go?

8 MR. PIERCE: If you know?

9 A It went to the Dow incinerator.

10 Q Was that true during the whole time that you were the
11 safety officer in the trichlorophenol process?

12 A Yes, to the best of my recollection.

13 Q Why did you recommend in Exhibit 12 that clothing known
14 to be contaminated should be disposed of with the
15 precautions described under disposal of wastes?

16 MR. PIERCE: Is that supposed to be a direct
17 quote from the document?

18 MR. DAVIS: That is a direct quote.

19 A May I read the entire part there?

20 Q Yes.

21 A I could only conjecture on why I stated it just that
22 way. Probably because most people weren't equipped or
23 wouldn't take the steps elaborated on in that same
24 section to assure that the laundry people and the
25 laundry equipment wasn't contaminated.

1 Q What steps would those have been?

2 MR. PIERCE: You want further conjecture?

3 MR. DAVIS: What he remembers.

4 A I think they are written in there.

5 Q Just from your memory?

6 A From my memory it's basically assuring that people
7 transporting the contaminated laundry are protected by
8 having it inside clean bags -- clean on the outside.
9 That the people putting the clothing into the laundry
10 equipment are educated and trained to avoid touching
11 the stuff as it goes in, making any contact. And that
12 after the equipment -- after the materials have been
13 washed that the equipment itself is rinsed.

14 Q Okay.

15 MR. DAVIS: Let's take a short break.

16 (Recess)

17 Q (By Mr. Davis, continuing): Let's go back and let
18 me ask you to look at what's been marked as Exhibit 21.
19 It's very difficult to read. I apologize for the poor
20 copy. I just want to ask you to see if you can
21 identify it.

22 MR. DAVIS: Off the record.

23 (Conference off the record.)

24 Q If you can just attempt to review this document, Mr.
25 Silverstein, and I have a couple questions I wanted to

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1 ask you about it.

2 MR. PIERCE: While the witness is reviewing
3 this I'd just like to state that once again this is
4 a very difficult copy to read, many parts of which are
5 completely illegible and which the date itself is very
6 difficult to ascertain.

7 MR. DAVIS: You agree, Stanley, that the date
8 looks like August 25th, 1964?

9 MR. PIERCE: To the best -- or '69. If you
10 take a look at it, Gary, you'll see the same thing.
11 I don't think we need to debate about that.

12 A As best I can, yes, sir.

13 Q Okay. Exhibit 21 which you have just reviewed talks
14 about a meeting that was held to discuss the chloracne
15 problem, correct?

16 A That's correct.

17 Q And there is a chronological chart of process changes
18 attached to this which the memo itself mentions that
19 you presented at the meeting.

20 MR. PIERCE: May I see that? Object to the
21 form and to the characterization of the chart but -- is
22 there a question?

23 A I did not see a table or chart of process changes as
24 such.

25 Q What is the table that's on the third page or chart on

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1 the third page?

2 A Well, as best I can read it the chart on the third page
3 is entitled "Materials Tested" and those are process
4 materials that have been tested.

5 Q Okay. If you don't mind me stepping around here. We
6 may have a page of this missing and it's one of the
7 things I am trying to determine. If you notice on
8 page 1 of Exhibit 21 it says: "L. Silverstein present
9 a chronological chart of the process changes, et
10 cetera, relating such changes to the chloracne problem."

11 Do you know if that is any earlier document that
12 we have looked at?

13 A I don't know to be honest with you. I didn't see a
14 chart that, you know, that fit that description.

15 Q Okay.

16 A In that document.

17 Q Okay. Then the remaining pages of the document deal
18 with process materials that were sampled and tested on
19 rabbit ears, is that -- and also there is some that
20 were tested on the bellies of rabbits, I believe.

21 MR. PIERCE: Objection. The document speaks
22 for itself.

23 A The first three tables appear to be process materials
24 that were tested on animals. The next one is wipe test
25 for 199 which are not process samples, of course, and

1 then the last one I didn't look at again.

2 Q These are tests that were done on the -- either the
3 process materials or the wipe samples from the
4 trichlorophenol production building?

5 MR. PIERCE: Once again I renew my objection.
6 The document speaks for itself.

7 Q Is that correct?

8 A To the best of my knowledge, yes.

9 Q When the trichlorophenol production process at the
10 Midland plant was shut down temporarily in 1964, in '65
11 did Dow purchase 2,4,5-T from other suppliers?

12 MR. PIERCE: Objection to the form. There is
13 no foundation. Answer to the best of your ability.

14 A I wasn't involved in that. I don't remember to be
15 honest with you.

16 Q Do you know if Dow ever purchased trichlorophenol from
17 other suppliers?

18 A I believe they did.

19 Q Was it during the time that the Dow process was
20 temporarily shut down?

21 MR. PIERCE: Objection to the form.

22 A Probably. It's logical.

23 Q Let me show you what's been marked as Exhibit 11 and
24 first of all let me identify it. It's a letter or a
25 memo dated March 10th, 1965, from L. G. Silverstein to

1 a long list of what appear to be Dow employees on Dow
2 stationery.

3 First of all, what is the subject of this memo?

4 MR. PIERCE: You want him to read the title?

5 Q Please read the title because I didn't in Exhibit 11.

6 A You or me?

7 Q Either.

8 MR. PIERCE: I will read it. "Hazard of
9 Monsanto-T Acid" appears to be the title.

10 MS. JONES: I couldn't hear it.

11 MR. PIERCE: "Hazard of Monsanto-T Acid". And
12 LeeAnn, the date is March 10th of what appears to be
13 1965.

14 A Okay.

15 MR. PIERCE: All right. The second page,
16 LeeAnn, also has a legibility problem.

17 Q Can you attempt to read the second page for the record,
18 Mr. Silverstein?

19 MR. PIERCE: If you can.

20 A Just the sentence?

21 Q Yes.

22 A "I believe Dow has a definite obligation to advise
23 Riverdale and Woodbury of the problem immediately."

24 Q Okay. Can you tell the jury what problem that you were
25 referring to?

1 A Well, as stated in the memo, some material contaminated
2 with acnegen.

3 Q This was Monsanto trichlorophenol that was contaminated
4 with the acnegen?

5 MR. PIERCE: Objection to the form and
6 characterization.

7 Q Is that correct?

8 MR. PIERCE: Answer it to the best of your
9 ability.

10 A Yes, sir.

11 Q And what is Woodbury and Riverdale?

12 A At this time I honestly don't remember what they were.

13 Q Were either Woodbury or Riverdale Monsanto facilities,
14 do you recall?

15 A I do not know.

16 Q Does Dow have any facilities in Woodbury or Riverdale?

17 A Not to my knowledge.

18 Q Okay. Do you know if any action was taken as a result
19 of the memo which has been marked as Exhibit 11 that
20 you wrote?

21 A I honestly do not know.

22 Q Was there a new process implemented by Dow in around
23 1965 and early 1966 for the production of
24 trichlorophenol at the Midland plant?

25 A To the best of my recollection a new plant started

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1 about 1967.

2 Q Okay. And just so that we can be clear on the date,
3 I'd like to refer you back to Exhibit 5 which I have
4 and I will give you as soon as I find the right page.
5 If you will look at page 13, the last paragraph.

6 A Yes, sir.

7 MR. PIERCE: Are you asking him about his
8 current recollection or --

9 Q I am asking if Exhibit 5 which is a memo that you wrote
10 or dictated refreshes your recollection as to the date
11 the new plant commenced?

12 A Not really.

13 Q You stated there it commenced in 1966?

14 A Yes, sir.

15 MR. PIERCE: I'm sorry. Were you asking him
16 does the document appear to say that when you say "you
17 stated there"? You are not dealing with his previous
18 statement of testimony but the document, is that
19 correct?

20 MR. DAVIS: Of course.

21 MR. PIERCE: All right.

22 Q You don't know of any facts today that contradict the
23 1966 commencement of operation date that you have
24 stated in Exhibit 5?

25 A No, sir.

1 MR. PIERCE: I'd like to just place an
2 objection in that the statement that you referred him
3 to even there in that document says as I remember it.
4 Q Okay. We have other documents as well that we can
5 refer to if that's a question. But what I want to
6 ask you is how Dow went about developing the new
7 process for production of trichlorophenol that was
8 commenced in approximately 1966?

9 MR. PIERCE: Objection to the form, it's
10 outside of this witness's knowledge. But answer it to
11 the best of your ability.

12 A It was a combination of some Dow research and purchase
13 of some technical information from another company.

14 Q You went to Europe in 1964 to look at some other
15 chemical companies' processes for trichlorophenol,
16 didn't you?

17 A Yes, sir, I was one of a couple guys.

18 Q Who else went with you?

19 MS. JONES: Excuse me. Mr. Silverstein, could
20 I ask you to speak up a little bit?

21 A I'm sorry, LeeAnn, but my attorney won't let me get
22 close to this thing.

23 MS. JONES: Stan, are you keeping him from the
24 speaker?

25 MR. PIERCE: I am moving it over now, LeeAnn.

- 1 A My recollection is that Mr. Al Lueck and a Mr. Walt
2 Trapp were the other members of the team.
- 3 Q And you visited a French chemical company?
- 4 A I believe so.
- 5 Q And a German chemical company?
- 6 A Yes, sir.
- 7 Q And what was the name of the German chemical company?
- 8 A Boehringer.
- 9 Q The one we have been speaking of previously that also
10 sent the letter that has been marked as Exhibit 6, is
11 that correct?
- 12 A I believe so.
- 13 Q What did you ascertain on that trip about technology to
14 produce trichlorophenol from your perspective as an
15 industrial hygienist?
- 16 MR. PIERCE: Object to the form of the
17 question. You can answer.
- 18 A Well, my part in the mission was to assess the
19 company's knowledge of the health hazards involved and
20 so I did that at both places.
- 21 Q What did you learn about Boehringer's knowledge of the
22 health hazards of dioxin or TCBD?
- 23 MR. PIERCE: Objection to the form.
- 24 A They seemed to be quite knowledgeable.
- 25 Q And what specifically did they tell you at that point?

1 A My recollection is that Mr. Al Lueck and a Mr. Walt
2 Trapp were the other members of the team.

3 Q And you visited a French chemical company?

4 A I believe so.

5 Q And a German chemical company?

6 A Yes, sir.

7 Q And what was the name of the German chemical company?

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10 sent the letter that has been marked as Exhibit 6, is
11 that correct?

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13 Q What did you ascertain on that trip about technology to
14 produce trichlorophenol from your perspective as an
15 industrial hygienist?

16 MR. PIERCE: Object to the form of the
17 question. You can answer.

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19 company's knowledge of the health hazards involved and
20 so I did that at both places.

21 Q What did you learn about Boehringer's knowledge of the
22 health hazards of dioxin or TCBD?

23 MR. PIERCE: Objection to the form.

24 A They seemed to be quite knowledgeable.

25 Q And what specifically did they tell you at that point?

1 A I don't remember. I'm sorry.

2 Q Okay. It was ultimately Boehringer technology that Dow
3 utilized to design the new plant that commenced in
4 approximately 1966, is that right?

5 MR. PIERCE: Objection. But if you are
6 capable of answering it --

7 A I believe so.

8 Q Was it true that when you visited Boehringer that the
9 Boehringer employees that you spoke with expressed that
10 they were interested in helping Dow or any other
11 chemical company to reduce exposure to the
12 chloracnogens?

13 MR. PIERCE: Objection to form.

14 A To the best of my recollection, yes.

15 Q And that Boehringer sold Dow the technology for a
16 nominal fee?

17 MR. PIERCE: Objection to the form and
18 characterization of fees.

19 A I don't remember having any part in the fees, sir.

20 Q Let's refer to Exhibit 5 which I think you still have
21 close to you. On page 11.

22 In Exhibit 5 on page 11 you refer to the
23 transaction as being one with a nominal fee, is that
24 right?

25 MR. PIERCE: Are you asking him is that what

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1 is on that document?

2 MR. DAVIS: Yes.

3 A That's what it says.

4 Q And you wrote this document?

5 A I believe so.

6 Q What happened to the old plant that had been shut down
7 in 1965.

8 MR. PIERCE: Objection to the form.

9 A At some time after shutdown it was dismantled and
10 disposed of.

11 Q How was it dismantled?

12 A Very carefully. With great precautions.

13 Q And how was it disposed of?

14 A I don't really have first-hand knowledge of that to be
15 honest with you.

16 Q Do you know if the parts were buried?

17 MR. PIERCE: Objection. Asked and answered.

18 A I don't know for sure.

19 Q What do you recall? I mean you obviously recall
20 something about that.

21 A Oh, yes, but the recollection is really, you know, not
22 specific, vague. In general, that some of the
23 equipment was cleaned up and salvaged and others sent
24 to disposal. Dow had its own waste disposal firm --
25 not firm but group in-house that made the decisions on

1 best disposal methods.

2 Q And when you say that it was dismantled very carefully
3 with great precautions, what precautions were taken?

4 A My recollection is it was done by a contractor that was
5 given very thorough training in the risks and the
6 precautions that we felt they should take and then
7 monitored by Dow personnel to be sure they did that.

8 Q Were there specific precautions as to protective
9 equipment?

10 A I honestly don't know that at this point.

11 Q Do you recall anything about the new process that was
12 commenced in approximately 1966?

13 MR. PIERCE: Objection. Asked and answered.

14 Q As far as the reaction steps go?

15 MR. PIERCE: Continue the objection.

16 A I remember nothing of the technology of the process
17 itself, no.

18 Q Okay. You do recall that the levels of dioxin in the
19 new process were less though, don't you?

20 MR. PIERCE: Objection to the form.

21 A Yes, sir.

22 Q Do you recall the method with which the reactants were
23 added to the reaction vessel to control the temperature
24 and pressure of the reaction?

25 A Not at all.

1 MR. PIERCE: Objection to the form of the
2 question and it's completely vague. I'm sorry, what
3 was your answer?

4 A I said not at all.

5 Q You mentioned earlier, I believe, that you were the
6 safety person for the trichlorophenol plant for a
7 period of about a year. What was your position after
8 that?

9 A A moment to try and remember, please. I believe that I
10 went to the chlorinated solvents industrial hygiene
11 project.

12 Q Did you still have some involvement with the
13 trichlorophenol plant or with the particular products
14 made at that plant after 1965?

15 A I had essentially no involvement after I had moved to
16 the other -- the new project.

17 Q Might you be a little vague about the dates when you
18 moved to the other project? I'm just trying to
19 establish what your involvement was.

20 A I'm pretty sure --

21 MR. PIERCE: I'd like to make an objection.
22 The question was asked and answered. Go ahead.

23 A I am pretty sure that I moved into the solvents
24 project in 1967.

25 Q Okay. I just want to show you what's previously been

1 marked as first of all Exhibit 15 which is a memo from
2 L. G. Silverstein to A. F. Lueck, L-u-e-c-k,
3 Trichlorophenol Plant, August 16th, 1966, on Dow
4 Chemical stationary.

5 Is this a memo that you authored, Mr. Silverstein?

6 A It appears to be a copy of one I authored, yes.

7 Q Let me show you Exhibit 16 which is a memo L. G.
8 Silverstein to C. A. Highhill, 2,4-D Plant, Dow
9 Chemical, August 16th, 1966. Is this a copy that you
10 authored, Mr. Silverstein?

11 A It appears to be a copy of a memo that I authored.

12 Q Let me also show you a memo that's been marked as
13 Exhibit 17 -- actually a letter that's been marked
14 as Exhibit 17 from L. G. Silverstein to Dr. Henry
15 Gilman, Department of Chemistry, Iowa State University
16 of Science and Technology, dated January 17th, 1967.
17 If you will take a look at this, please.

18 One of the things I wanted to ask you about
19 Exhibit 17 is what, if you know, type of testing was
20 Dr. Gilman doing in 1967 that this memo refers to or
21 letter refers to?

22 A To my recollection I ran into or, you know, found a
23 chemical abstract, you know, describing that he was
24 doing -- that he had made or was doing something with
25 tetrabromodioxin and wrote and requested the sample

1 that's described there. But I would -- you know, could
2 only say that he was an academic in my recollection. I
3 have no idea what he was doing with the stuff.

4 Q Why did you tell him that clean-up and housekeeping
5 should be the same as required for work with
6 radioisotopes generally and better than is normally
7 required for Carbon-14 work?

8 A Because my background as a radiation safety specialist
9 I used that analogy once in a while to, you know,
10 people who were knowledgeable in radioactive work.
11 They could readily understand what I was talking about
12 in terms of the precautions needed.

13 Q Okay. In addition to the testing of the chloracne
14 producing materials on rabbit ears, Dow also caused
15 some tests to be done on human beings, correct?

16 MR. PIERCE: Objection to the form of the
17 question, to the characterization of what Dow did or
18 did not do. But answer the question.

19 A I recall some -- oh, you know, knowing that that had
20 happened, yes.

21 Q Do you recall any of the details of that?

22 A My recollection is that it was a consulting
23 dermatologist in the East who had done some human
24 volunteer studies.

25 Q These were prisoners that were the so-called

1 volunteers, correct?

2 MR. PIERCE: I really object to the
3 characterization, to the use of innuendo as completely
4 unnecessary. But go ahead and answer.

5 A I remember hearing that, yes.

6 Q Just let me rephrase the question. The persons upon
7 whom the materials were tested were prisoners, is that
8 correct?

9 A I have no first-hand knowledge of that. I heard it,
10 yes.

11 Q Let me refer you to Exhibit 5, an insert directly
12 after page 13 of Exhibit 5. In Exhibit 5 you discuss
13 the human testing that we have been referring to,
14 correct?

15 MR. PIERCE: If you ask him -- are you asking
16 him if that's what the document indicates?

17 MR. DAVIS: I am asking him if that's what he
18 wrote in Exhibit 5.

19 A It looks like something I wrote, yes, sir.

20 Q Concerning human testing of these materials on
21 prisoners?

22 A I see the human testing is the title.

23 MR. PIERCE: I don't -- Mr. Davis, I object.
24 I don't see the word prisoners on this page. Nor may a
25 prisoner not be a volunteer.

1 Q You understood or at least you heard these were
2 prisoners that were tested, correct?

3 A By word of mouth is my recollection, yes, sir.

4 Q Were there other chlorophenol materials that were
5 produced in the Midland plant that caused the same type
6 of skin reaction on rabbit ears as the materials from
7 the trichlorophenol process?

8 MR. PIERCE: Objection to the form of the
9 question.

10 A Well, I learned in the course of my involvement that
11 there had been past experience with that, yes.

12 Q Were some of these other materials called Dowicides?

13 A Yes.

14 Q Let me show you Exhibit 13 and let me identify that as
15 a memo from L. G. Silverstein to J. B. Fernandez,
16 Organic Chemicals Product Research, Dow Chemical, April
17 10th, 1970.

18 MR. DAVIS: Still with us, LeeAnn?

19 MS. JONES: Yes.

20 Q Are you the author of this memorandum, Mr. Silverstein?

21 A It appears to be something I wrote, yes, sir.

22 Q This memorandum mentions other toxic effects of known
23 or suspected acnegens must be kept in mind. What are
24 those other effects that you're aware of?

25 A The more familiar effects of injury to eyes and skin;

1 corrosive injury in particular is what I had in mind, I
2 think.

3 Q Are you aware of any other effects as we sit here today
4 that you associate with exposure to dioxin?

5 MR. PIERCE: Objection to the form.

6 A I missed your last word.

7 Q Are you aware today of other health effects other than
8 chloracne that you associate with exposure to dioxin?

9 MR. PIERCE: Continue the objection.

10 MS. JONES: I object to the extent it's
11 calling for any sort of an expert opinion.

12 Q You may answer.

13 A Yes. Once again I'm not a toxicologist. I have been
14 following the veterans' concerns and the public press
15 which is not the best scientific journal and I have
16 reservations.

17 Q You were aware, weren't you, that in the rabbit tests
18 that Dow was doing that Dow found liver effects as well
19 as the skin effects?

20 A Yes, sir.

21 MR. PIERCE: Objection to the form and as to
22 the broad generalization and nonspecific nature of the
23 question.

24 Q I'll be more specific if Mr. Pierce wants me to be.
25 That the Dow tests on the materials from the

1 trichlorophenol process that contained dioxin also in
2 addition to affecting the skin of the rabbit's ears
3 would cause toxicity to the livers of the rabbits, is
4 that correct?

5 MR. PIERCE: Continue the objection.

6 A I was aware of this.

7 MS. JONES: I couldn't --

8 A I was aware of this, LeeAnn.

9 MS. JONES: Was?

10 A Yes.

11 MS. JONES: Thank you.

12 Q You were aware of that in the 1964-1965 time frame?

13 A Yes, sir.

14 Q Did you know about any subsequent process changes that
15 were made in the Dow process after 1966, the one that
16 we had discussed with the German process?

17 MR. PIERCE: Objection to the form. This
18 question has been asked and answered numerous times
19 during this deposition. But go ahead.

20 Q You may answer.

21 A No, sir.

22 Q Ever hear of a xylene extraction step that was put into
23 the trichlorophenol process to reduce the concentration
24 of dioxin even further?

25 MR. PIERCE: Objection to the form.

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1 A No, sir.

2 Q Okay. Have you ever seen the document that is marked
3 as Exhibit 19?

4 And you might read the title of it, Stanley, since
5 you got it there.

6 MR. PIERCE: It has a cover page saying "NaTCP
7 Solution IWD".

8 A I guess I have to read every word to determine --

9 Q Go ahead.

10 A I don't believe I have ever seen this document, sir.

11 Q Okay. Thank you. With the process that Dow
12 implemented in around 1966 was there a danger of
13 over-pressurization of the trichlorophenol reactor?

14 MR. PIERCE: Objection. Once again, the
15 witness has answered numerous times that he is not
16 familiar with the process. But go ahead once again.

17 A I am not qualified, I don't know anything about that.

18 Q Do you recall at all whether the process, particularly
19 the trichlorophenol reactor, had a ruptured disk?

20 A I don't know.

21 Q Have you ever had any communications with any
22 individual from Hercules, Incorporated, or what was
23 formerly known as the Hercules Powder Company?

24 MR. PIERCE: At any time?

25 MR. DAVIS: At any time.

1 A The only one I recall is Emil Christofano who is a
2 friend of mine.

3 Q What communications have you had with Mr. Christofano
4 concerning trichlorophenol or phenoxy herbicides or
5 dioxin?

6 MR. PIERCE: Objection to the form of the
7 question.

8 MS. JONES: I object in that it's vague.

9 A I have never discussed these matters with him to my
10 recollection.

11 Q Have you ever had any communications with anyone
12 representing or working for Transvaal, Incorporated or
13 the Vertac Chemical Company?

14 A No, sir.

15 Q Is it fair to say that you determined that extreme
16 precautions were necessary to protect the workers in
17 the Dow trichlorophenol plant from exposure to dioxin?

18 MR. PIERCE: Objection to the form of the
19 question and specifically to the term he determined.

20 MS. JONES: I object also.

21 A In the context of the times, and remembering that
22 we didn't know a lot about what was going on, it was --
23 it appeared to us that we should take extensive
24 precautions to protect our employees to minimize
25 exposure which is a basic precept of industrial

1 hygiene.

2 Q And you also determined, did you not, that the process
3 area for the production of trichlorophenol needed to be
4 monitored with the wipe tests on a frequent basis
5 to determine the levels of contamination of dioxin in
6 the process area?

7 MR. PIERCE: Objection to the form of the
8 question. Also object to the statement that he
9 determined. But go ahead.

10 Q You may answer.

11 A We used wipe tests as a housekeeping indicator for the
12 production plant and kept it as clean as we were able
13 to achieve as evidenced by the wipe test data.

14 Q And there was also a chloracne hazard in the 2,4,5-T
15 production process, was there not, at least in 1964 or
16 '65 time frame?

17 MR. PIERCE: Objection to the form of the
18 question.

19 A Not to my knowledge based on what I recall of our
20 information.

21 Q Did you test the 2,4,5-T processing area for the
22 presence of the materials that caused chloracne?

23 A I believe I did, yes.

24 MR. DAVIS: That's all I have.

25 MR. PIERCE: Okay. When do you want to start

1 again?

2 MS. JONES: Was that all that Gary had?

3 (Conference off the record.)

4 MS. JONES: I have just a couple of documents.
5 Could I fax those documents to you guys somewhere?

6 MR. DAVIS: I don't know how we can do that,
7 LeeAnn. I don't know if this hotel has a fax. I mean
8 it's something you really need to be here for.

9 MS. JONES: I have got a document dated March
10 29, 1965. It is a memo prepared by Mr. Silverstein to
11 V. K. Rowe with a carbon copy of a whole list of
12 people, it's entitled "Report on the Chloracne Problem
13 Meeting on 3-24-65".

14 MR. DAVIS: Okay. I think we have introduced
15 that one. Let me -- it was difficult to read. No,
16 this is not it. I don't know that I have that. What
17 else?

18 MS. JONES: Okay. I have got an April 25th,
19 1967 memo to K. E. Coulter, C-o-u-l-t-e-r, regarding
20 chloracne research program.

21 MR. DAVIS: Going back to that first one,
22 LeeAnn, was that with regard to the meeting in Midland?

23 MS. JONES: Yes. 3-24-65 meeting.

24 MR. DAVIS: Okay. I may have that. I didn't
25 realize it was from Mr. Silverstein.

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1 MS. JONES: It is part of the documents you
2 guys produced at Dr. Ratalik's deposition.

3 MR. PIERCE: Who is the author of the '67
4 memo?

5 MS. JONES: I can't tell from my copy.

6 MR. DAVIS: If you want to fax it up here --

7 MR. PIERCE: Is Mr. Silverstein even mentioned
8 on the 1967 one or is he the author?

9 MS. JONES: I can't tell from the copy that I
10 have got. That's what I wanted to ask him.

11 MR. DAVIS: I don't have that one.

12 (DepX# 22 marked.)

13 MR. DAVIS: What would you like to ask about
14 it? We have got the March 29th, 1965 document marked
15 as Exhibit 22 and we have the April 10th, 1970 document
16 marked already as Exhibit 13.

17 MS. JONES: Okay. Great.

18 EXAMINATION

19 BY MS. JONES:

20 Q Mr. Silverstein, would you like to take a couple of
21 minutes to look over those documents or do you feel
22 like you have already looked over them.

23 MR. PIERCE: Well, obviously he has not looked
24 over one of them.

25 Q Right, that's the March 29th. And to narrow it down to

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1 save you some time the only things I am going to ask
2 you about are on the first couple of pages of that
3 document.

4 I just wanted to let you know for your purposes I
5 am going to be asking questions about the first couple
6 of pages but you may want to look over the whole
7 document just to familiarize yourself with it.

8 A Yes, I think so. Okay.

9 Q Okay. You ready?

10 A Yes, ma'am.

11 Q Mr. Silverstein, the exhibit that has been marked as
12 Exhibit 22 which is a letter dated -- or a memo dated
13 March 29th, 1965, it appears to be authored by
14 yourself, is that correct?

15 A It appears to be a document I wrote, yes, ma'am.

16 Q And you signed it there at the bottom of page 5, is
17 this correct?

18 A Wait a minute. It looks like my signature, yes.

19 Q And what is that document entitled?

20 A "Report on the Chloracne Problem Meeting on 3-24-65".

21 Q And what was the purpose of your preparing that
22 document?

23 MR. PIERCE: If you recall?

24 A I believe I was asked to write a summary of the
25 meeting, LeeAnn.

1 Q I'd like to direct your attention to page 2 of that
2 document to help refresh your recollection.

3 MR. PIERCE: There is no indication the
4 witness needs his recollection refreshed.

5 MS. JONES: I'm not suggesting that he does.

6 Q Do you recall a Dr. Holder giving a report at that
7 meeting?

8 A In general terms, yes, I remember him reporting.

9 Q Do you recall what was the topic of Dr. Holder's
10 report?

11 A He reported on the medical findings and treatment of
12 the Dow employees.

13 Q Do you recall what if anything he reported about any
14 clinical studies that had been done on the workers from
15 Dow who had chloracne?

16 A I don't recall any details, I'm sorry.

17 Q Do you recall if chemical studies had been done on
18 those workers?

19 A I'm out of my field. What do you mean by clinical
20 studies, ma'am?

21 Q Mr. Silverstein, if I could refer you to page 2, about
22 6 or 7 lines down, it states, and if you could just
23 confirm whether you recall this topic being addressed,
24 that he did review the clinical studies that are being
25 made on these people with emphasis on the liver function

1 tests?

2 A Yes, ma'am. I believe I was referring to blood
3 sampling.

4 Q Okay. And do you recall the next sentence, is this
5 correct that the memo states he mentioned the single
6 liver biopsy that has been taken and studied in which
7 the liver was normal although the man had a rather
8 pronounced case of chloracne, is that what you prepared
9 in that memo?

10 MR. DAVIS: Let me object to the reading of
11 portions of the document. You may answer.

12 Q Mr. Silverstein, you can go ahead and answer the
13 question. Did you report that in that March 29th memo?

14 A Yes, ma'am, to the best of my recollection that's what
15 I wrote.

16 Q Did you recall those liver biopsies having been done or
17 that particular liver biopsy?

18 A I remember a single liver biopsy being available to us
19 at that time, yes.

20 Q Do you remember what the result of that biopsy was?

21 A I remember being told that there was no liver injury
22 evidence.

23 Q And did the person on whom the liver biopsy was
24 performed have a case of chloracne?

25 A According to Dr. Holder, yes. I never knew or met the

1 patient.

2 Q Do you recall whether in the clinical studies that Dr.
3 Holder performed he found any other significant effects
4 other than chloracne among the Dow workers?

5 MR. DAVIS: I am going to object to the form
6 of the question as being vague.

7 MR. PIERCE: You can answer.

8 A Not to my knowledge.

9 Q Did you report in that March 29th, 1965 memo that Dr.
10 Holder reported to the group that he mentioned the
11 incidence of fatigue among the afflicted people as
12 being the only other significant finding in these
13 folks?

14 MR. DAVIS: Object. The document speaks for
15 itself.

16 Q Could you go ahead and answer, do you recall whether
17 you reported that he mentioned that at the meeting?

18 A I remember that being known in terms of the medical
19 department telling us about it that this seemed to be a
20 finding amongst the folks but I don't class that as a
21 clinical study. But I am a layman.

22 Q Do you also recall that there were no other significant
23 findings reported by Dr. Holder?

24 MR. DAVIS: Objection.

25 A That's my general recollection, yes, ma'am.

1 Q Do you recall back in 1965 what the limit of
2 detectability of TCBD using the gas chromatography
3 method was?

4 A My recollection is that, it was -- that it changed, of
5 course; with improvements that it was something like 1
6 ppm. That's the number I remember.

7 Q All right. Now, if you would take a look at the
8 exhibit that is dated April 10th, 1970, which I believe
9 already has been marked as Exhibit #13.

10 A Yes, ma'am.

11 Q Could you tell me who the author of that memo was?

12 A It appears to be a document that I authored.

13 Q Who did you send it to?

14 A J. B. Fernandez.

15 MR. PIERCE: Are you asking his independent
16 recollection now or what the document indicates?

17 MS. JONES: What the document indicates.

18 A It is addressed to J. B. Fernandez.

19 Q What was the topic of that memorandum?

20 A It is entitled "Dowicides Chloracne History".

21 Q Did you know in about 1970 at the time you prepared
22 that memorandum on April 10th, 1970, that studies which
23 had been done at that point indicated that the rabbit
24 ear test was more sensitive than human response to the
25 acnegen?

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1 A I believe that's what I knew at the time or thought I
2 knew.

3 Q In reference to the 1967 study that Mr. Davis asked you
4 about earlier of the human volunteers, do you recall
5 that that study indicated that rabbits were at least 10
6 to 100 times more sensitive to 2,3,7,8-TCBD than the
7 human volunteers who were exposed in the same manner?

8 MR. DAVIS: Objection to the leading question.

9 A I recall that I made that judgment, yes.

10 Q Since Mr. Davis has objected to the question I would
11 like to rephrase it. Do you recall anything, any
12 judgments that you made about the 1967 human volunteer
13 study of exposure to 2,3,7,8-TCBD as compared to the
14 rabbit ear studies?

15 A My recollection is that I judged that rabbit ears were
16 10 times more sensitive as an indicator than human
17 beings.

18 Q Mr. Silverstein, referring to many of the questions
19 that Mr. Davis has asked you today about precautions
20 that you either recommended or that were implemented by
21 Dow, what was the purpose of instituting those
22 precautions and procedures?

23 MR. PIERCE: Objection to the form of the
24 question.

25 Q You can go ahead and answer.

1 A The changes, the precautions were all aimed at reducing
2 exposure of Dow employees to the materials.

3 Q Were those all instituted after the 1964 incident of
4 Dow workers coming down with chloracne?

5 A Some of them were in force before that to my -- to the
6 best of my recollection, LeeAnn.

7 Q If you will bear with me for just a minute while I go
8 back through my notes. Mr. Silverstein, back in 1964
9 and 1965 did you know anything about the Hercules
10 process for manufacturing 2,4,5-T?

11 A No, ma'am.

12 Q Do you currently know anything about the Hercules
13 process for manufacturing 2,4,5-T?

14 A No, ma'am.

15 Q Do you have any way of knowing whether any differences
16 existed between the Hercules process and the Dow
17 process for manufacturing 2,4,5-T?

18 A In the course of my involvement in that Dow tested some
19 Hercules' products, that's the only knowledge I have.

20 Q But you have no knowledge about whether there were any
21 differences between the two processes used by the
22 companies?

23 A I have no knowledge on that subject.

24 Q Would you have any way of knowing whether differences
25 in the process used by Hercules as opposed to the

1 process used by Dow might have some effect on the
2 sensitivity of the gas chromatography method for
3 detecting TCBD in either the product or the waste of
4 Hercules?

5 MR. PIERCE: Objection to the form of the
6 question and objection to this witness being asked
7 areas far outside his expertise.

8 MR. DAVIS: I join in that objection.

9 Q You can go ahead and answer if you know.

10 A Well, they stole my answer. You are way outside of my
11 area of expertise. I have no idea.

12 Q That's a perfectly fine answer. Mr. Silverstein, based
13 on your experience as an industrial hygienist would it
14 be fair to say that different precautions are necessary
15 in a laboratory setting than in an actual production
16 setting?

17 A That's a fair generalization, yes, ma'am.

18 Q So precautions and procedures that may be necessary in
19 one setting may not be necessary or appropriate in
20 another?

21 MR. DAVIS: Objection to the leading question.

22 A Another good generalization.

23 Q Mr. Davis referred to a French company that you visited
24 when you went to Europe to investigate some other plant
25 processes. Do you recall the name of that company?

1 A I do not, ma'am.

2 Q Mr. Silverstein, when did you first learn that Monsanto
3 had experienced problems with chloracne among its
4 workers at their plant in Nitro, West Virginia?

5 MR. PIERCE: Objection to the form and no
6 foundation.

7 Q First, to change that, did you ever learn that Monsanto
8 experienced any problems with chloracne among its
9 workers in Nitro, West Virginia?

10 A I remember becoming aware of that at sometime but I
11 don't remember when.

12 Q Do you remember ever learning that BASF experienced
13 problems with chloracne among its workers?

14 A I don't remember that, no, ma'am.

15 Q Do you ever remember that Boehringer, the German plant
16 that you visited, experienced chloracne with its
17 workers?

18 A Yes, ma'am, I do remember that.

19 Q Do you know when you first learned that?

20 A I don't know.

21 Q Do you have a recollection as to approximately when you
22 first learned that?

23 A Early in 1964 I think.

24 Q Did you ever learn whether Diamond Alkali ever
25 experienced any problems with chloracne among its

1 workers?

2 A I'm thinking. I don't remember knowledge on Diamond
3 Alkali, no.

4 Q Do you recall ever learning that Rhone Polunc had a
5 problem with chloracne among its workers?

6 A No, ma'am. I didn't hear that name until I left Dow.

7 Q Have you learned since leaving Dow that Rhone Polunc
8 had a problem with chloracne among its workers?

9 A No. You were the first to advise me.

10 MR. PIERCE: I wouldn't call that advising.

11 Q Do you recall ever learning whether Phillips Dufar had
12 a problem with chloracne among its workers?

13 A That name strikes a familiar bell in my recollection
14 but only the name, I don't remember details.

15 Q In investigating the problem that Dow experienced with
16 chloracne among its workers and in your job as an
17 industrial hygienist trying to come up with possible
18 solutions to that problem, would you have been
19 interested in investigating any plant that was
20 operating and its procedures which had managed not to
21 have any problem with chloracne in its production
22 process?

23 MR. PIERCE: Objection to the form of the
24 question.

25 MR. DAVIS: I join.

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1 Q I will rephrase it. Mr. Silverstein, did you conduct
2 an investigation to determine possible process
3 improvements that you could make to solve the
4 difficulty that Dow was having with chloracne among its
5 workers?

6 MR. PIERCE: Objection to the characterization
7 and I think he's answered in respect to his knowledge
8 of production techniques earlier but go ahead and
9 answer.

10 A Well, I was I'm sure interested in ways to reduce the
11 problem and control it. That would include process
12 steps but I'd ask an engineer to go look for me in that
13 instance.

14 Q Would you have been interested in investigating the
15 processes used by any company that did not experience a
16 chloracne problem?

17 MR. DAVIS: Objection, lack of foundation.

18 MR. PIERCE: Objection as to form.

19 A I would have been very interested in their industrial
20 hygiene procedures, definitely.

21 Q Were you aware in the 1960's that Hercules did not have
22 any problem with chloracne at its plants?

23 MR. DAVIS: Objection. Leading and lacks
24 foundation.

25 A I don't remember.

1 Q Strike it. Were you aware whether or not Hercules had
2 a chloracne problem at its plant?

3 A I don't remember having a knowledge either way on that
4 one, LeeAnn.

5 Q If you had been aware at the time that Hercules did not
6 have chloracne among its workers would that have been
7 something that you would have been interested in
8 investigating?

9 MR. PIERCE: Objection. Completely
10 speculative.

11 MR. DAVIS: I join.

12 A I believe so.

13 MS. JONES: That's all I have.

14 MR. PIERCE: Thank you. We'll see you later.

15 MR. DAVIS: One follow-up.

16 EXAMINATION

17 BY MR. DAVIS:

18 Q Just going back to Exhibit 22 which was introduced by
19 Ms. Jones, this Exhibit 22 describes a chloracne
20 problem meeting on March 24th, 1965. Were you present
21 at that meeting, Mr. Silverstein?

22 A Yes, sir.

23 Q Was Mr. C. L. Dunn from Hercules present at that
24 meeting?

25 A I do not remember specifically, sir.

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1 Q I will show you Exhibit 22. Does that refresh your
2 recollection?

3 MR. PIERCE: Are you asking him if that's what
4 it says or whether it refreshes his recollection of C.
5 L. Dunn being present?

6 Q Does Exhibit 22 say that C. L. Dunn was present at the
7 meeting?

8 A Yes.

9 Q And you wrote Exhibit 22 shortly after that meeting,
10 correct?

11 A Yes, sir.

12 Q And does Exhibit 22 also show that Dr. John Frawley
13 from Hercules was present at that meeting?

14 A The document shows that, yes, sir.

15 MR. DAVIS: That's all I have.

16 MR. PIERCE: Okay. LeeAnn?

17 MS. JONES: Okay.

18 (Deposition concluded.)

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1 STATE OF MICHIGAN)

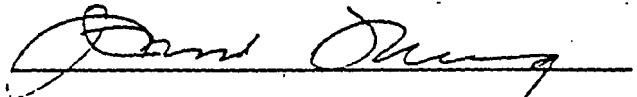
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2 COUNTY OF SAGINAW)

3
4 I certify that this transcript, consisting of 92
5 pages, is a complete, true, and correct record of the
6 testimony of LAWRENCE G. SILVERSTEIN held in this case
7 on July 18, 1990.

8 I also certify that prior to taking this deposition
9 LAWRENCE G. SILVERSTEIN was duly sworn to tell the
10 truth.

11 I also certify that I am not a relative or employee
12 of or an attorney for a party; or a relative or employee
13 of an attorney for a party; or financially interested in
14 the action.

15
16 July 24, 199017 
J. Richard Loberg, RPR, CSR-2315

18 Notary Public, Saginaw County, MI

19 My commission Expires: 9-3-91

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NEWMAN v. AT&T - Attachment to Memo of
11/29/91 - Exhibit of Documents

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ATTACHMENT TO MEMORANDUM OF NOVEMBER 29, 1991
(NEWMAN V. AT&T)

EXHIBIT LIST

1. 2/22/71: Courtney, K. Diane et al, "Teratology Studies with 2,4,5-Trichlorophenoxyacetic Acid and 2,3,7,8-Tetrachlorodibenzo-p-dioxin", Toxicology and Applied Pharmacology, Vol. 20, pp. 396-403, National Institute of Environmental Health Sciences, Research Triangle Park, North Carolina. This study was done with mice and showed that these compounds produced cleft palates and kidney malformations. (These samples were supplied by Dow Chemical with TCDD contamination of 0.5 ppm).

Note: Based on other similar studies I have reviewed, the strain of mice used produces different results with different laboratories doing these tests. Pick the right mouse, and your product will appear to be harmless! In this particular test, even small amounts of TCDD caused adverse damage to the mice on an acute basis. What you would like to see are long term chronic effects from these same chemical samples. Current experts say that it will produce various forms of cancer in some of the test animals every time if you do a chronic test versus an acute test.

2. 6/4/73: Yoder, J. et al, "Lymphocyte Chromosome Analysis of Agricultural Workers During Extensive Occupational Exposure to Pesticides", Mutation Research, Vol 21, pp. 335-340. This study looked at exposed individuals just after a heavy spraying period and noted a marked increase in the frequency of chromatid lesions. This was done in Idaho and sponsored by the EPA to evaluate the effects of pesticide exposure on human health. 2,4-D was the particular herbicide that most of the workers were exposed to, but some were also exposed to 2,4,5-T.

Note: Once again, this was only an acute study, but it showed immediate effects in many workers. If a chronic testing were done over a period of years, the true results would be known.

3. 6/21/73: Russian Study by Pilinskaya, M.A., "Cytogenetic Effect of the Herbicide 2,4-D on Human and Animal Chromosomes", Tsitologiya i Genetika, Vol. 8, No. 3, pp. 202-206 (1974). The study looked at the cytogenetic action of 2,4-D in lymphocyte cultures of human peripheral blood and in bone-marrow cells from unpedigreed white mice. It was shown that human chromosomes in cultures were more sensitive to the injurious action of 2,4-D than that of the mice. The results obtained enabled the Russians to assign the herbicide 2,4-D to the class of substances presenting a potential genetic hazard to humans.

4. 11/3/81: Burmeister, Leon F., et al, "Leukemia and Farm Practices in Iowa", American Journal of Epidemiology, vol. 115, No. 5, pp. 720-728. Death certificate analyses of 1675 white, male Iowans over age 30 years who died of Leukemia in 1964-1978 were completed. The highest ratios of deaths were in those counties with the largest number of acres treated with herbicides among persons 65 years of age or younger. The types of leukemia causing elevated mortality in Iowa farmers were CHRONIC LYMPHATIC LEUKEMIA and unspecified lymphatic. 39.5% of the deaths from leukemia in white males over 30 years of age were farmers in the 1964-1978 period studied. (It noted a similar Nebraska study where 39.9% of the leukemia deaths in white males over 30 years of age were also farmers). The study noted that one mechanism of increasing the risks for farmers for leukemia and other cancers is contamination of shallow farm wells and farm ponds.

5. 10/10/85: Rivarola, V.A., et al, "DNA and Protein Synthesis Inhibition in Chinese Hamster Ovary Cells by Dichlorophenoxyacetic Acid", Toxicology Letters, Vol. 29, pp. 137-144. This was a study done in Argentina that tested the health effects of 2,4-D on DNA and protein synthesis and determined that 2,4-D affects both of these. The way these cells were affected depended on their stage of growth and the method of treatment. The effect was expressed as an inhibition of DNA and protein synthesis.

6. 10-18 March 1987: From the World Health Organization: International Agency for Research on Cancer meeting in Lyon, France on "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans", pp. 156-160 of Supplement 7 on "CHLOROPHENOXY HERBICIDES". The overall view of the expert opinions given was that these herbicides were **possibly carcinogenic to humans**. THE CONSENSUS OF OPINION WAS BASED ON THE FACT THAT ENOUGH TESTING HAD NOT BEEN DONE ON ANIMALS.

Comment: The arguments presented here centered on acute exposures. If it doesn't give you cancer immediately, then it gets a "possible category" rating. This category is generally used for agents for which there is limited evidence in humans in the absence of sufficient evidence in experimental animals.

7. 10/7-8/88: First Annual Scientific Assembly on Environmental Health in New Orleans. They presented talks on: ROUTES OF EXPOSURE, THE POLITICS OF CANCER; HOW CHEMICALS AFFECT HEALTH; REPRODUCTIVE TOXICITY; FEDERAL/STATE INVOLVEMENT; HEALTH STUDIES; NEUROTOXICITY; CASE STUDIES; and several others. Video tapes are available on all these talks for \$14.95 each or a set of all seven for \$65.00.

Comment: These tapes were highly recommended by Mike Caddell. (Dr. Marvin Legator appears on two of the tapes).

8. 1/88: USDA Publication from the Pacific Northwest Region of

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The U.S. Forest Service on "Managing Competing and Unwanted Vegetation: Final Environmental Impact Statement", Section 6 titled "Data for evaluation of Human Epidemiology." This study evaluates exposures of 2,4-D and/or 2,4,5-T and looks at the types of cancers associated or possibly associated with them including lung cancer, stomach cancer, leukemia, Hodgkin's disease, Non-Hodgkin's Lymphoma, and soft tissue sarcomas. It also implicates reproductive effects and clearly states there are neurologic effects.

9. 1988: Stokes, C. S., et al, "Agricultural Chemical Use and Cancer Mortality in Selected Rural Counties in the USA", Journal of Rural Studies, Vol. 4, No. 3, pp. 239-247. Findings of this study suggest that agricultural chemical use is related to county cancer mortality. For three of the five categories of cancer included, agricultural chemical use was the best predictor of cancer mortality. They look at groupings of cancer in : Genital, urinary, lymphatic and hematopoietic, respiratory, and digestive areas of the body. In four of these five areas, herbicide use in particular was significantly related to cancer rates. The respiratory cancer category was the only one that did not rate high from these herbicide exposures.

10. 1980's (?): "Genetic Toxicology: An Agricultural Perspective", edited by Fleck, R.A. et al . This study states "As competing organisms evolve resistance to commonly used agents, new and more effective poisons and repellents must constantly be developed. The fundamental problem in pesticide development is to produce chemicals that act specifically against certain organisms without adversely affecting others. BECAUSE OF THE SIMILARITIES IN THE STRUCTURAL, METABOLIC AND GENETIC COMPONENTS OF ALL LIFE FORMS, ABSOLUTE SPECIES SPECIFICITY IS FREQUENTLY DIFFICULT TO OBTAIN. Furthermore, such toxic chemicals improperly used may engender biological effects beyond those for which they were originally manufactured."

Note: This study shows the specific genetic centers that 2,4-D and 2,4,5-T attack.

11. 4/4/90: Editorial by Blair, A., "Herbicides and Non-Hodgkin's Lymphoma: New Evidence From a Study of Saskatchewan Farmers", Journal of the National Cancer Institute, Vol. 82, No. 7, pp. 544-545. Evidence from 69,513 Saskatchewan farmers, age 35 and older, which provide further evidence that the use of herbicides is associated with the risk of non-Hodgkin's lymphoma. Mortality from non-Hodgkin's lymphoma rose significantly with increasing numbers of acres sprayed with herbicides, particularly on smaller farms where the farmer is more likely to have personally engaged in herbicide application. He points out that "The International Agency for Research on Cancer concluded that the evidence for carcinogenicity of 2,4-D and 2,4,5-T in animals was inadequate. This presents a dilemma to the scientific community in how to draw conclusions regarding carcinogenicity of a substance when the epidemiologic and experimental data do not agree, especially

in situations where the epidemiologic evidence is positive and experimental evidence is not." He further states "EXPERIMENTAL INVESTIGATIONS OF PESTICIDES SHOULD UTILIZE DERMAL EXPOSURE, THE PRINCIPAL ROUTE OF OCCUPATIONAL EXPOSURE IN HUMANS."

12. 3/90: "Environmental Health Monthly", "Abstract", Vol.2, No 6. This is an abstract from the study presented in my exhibit #9 above. It makes a further point in this review by saying "cancer mortality rates tend to underestimate the disease experience of a population because the actual numbers of people with the disease at any given time is greater than the number of people who have died from it.

Comment: What this is saying is that the numbers of people who have contracted cancer and are still living, exceeds those who have previously died from it. You could conclude that something has been introduced into the environment in the last 30 to 40 years (the time for many chronic forms of cancer to show themselves) that has changed the rate at which the population is getting cancer. We you see how these herbicides have affected our water supplies, our farm crops and farm animals, gotten into almost all of our food chains, our fish, and then when banned from this country, the chemical manufacturers take it to third world countries and spray it on their crops which are exported back to us, it is no great mystery why so many more people are now getting cancer. The irony of all this is that companies like Dow are still telling everyone that their herbicides are perfectly safe.

13. 4/4/90: Wigle, D.T. et al, "Mortality Study of Canadian Male Farm Operators: Non- Hodgkin's Lymphoma Mortality and Agricultural Practices in Saskatchewan", Journal of the National Cancer Institute, Vol. 82, No.7, pp.575-582. This is the full study of the editorial mentioned above in my exhibit #11. They conclude by showing that these farmers who have been exposed to herbicides have a 220% greater risk in dying from non-Hodgkin's lymphoma than those in other occupations.

14. November 1990: 33 Law Reporter, p. 373. "Nonmedical Expert Witness With Adequate Training, Education, and Experience Could Express Novel Cancer-Causation Theories." Rubanick v. Witco Chem. Corp., 576 A.2d 4 (N.J. Super. Ct. App. Div.1990). The appeals court held that a biochemist who had done extensive research in cancer causation was qualified to testify on cancer development and related scientific matters based on his knowledge, training, and experience. Even though his theory was a novel scientific opinion that had not been accepted by at least a substantial minority of the scientific community, the court held that lack of agreement within the scientific community goes to the weight of the testimony - not its admissibility.

Another article was: "Expert's Testimony Was Admissible Despite the Lack of Epidemiological Evidence Linking Chemical Exposure to Colon Cancer." Christophersen v. Allied-Signal Corp., 902 F.2d 362 (5th Cir. 1990). The court said that, generally,

of detail. Even the damages are broken down into numerous sub-categories. This has to be a strong way of intimidating your opponent when you have a good case. If this were read to a jury before the presentation of your evidence, it would be very hard for the jury not to be greatly affected. Exhibits were attached to this petition giving credible evidence to each and every point claimed.

NOTE: Mike Caddell recommended that if your case should go before mediation, or you have a serious settlement conference with Dow, that you insist on having in-house management present, besides their lawyers. The attorney's usually do not have the authority to offer beyond a certain amount, and Mike said it has been his experience that they will often "low ball" the final offer just to get a complete look at your whole case. If their insurance carrier is involved, insist on having a management representative there that has the authority to make a final offer.

20. 8/2/91: Legator Exhibit #1 from his deposition titled "Possible Manifestations of Mutational Events in Humans." This was his way of showing a jury exactly how the herbicides are absorbed into your body through the skin and attack the DNA, which goes on to the various cell groups and picks the course of attack for your body. He has a lot of credibility in his field of medicine and has appeared all over the world talking about this process.

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EX. # 1-20

Teratology Studies with 2,4,5-Trichlorophenoxyacetic Acid and 2,3,7,8-Tetrachlorodibenzo-P-dioxin

K. DIANE COURTNEY* AND JOHN A. MOORE

National Institute of Environmental Health Sciences, P.O. Box 12233,
Research Triangle Park, North Carolina 22709

Received February 22, 1971

Teratology Studies with 2,4,5-Trichlorophenoxyacetic Acid and 2,3,7,8-Tetrachlorodibenzo-P-dioxin: COURTNEY, K. D., and MOORE, J. A. (1971). *Toxicol. Appl. Pharmacol.* 20, 396-403. The herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) were teratogenic in the CD-1, DBA/2J, and C57B1/6J strains of mice. Both compounds produced cleft palates and kidney malformations. When these compounds were administered in combination, the activity was not potentiated at the doses employed. In the CD rat, 2,4,5-T was neither teratogenic nor fetotoxic. However, TCDD produced kidney anomalies. Prenatal administration of 2,4,5-T did not affect the postnatal growth and development of the CD rat.

The herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) is one of the chlorinated phenoxyacid class with extensive utilization as a defoliant (Audus, 1964). Pharmacologic and toxicologic reports considered this compound to be only moderately toxic in animals (Drill and Hiratzka, 1953; Rowe and Hymas, 1954). A recent report found 2,4,5-T to be teratogenic in mice and rats (Courtney *et al.*, 1970), but it was later found that the sample of 2,4,5-T used contained 30 ppm of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), a by-product formed during the commercial manufacturing process. TCDD and other closely related compounds are considered extremely toxic and have been implicated in outbreaks of chloracne in chemical workers (Schulz, 1968), lethal hepatonecrosis in rabbits (Schulz, 1968), chick edema factor (Higginbotham *et al.*, 1968), and a disease in animals fed toxic fat (Allen and Carstens, 1967). Since it was not known whether the teratogenic results previously reported were due to 2,4,5-T, TCDD or the combination, a study was initiated in mice and rats to determine the teratogenic agent.

MATERIALS AND METHODS

Two different samples of 2,4,5-T and one sample of TCDD were used. All samples were supplied by Dow Chemical Company, Midland, Michigan. The samples of 2,4,5-T designated by the authors as technical (2,4,5-T/tech) and analytical (2,4,5-T anal) grade were analyzed by the Dow Chemical Company; the results of their analyses are presented in Table 1. The analysis of TCDD found it to be of greater than 99% purity.

* Present address: Perrine Primate Laboratory, EPA, p.o. Box 490, Perrine, FL 33157.

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TABLE 1

CHEMICAL ANALYSIS OF ANALYTICAL AND TECHNICAL GRADE SAMPLES OF
2,4,5-T. ANALYSES SUPPLIED BY DOW CHEMICAL COMPANY

Impurities	Quantity of impurities	
	Technical ^a	Analytical
TCDD (2,3,7,8-tetrachlorodibenzo- <i>p</i> -dioxin)	0.5 ppm	<0.05 ppm
2,5-Dichlorophenoxyacetic acid	0.42%	<0.1%
2,4-Dichlorophenoxyacetic acid	0.05%	<0.1%
2,6-Dichlorophenoxyacetic acid	<0.02%	0
2,3,6-Trichlorophenoxyacetic acid	0.55%	<0.1%
2,4,6-Trichlorophenoxyacetic acid	<0.1%	0
Bis(2,4,5-trichlorophenoxy) acetic acid	0.4%	0
3 Isomers of dichloromethoxyphenoxyacetic acid	2.9%	0.2%
2,4,5-Trichlorophenol	<0.1%	0

^a Dow Lot No. 120449.

Three strains of mice and 1 strain of rat were used. The random-bred mouse, CD-1 strain, was considered the animal of choice for these studies since it would allow for the expression of results against a heterogeneous genetic background. To assess results against a homozygous genetic background, two inbred strains of mice, DBA/2J and C57B1/6J, were also used. Rats of the CD strain were used. Both the CD-1 mice and CD rats were procured from Charles River Laboratories, Wilmington, Massachusetts. The mice of the two inbred strains, DBA/2J and C57B1/6J were procured from the Jackson Laboratories, Bar Harbor, Maine and subsequently mated at the Institute. Detection of a vaginal plug in mice and presence of sperm in vaginal smears from rats indicated day 0 of pregnancy. All animals were primiparous females, housed individually, and allowed free access to food and water.

2,4,5-T and TCDD were administered sc as solutions in 100% (CH₃)₂SO (dimethyl sulfoxide) in volumes of 100 μ l per mouse for each injection. This procedure was selected since a previous study (Courtney, *et al.*, 1970) showed that the po or sc route yielded equivalent incidences and types of anomalies. 2,4,5-T was administered to rats by gastric intubation as a suspension in 15% sucrose solution: volumes of 200 μ l per rat were used for each administration. TCDD was administered sc to rats in (CH₃)₂SO in volumes of 100 μ l per injection. In all animals, the administration of compounds commenced on day 6 of gestation and continued on a daily basis through day 15 of gestation.

CD-1 strain mice were killed on day 17 of gestation, C57B1/6J and DBA/2J strains of mice on day 18 of gestation, and CD strain rats on day 20 of gestation. All animals were killed by decapitation after which both mother and fetuses were examined grossly. Fetuses were fixed in Bouin solution until necropsied.

The following conventions were observed in compiling data. If a fetus was either dead or resorbed, it was regarded as a dead fetus. Only live fetuses were examined for physical abnormalities. A fetus was classified abnormal if it was alive and had at least one type of anomaly (regardless of type). Similarly, a litter was classified as abnormal if it contained one or more abnormal fetuses. A fetus was said to have abnormal kidneys if at least one of its kidneys was affected. In calculating the ratios of liver to body weight in

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the mother, maternal body weight was defined as the difference between the weight of the mother on the day it was killed and the gravid uterus weight. Maternal weight gain was defined as the difference in the adjusted maternal weight on the day it was killed and its weight on day 6 of pregnancy.

For statistical analysis, the litter was considered the experimental unit. Five litters or less were considered an insufficient sample size for statistical analysis. Averages were calculated for each litter, then across litters. The Mann Whitney U and chi square tests were used.

RESULTS AND COMMENTS

The 3 experiments with the CD-1 mouse are presented separately so that the experimental animals could be compared to their respective controls. This was preferred due to slight variations observed in the randombred mouse.

Table 2 presents the toxicologic evaluation of 2,4,5-T and TCDD in the pregnant mouse and rat. It had been reported earlier that $(\text{CH}_3)_2\text{SO}$ was neither toxic nor teratogenic under the conditions of this experimental design (Courtney *et al.*, 1970). The current data confirm this observation. The following results are shown in Table 2.

Fetal mortality. 2,4,5-T/tech was fetocidal in the CD-1 mouse at a dose of 150 mg/kg which may be close to a maternal toxic dose. At all other doses studied, 2,4,5-T/tech or 2,4,5-T/anal did not affect fetal viability in the mouse. In the rat, there was a significant increase in fetal mortality at a dose of 80 mg/kg. Since this dose was a maternal LD₄₀, the increase in fetal mortality may be related to maternal toxicity. TCDD did not increase fetal mortality in the mouse or rat at the doses employed.

Fetal weight. In all mouse strains, both samples of 2,4,5-T, at 100 mg/kg and greater, significantly reduced fetal weight. The lowest dose of 2,4,5-T, in experiment 1 with the CD-1 mouse, did not affect fetal weight. An apparent dose-related response is seen in this experiment and experiment 3. The reduction in fetal weight is probably a toxic action on the fetus. The administration of 2,4,5-T/tech to rats did not affect fetal weight. TCDD did not significantly affect fetal weight of either mice or rats.

Maternal weight gain. Maternal toxicity was evaluated by the maternal weight gain during gestation. In the studies with the C57B1/6J mice, 2,4,5-T/tech produced a significant reduction in maternal weight gain. In all other mouse studies, neither 2,4,5-T/technical, nor 2,4,5-T/analytical, nor TCDD significantly affected maternal weight gain. In the rat, 2,4,5-T/tech caused a reduction in maternal weight gain at the 2 highest dose levels while TCDD was without significant effect. In general, a reduction in maternal weight gain suggests some maternal toxicity.

Maternal liver to body weight ratio. Both samples of 2,4,5-T caused a significant increase in the ratio of maternal liver to body weight in all 3 strains of mice. In the CD-1 mouse, TCDD did not affect this parameter, but did produce a significant increase in this ratio in the inbred strains of mice. In the rat studies, neither 2,4,5-T nor TCDD affected this ratio. The significance of liver enlargement due to pesticides has been extensively discussed by Golberg (1966). It is attributed in many cases to a hyperplasia and concomitant increase in the metabolism of pesticides, stimulated or induced by the pesticide itself. In the rat, there was no increase in the ratio of liver weight to body weight, and the rat does not readily metabolize 2,4,5-T unless it is induced (Courtney, 1970). In contrast, with 2,4,5-T stimulation there was liver enlargement in the mouse.

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TOXICOLOGIC EVALUATION OF 2,4,5-T AND TCDD*

Species	Compound	Dose d	No of litters	Average % fetal mortality/litter	Average fetal weight (g)		Maternal weight gain (g)		Maternal liver/body weight × 100	
					$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
CD-1 mouse, random bred										
Expt. 1	DMSO c	a	12	6.6	1.35	0.09	2.25	2.00	7.73	0.37
	2,4,5-T/tech	50	7	6.6	1.26	0.07	2.87	1.84	8.22	0.72
	2,4,5-T/tech	100	3	7.5	1.00	0.07	4.76	0.89	9.35	0.44
	2,4,5-T/tech	150	4	51.7	0.91	0.14	4.14	2.45	10.23	0.67
Expt. 2	DMSO	a	9	8.8	1.02	0.20	2.92	1.54	8.06	0.50
	2,4,5-T/anal	100	9	9.6	0.73*	0.16	2.97	1.76	9.51*	0.96
	TCDD	1	9	13.6	1.07	0.24	2.44	1.93	7.62	0.95
	TCDD	3	10	12.4	0.96	0.24	2.80	1.85	8.54	0.41
Expt. 3	DMSO	a	8	8.4	1.09	0.20	3.44	1.86	8.59	1.08
	2,4,5-T/tech	100	10	10.7	0.85*	0.13	4.46	2.22	10.18*	0.46
	2,4,5-T/anal	100	10	11.6	0.86*	0.17	3.17	2.85	10.53*	1.20
	2,4,5-T/anal	125	9	12.9	0.71*	0.25	3.75	4.16	10.99*	0.70
	2,4,5-T/anal + TCDD	100 + 1	10	11.8	0.78*	0.11	3.75	1.85	10.69*	0.55
DBA/2 mouse, inbred	DMSO	a	24	26.1	0.85	0.11	3.82	1.68	8.65	0.64
	2,4,5-T/tech	100	11	27.0	0.67*	0.10	2.37	2.15	9.72*	0.78
	TCDD	3	9	27.0	0.89	0.13	3.97	1.89	9.15*	0.38
C57Bl/6 mouse, inbred	DMSO	a	24	10.8	0.99	0.09	3.35	1.48	8.00	0.60
	2,4,5-T/tech	100	15	15.9	0.75*	0.12	1.67*	1.68	10.39*	1.00
	TCDD	3	7	5.3	1.05	0.16	3.25	1.27	9.31*	0.30
CD rat, random bred										
Group 1	Sucrose	a	29	3.4	2.48	0.25	65.56	11.56	5.17	0.36
	2,4,5-T/tech	10	10	1.8	2.40	0.38	61.13	11.44	5.23	0.39
	2,4,5-T/tech	21.5	8	1.4	2.54	0.20	63.83	9.19	5.04	0.25
	2,4,5-T/tech	46.4	7	3.8	2.20	0.42	43.21*	19.80	5.29	0.48
	2,4,5-T/tech	80.0 b	4	52.1	2.30	0.20	27.25	25.17	5.95*	0.31
Group 2	DMSO	a	9	0.0	2.44	0.05	69.70	13.15	5.35	0.39
	TCDD	0.5	6	3.0	2.41	0.17	57.96	10.12	5.65	0.45

* Abbreviations: a = 100 µl/animal; b = maternal LD40; * p < 0.05; c = dimethyl sulfoxide; d = TCDD expressed as µg/kg; 2,4,5-T expressed as mg/kg.

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and the mouse does show an increase in microsomal drug metabolism (unpublished data).

Cleft palate. The teratogenic evaluation of 2,4,5-T and TCDD is presented in Table 2. Both samples of 2,4,5-T produced cleft palate in all 3 mouse strains. A dose-related response is suggestive in the CD-1 mouse with 2,4,5-T/tech in experiment 1 and is apparent in experiment 3 with 2,4,5-T/anal. Also, in experiment 3, both samples of 2,4,5-T at 100 mg/kg were equivalent in response since the number of litters affected and the incidence of cleft palate in these litters were essentially the same.

TCDD also produced cleft palate in all 3 strains of mice. In experiment 2, with the randombred mouse, TCDD was studied at 2 dose levels. At the lower dose level, 1 μ g/kg, only 1 litter had fetuses with cleft palate, while at the 3 μ g/kg dose, 3 out of 10 litters had fetuses with cleft palate. Also, in experiment 3, TCDD was combined with 2,4,5-T/anal to determine whether the response of 1 compound was affected by the presence of the other. Cleft palates were produced by the combination but there appeared to be no potentiation of the teratogenic effect.

Neither 2,4,5-T nor TCDD produced cleft palate in the rat fetuses. An additional study was undertaken to evaluate the possibility that 2,4,5-T could cause cleft palate in the rat. Nine rats received 2,4,5-T/tech, 150 mg/kg, sc on days 13 and 14 of gestation, the time of palate closure. This is the maximum dose which could be tolerated for 2 days and not cause maternal mortality. No cleft palates were observed in these fetuses; however, there was an increase in fetal mortality (14%) which was statistically significant compared to the control value (0%).

Kidney anomalies. The other anomaly to be considered in these studies involves the kidney. All kidneys were sliced open and examined grossly. The anomalies observed could be described as unilocular cystinephrotic kidney as well as hydronephrosis of all gradations. Histopathologic studies are under way to clearly define the renal malformations. Until further definition is accomplished, all types of kidney malformations are simply tallied as kidney anomalies.

As can be seen from the 3 experiments with the CD-1 mouse, the incidence of renal anomalies in the control animals varied. In the first experiment no kidney malformations were observed, whereas in the second and third experiments there was a low incidence which may be considered normal for this strain. The 2 inbred strains also had a low background incidence of kidney anomalies.

In experiment 1 with the CD-1 mouse, 2,4,5-T/tech did not affect kidney development. In the fetuses from mice treated with 2,4,5-T/anal, 100 mg/kg (experiments 2 and 3), there was an increase in the incidence of litters affected and also in the average number of fetuses in these litters displaying kidney malformations. Administration of 2,4,5-T/tech did not produce as great a response. In the studies with the inbred strains of mice, 2,4,5-T/tech did not increase in the incidence of kidney anomalies relative to the control values.

Treatment with TCDD produced a marked increase in the incidence of kidney anomalies in all mice strains, and a dose-related response is evident in experiment 2 with the CD-1 mouse. There was no potentiation of the response when 2,4,5-T/anal was administered in combination with TCDD. The mouse studies showed that the C57Bl/6J mouse was the most sensitive strain to TCDD-induced effects in that almost 100% of the fetuses displayed kidney anomalies.

TABLE 1
INCIDENCE OF CLEFT PALATE AND KIDNEY ANOMALIES IN FETUSES OF CD-1, C57BL/6J, AND BALB/C MICE

Cleft palates

Kidney anomalies

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INCIDENCE OF CLEFT PALATE AND KIDNEY ANOMALIES IN 2,4,5-T AND TCDD-TREATED MICE AND RATS*

Species	Compound	Dose d	No. live litters	Av. No. live fetus/litter	Cleft palates		Kidney anomalies	
					No. litters affected	Av. No. cleft palates in affected litters	No. litters affected	Av. No. affected fetuses in affected litters
<i>Mouse</i>								
CD-1, random bred								
Expt. 1	DMSO c	a	12	11.8	0	0	0	0
	2,4,5-T/tech	50	7	12.0	0	0	0	0
	2,4,5-T/tech	100	3	11.7	1	3.0	0	0
	2,4,5-T/tech	150	3	9.0	3	5.3	0	0
Expt. 2	DMSO	a	9	11.4	0	0	3	1.0
	2,4,5-T/anal	100	9	11.8	8	4.4	7	1.7
	TCDD	1	9	9.4	1	2.0	5	4.6
	TCDD	3	10	10.4	3	1.0	10	6.5
Expt. 3	DMSO	a	8	11.3	0	0	5	2.0
	2,4,5-T/tech	100	10	10.4	4	2.0	8	2.4
	2,4,5-T/anal	100	10	9.8	4	2.0	10	4.2
	2,4,5-T/anal	125	9	9.7	7	5.4	6	4.3
	2,4,5-T/anal + TCDD	100 + 1	10	10.9	4	3.3	8	5.3
DBA/2J, inbred	DMSO	a	23	5.1	0	0	3	1.0
	2,4,5-T/tech	100	11	3.7	3	1.0	1	1.0
	TCDD	3	9	6.1	2	1.0	8	1.8
C57Bl/6J, inbred	DMSO	a	23	7.2	0	0	2	1.0
	2,4,5-T/tech	100	15	6.7	6	1.2	0	0
	TCDD	3	7	8.3	5	2.6	7	8.0
<i>Rat</i>								
CD random bred								
	Sucrose		29	9.3	0	0	0	0
	2,4,5-T/tech	10	10	10.2	0	0	2	1.0
	2,4,5-T/tech	21.5	8	10.6	0	0	3	1.3
	2,4,5-T/tech	46.4	7	8.9	0	0	1	2.0
	2,4,5-T/tech	80 b	2	12.5	0	0	1	4.0
	DMSO	a	9	11.6	0	0	0	0
	TCDD	0.5	6	8.0	0	0	4	1.8

* Key to letters: a - 100 μ l/animal; b - maternal LD40; c - dimethyl sulfoxide; d - TCDD expressed as μ g/kg; 2,4,5-T expressed as mg/kg.

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In the rat, 2,4,5-T tech produced a minimal response in kidney malformation. TCDD produced a slightly greater response; therefore, additional studies were taken in the rat to evaluate the effect of TCDD on kidney development. TCDD was administered on days 9 and 10 (6 rats) or days 13 and 14 (8 rats) of gestation at a dose of 2 μ g/kg, in (CH₃)₂SO sc. In the control rats, there were no fetuses with kidney malformation as compared to an 11% incidence from treatment with TCDD on days 9 and 10 and 34% incidence from treatment on days 13 and 14. Thus, it appears that TCDD impairs kidney development in the rat fetus. In these studies, no cleft palates were observed in the control or experimental fetuses.

Some sources of species and strain differences in teratology have been reported (Baker *et al.* (1970) and Smithberg (1967)); however, until the mechanism of action of 2,4,5-T or any other teratogen is more fully understood, it is difficult to explain the difference in species response. Currently, the fetal response to 2,4,5-T is being studied in the mouse and rat to see whether this might explain the difference in response of these 2 species.

Other anomalies. A few additional types of anomalies were observed in the control and experimental rats. In general, the type and incidence of these anomalies were similar in control and experimental animals.

Also, in this study, 2 very mild hemorrhagic gastrointestinal tracts were observed in 2,4,5-T treated rats and 6 hemorrhagic gastrointestinal tracts in TCDD treated rats. Hemorrhagic gastrointestinal tracts are probably a result of toxicity as opposed to a malformation. In this case, the toxicity is most likely on the fetus as opposed to maternal toxicity being reflected in the fetus.

Postnatal study. In order to confirm that 2,4,5-T was not teratogenic in the rat, a postnatal study was undertaken. Eight pregnant rats were administered 50 mg/kg, po, in sucrose from day 6 through 15 of gestation. Seven control rats were administered 0.2 ml sucrose. All rats were allowed to litter. The neonates were examined on day 1 and twice weekly thereafter until sacrificed on day 21. Litter size was comparable in the 2,4,5-T/anal treated litters to the controls at all times. Litter size was less than 1% in both groups. The weight gain for the 3 wk period was comparable in both groups. Eye opening occurred on days 13 and 14 for all neonates, both in the 2,4,5-T/anal treated and control groups. Thus, under the conditions of these experiments, 2,4,5-T is not a teratogen in this strain of rat and prenatal administration does not impair postnatal development.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance of Mrs. J. Putnam, Mr. M. Harris, and Mr. M. Riley. The statistical analyses were performed by Dr. M. Hogan, and J. Haseman. The authors thank Dow Chemical Company for their assistance in supplying the chemicals and the analyses.

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LYMPHOCYTE CHROMOSOME ANALYSIS OF AGRICULTURAL WORKERS DURING EXTENSIVE OCCUPATIONAL EXPOSURE TO PESTICIDES*

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Received March 1st, 1973

Revision received June 4th, 1973

SUMMARY

Lymphocyte cultures from 42 pesticide applicators and 16 controls were scrutinized for chromosomal aberrations during the midwinter ebb in pesticide spraying operations, and again during the peak summer period of intense spraying activity. Cultures prepared from the exposed individuals during the heavy spraying period showed a marked increase in the frequency of chromatid lesions. This trend was especially noticeable among workers exposed primarily to herbicides. A few chromatid exchange figures were also noted among the exposed group. Also discussed is the need for better methods of estimating the potential mutagenic threat, if any, of such observed clastogenicity.

INTRODUCTION

The Idaho Community Study on Pesticides is one of thirteen similar research facilities throughout the United States in areas where pesticides are extensively used. Sponsored by the Environmental Protection Agency, the primary task of this unified investigative effort is to evaluate the effects of pesticide exposure on human health. The Idaho program is now in its sixth year of intense clinical, biochemical and epidemiological scrutiny of a core group of carefully selected volunteers having extreme occupational exposure to various pesticides. An additional parameter currently being examined in detail is the possibility of using cytogenetic analysis of lymphocyte chromosomes as an index of pesticide mutagenicity in man.

Cytogenetic analysis of chromosomal aberrations in somatic cell cultures is one of the major methods of testing currently recommended for evaluating chemical mutagenesis in mammalian systems^{1,2,3,4}. Most investigators agree that the dominant lethal test and the host-mediated assay are also important test procedures, and that

* This research was supported under Contract No. 68-02-0882 by the Division of Pesticide Community Studies, Office of Pesticides Programs, Environmental Protection Agency, and by the Idaho State Department of Environmental and Community Services.

all three should be utilized in confirming mutagenicity in mammals. However, the latter two techniques are not suited for use with human subjects, and somatic cell cultures thus remain the only practical method of assaying morphological evidence of apparent damage to the human genetic material, *per se*. With respect to such cultures, *in vivo* techniques are preferred over *in vitro* tests because they provide the added advantage of taking metabolism into account^{6,12}. Although such an approach by itself cannot provide unassailable proof of concurrent gametic involvement, it appears likely that autosomal aberrations may indicate parallel gonosomal events of a similar nature¹⁴. Even as a purely somatic indicator, analysis of lymphocyte chromosomes would seem highly pertinent when one considers that many spontaneously occurring diseases, certain neoplasms included, are now believed to be caused by environmental pollutants³.

The tremendous array of agricultural xenobiotics now in common use constitutes a large portion of the various chemical agents to which man is environmentally exposed. The indiscriminate use of such substances would logically present the possibility of a genetic legacy of increased mutation frequency and subsequent human hazard. Increased aberrations of lymphocyte chromosomes have been recently reported⁹ in a group of Michigan fruit producers involved in heavy pesticide spraying. Accordingly, we have examined chromosomes of peripheral lymphocytes (leukocytes) cultured from persons selected from our occupationally exposed study group. The prevalence of chromatid lesions among these volunteers has then been compared with that of a control group, both prior to and during the heavy spray season.

MATERIALS AND METHODS

It was initially hoped that sufficient numbers of persons having exclusive occupational exposure to a single chemical series could be obtained. However, because of the great agricultural diversity of this region, such a sampling technique proved to be impossible. Within Canyon County alone, in which most of the exposed participants reside, more than one million pounds of pesticides were applied to crops during 1972 (ref. 10). This figure, irrespective of other agricultural chemicals such as fertilizers, amounts to approx. 4 pounds of pesticides for each acre of farmland. Persons highly exposed to pesticides in this area usually apply a large variety of chemicals throughout the growing season, and multiple exposure is the rule rather than the exception. For these reasons, dose or duration of exposure is another variable that cannot be rigidly defined by such an approach.

Because of their local prevalence in pesticide-related occupations, only male Caucasians were sampled. Persons with recent histories of viral infections, chemotherapy or X-ray treatment were rejected, as were those with histories of malignancies. A total of 16 control and 42 exposed persons, matched as closely as possible as to ages and physical characteristics, were chosen. High exposure was defined as spraying with pesticides for at least 4 h per day on three or more days per week throughout the peak spray season of June 15th through August 30th. The control group was composed of businessman, students, health professionals and teachers who had no history of involvement with pesticides. Ages of the control group ranged from 19 to 64 (mean 36.8). Persons in the exposed group ranged in age from 18 to 70 (mean 38.6) and had from 1 to 25 years (mean 8.5) of prior occupational exposure to pesticides. As shown

TABLE 1

PESTICIDES MOST COMMONLY USED BY
ORDER OF FREQUENCY

Group A Insecticide-exposed	
Common name	Type ^b
Demeton	OP
Ethyl parathion	OP
Trichlorofen	OP
Naled	OP
Malathion	OP
Dicofol	OC
Diazinon	OP
Endosulfan	OC
DNOC	PH
Methyl parathion	OP
Toxaphene	OC
Dimethoate	OP
DDT	OC
Chlordimeform	OC
Oxydemetonmethyl	OP
TEPP	OP
Carbaryl	C

^a Nomenclature after Borz¹ and Fr¹.^b OP, organic phosphorus series; OC, organochlorine series; PH, phosgene series.

in Table I, persons in the exposed group had a mean age of 42.3; mean years of prior occupational exposure to pesticides was 8.5; mean years of prior agricultural exposure was 10.5. The pesticides most frequently used by the exposed group were demeton, ethyl parathion, and malathion. The pesticides applied less frequently by the control group were diazinon, DDT, and DDT. The mean age of local weed control agencies was 36.5; mean years of prior agricultural exposure was 10.5. The pesticides most frequently used by the control group were diazinon, DDT, and DDT.

Blood samples (10 ml) were obtained from all persons during the off-season, January-March. Blood samples were also obtained from all persons during the peak season of pesticide application, June-August. The daily exposure among the agricultural workers was extensively noted prior to both sampling periods.

Lymphocyte cultures were prepared using the technique of (Difco Laboratories, Detroit, MI) previously reported by Mookerjee¹⁵. The procedure was to increase mitogenic stimulation to facilitate the technique. The saturation of mitotic division in order to mini-

TABLE I

PESTICIDES MOST COMMONLY USED BY EXPOSED SUBJECTS IN THIS STUDY* (LISTED IN DECREASING ORDER OF FREQUENCY)

Group A Insecticide-exposed		Group B Herbicide-exposed
Common name	Type ^b	Common name
Demeton	OP	2,4-D
Ethyl parathion	OP	Amitrole
Trichlorofon	OP	Atrazine
Naled	OP	Zineb (fungicide)
Malathion	OP	DCPA
Dicofol	OC	Dicamba
Diazinon	OP	Chlorpropham
Endosulfan	OC	Alachlor
PNOC	PH	Metiram (fungicide)
Methyl parathion	OP	Trifluralin
Toxaphene	OC	Maneb (fungicide)
Dimethoate	OP	Picloram
DDT	OC	Diquat
Chlordimeform	OC	2,4,5-T
Oxydemetonmethyl	OP	
TEPP	OP	
Carbaryl	C	

* Nomenclature after Berg³ and Frear⁴^b OP, organic phosphorous series; OC, organic chlorine series; PH, phenolic series; C, carbamate series

mammals. However, the objects, and somatic cell morphological evidence. With respect to such because they provide the Although such an approach to gametic involvement, it parallel gonosomal events of cells of lymphocyte chromo- that many spontaneously believed to be caused by

now in common use consti- man is environmentally tically present the pos- and subsequent human nes have been recently re- heavy pesticide spraying. lymphocytes (leukocytes exposed study group. The been compared with, spray season.

ns having exclusive occu- ned. However, because of technique proved to be the exposed participants pplied to crops during 1972 fertilizers, such as fertilizers, of farmland. Persons highly of chemicals throughout er than the exception. For ble that cannot be rigidly

occupations, only male rmal infections, chemo- with histories of malignan- as fully as possible as to re- was defined as spraying per week throughout the ted group was com- who had no history rned from 19 to 64 (mean 38.6) and had 3 pesticides. As shown

in Table I, persons in the exposed group were further divided into two subgroups in accordance with their predominant type of occupational exposure. Group A (mean age, 42.3; mean years of prior exposure, 12.0) consisted of 16 cropdusters, formulators, spray rig operators and farmers who were chiefly exposed to insecticides. The specific chemicals most frequently dispersed by Group A were the organic phosphorous compounds demeton, ethyl parathion, trichlorofon and naled. These and other insecticides applied less frequently by the group are summarized in Table I. Group B (mean age, 30.5; mean years of prior agricultural exposure, 6.3) was comprised of 26 employees of local weed control agencies. These persons were all predominantly exposed to herbicides; especially 2,4-D, amitrole and atrazine (Table I).

Blood samples (10 ml heparinized) were first obtained from all volunteers during the off-season, January–February, 1971, when none of them had been occupationally exposed for a period of at least 30 days. A second blood sample was then obtained from all persons during the period of July through August, which is well into the peak season of pesticide application and represents a common interval of intense daily exposure among the agricultural workers selected. Each person was interviewed extensively prior to both samplings and all pesticide-related information was carefully noted.

Lymphocyte cultures were prepared by means of Difco TC chromosome culture kits (Difco Laboratories, Detroit, Michigan). The technique is based on the procedure previously reported by MOORHEAD *et al.*¹² Our only modification of their standard procedure was to increase incubation temperature from 37° to 38°, which seemed to facilitate the technique. The samples were cultured for 48 h to obtain cells in the first mitotic division in order to minimize the variability in aberration yield that is some-

times associated with longer culture times¹. Flame-dried slides were stained with Giemsa and rearranged and coded by a person other than the scorer to avoid bias. 25 metaphase spreads from each person were then examined microscopically for chromosomal aberrations. Only karyotypable cells having widespread chromatids with minimal overlapping were selected for scoring. Photographs were made of all abnormal metaphase figures and karyotyping was performed whenever there appeared to be evidence of obvious chromosomal rearrangement. The criteria of GILBHART⁷ were followed in the determination of chromatid achromatic lesions (gaps), breaks and chromatid exchange figures.

RESULTS AND DISCUSSION

Other than random loss of chromosomes, heteroploidy was not demonstrated in any of the 1450 mitotic bursts examined. With respect to chromosomal lesions, the majority of achromatic areas (gaps) and breaks were confined to single chromatids. Although isochromatid lesions were occasionally encountered in both control and exposed individuals, this apparent trend toward chromatid aberrations rather than chromosome aberrations would appear to merit further study.

The incidence of chromatid lesions on a per person basis is presented in Table II. The mean number of gaps and breaks per person per 25 cells examined did not appreciably change for the control group at either sampling period. Among the exposed group, however, the mean number of gaps per person nearly doubled in cul-

TABLE II
SEASONAL VARIATION IN THE OCCURRENCE OF CHROMATID LESIONS

Group	Number of cells		per person per 25 cells examined			
			Chromatid gaps		Chromatid breaks	
			Off-season	Mid-season	Off-season	Mid-season
Controls	16	Mean $\pm$ S.E.	0.63 $\pm$ 0.22	0.69 $\pm$ 0.24	0.31 $\pm$ 0.12	0.44 $\pm$ 0.22
		Range	0-3	0-3	0-1	0-3
Total exposed	42	Mean $\pm$ S.E.	0.62 $\pm$ 0.11	1.14 $\pm$ 0.17	0.17 $\pm$ 0.08	1.71 $\pm$ 0.24
		Range	0-2	0-5	0-2	0-6
Group A (Insecticide-exposed)	16	Mean $\pm$ S.E.	1.00 $\pm$ 0.22	0.75 $\pm$ 0.27	0.31 $\pm$ 0.18	1.56 $\pm$ 0.29
	10	Range	0-2	0-3	0-2	0-3
Group B (Herbicide-exposed)	26	Mean $\pm$ S.E.	0.38 $\pm$ 0.10	1.38 $\pm$ 0.22	0.07 $\pm$ 0.05	1.81 $\pm$ 0.35
		Range	0-1	0-5	0-1	0-6

tures from the mid-summer samples, and the mean number of breaks observed per person increased by a factor of 10. The maximum number of gaps found in any single exposed individual (Table II) increased from 2 in the slack season cultures to 5 in the midseason cultures. Maximum breaks for any single exposed volunteer rose from 2 to 6 during the same period. (Different persons were involved in each of the four cases cited.)

Those exposed primarily to insecticides (Group A) exhibited a 25% reduction in the mean number of gaps per person in cultures from the high exposure period. However, the mean number of breaks increased 5-fold in these same samples. Members of the group frequently involved with herbicide spraying (Group B) showed an in-

crease of nearly 4 times the mean number of breaks per person per 25 cells examined during the high exposure period (Table II). Also noteworthy is that breaks, respectively, during the high and slack exposure groups. On the other hand, the mean number of gaps noted in Group B workers during the slack season is a possibility of induced compensatory proliferation of chromosomal repair.

During the July-August season (when 100 cells examined), a small number of cells included one Group A quadriradial, two Group B triradials, and a possible Group G triradial. Such general population at a frequency of 1% in our exposed group approaches that of any of these configurations, but, unlike the controls, were sampled in the control group. A version in the A 2 chromosome. This appears in any of the other 25 cells examined.

From these results, it is apparent that damage in lymphocyte cultures is greater during the heavy spray season. However, the possibility of concurrent damage is relative. Because of the tremendous variability in the direct phenotypic surveillance and retrospective techniques. One can compare existing health statistics. Unpublished data compiled with the geneticist in the incidence of such parameters as neoplasms, etc., among agricultural workers because of insufficient data. On a basis of estimate mutagenicity in suspected view techniques. However, a major researcher and subject.

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Slides were stained with
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ly was not demonstrated
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asis is presented in Table
5 cells examined during
2 period. Among the ex-
n nearly doubled mean

Chromatid breaks	
Off-season	Mid-season
0.31 ± 0.12	0.44 ± 0.22
0-1	0-3
0.17 ± 0.08	1.71 ± 0.24
0-2	0-6
0.31 ± 0.18	1.56 ± 0.29
0-2	0-3
0.07 ± 0.05	1.81 ± 0.35
0-1	0-6

of breaks observed per
f gaps found in any single
eason cultures to 5 in the
l volunteer rose from 2 to
in each of the four cases

hibited a 25% reduction
the high exposure period.
s same samples. Members
Group B showed an in-

crease of nearly 4 times the mean number of gaps per person during the peak spraying season. Mean breaks per person for Group B increased by a factor of 25 during this period (Table II). Also noteworthy is that the two subjects having the most gaps and breaks, respectively, during the high exposure period were members of the herbicide-exposed group. On the other hand, the markedly low frequency of breaks (0.07 ± 0.05) noted in Group B workers during the slack season invites speculation as to the possibility of induced compensatory protection occurring at this time in the form of enhanced chromosomal repair.

During the July-August scoring of the 42 highly exposed individuals (1050 cells examined), a small number of chromatid exchange figures were noted. These included one Group A quadriradial, two Group C triradials, two Group F quadriradials and a possible Group G triradial. Such interchanges have been found to occur in the general population at a frequency of about one per 3000 cells⁴. The frequency noted in our exposed group approaches one per 200 cells. None of the controls exhibited any of these configurations, but, unfortunately, fewer individuals (400 cells examined) were sampled in the control group. One exposed individual also had a pericentric inversion in the A 2 chromosome. This was confirmed by karyotyping but did not appear in any of the other 25 cells scored for that person.

From these results, it is apparent that the extent of visible chromosomal damage in lymphocyte cultures prepared from the exposed group is considerably greater during the heavy spray season. Without additional correlative studies, however, the possibility of concurrent mutagenic involvement must remain only speculative. Because of the tremendous limiting factors imposed by long generation times, the direct phenotypic surveillance of human populations is restricted to only a few retrospective techniques. One such method would logically include the analysis of existing health statistics. Unfortunately, contemporary vital records are not usually compiled with the geneticist in mind. We have recently attempted to examine the incidence of such parameters as stillbirths, teratisms, retardation etiologies, neoplasms, *etc.*, among agricultural workers in this state, and have had little success because of insufficient data. On a more personal level, another aid in seeking to estimate mutagenicity in suspected populations is the large scale use of detailed interview techniques. However, a major obstacle here is the extent of credibility between researcher and subject.

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SHORT COMMUNICATION

Lack of mutagenicity of th

Cyclamate, a commonly used sweetener in rabbits, dogs and man, although placed²⁸, CHA and N-OH-CHA are to be a considerable individual is an indication that the amount of radiation²⁸.

Cyclamate has been found in four cytogenetic assay systems in mutations to 8-azaguanine resistance CHA on chromosome breakage, *in vitro* are contradictory^{10,18}. Chinese hamster bone marrow N-OH-CHA failed to induce an early negative in a host-mediated implantation loss in rats¹² and mutations was detected¹⁶. In mice but did not induce dominant mutations.

In view of the conflicting results regarding the use of cyclamate effects of the cyclamate metabolic constitution *R(1)2;B* or *Y* concentrations ranging from 0.01 to 0.20% (0.01-0.20%). Following two or three females of the generation denoted (b) where mass mating the males were mated for 6 successive cell stages, whereas in the feeding for a period of 5 days. The translocations were scored.

Chemical damage to several generations and become chemical mutagens is, therefore, of MNNG have even been four tests for sex-linked recessive detect mosaic lethals. For detection.

In Tables I and II the data. It can be seen that the frequency including postmeiotic (A, B, C) larval feeding. Although the number

Abbreviations: CHA = cyclohexylamine; N-OH-CHA = N-hydroxycyclohexylamine; MNNG = N-methyl-N-nitrosoguanidine.

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CYTOGENETIC EFFECT OF THE HERBICIDE 2,4-D ON HUMAN AND ANIMAL CHROMOSOMES

M. A. Pilinskaya

Tsitologiya i Genetika, Vol. 8, No. 3, pp. 202-206, 1974

UDC 615-099-056.7

Introduction. Certain pesticides can make a definite contribution to induced mutation in man. Identification of those pesticides that are potential mutagens, whose accumulation in various environmental objects can present a genetic hazard not only to individuals but also to the population as a whole, is therefore an especially pressing task.

From this standpoint, it is wise to investigate the mutagenic activity of widely used herbicides of the 2,4-D group (chlorophenoxy derivatives).

The cytogenetic action of chlorinated phenoxy acid derivatives has been investigated principally for various plants [1-5]. Some members of the chlorophenoxy series have recently been studied in insects and mammals [6-8].

The present investigation was conducted to investigate the cytogenetic effect of one preparation in this group, 2,4-dichlorophenoxyacetic acid (2,4-D) on human somatic cells in vitro and mouse cells in vivo. This herbicide was selected from the rather extensive chlorophenoxy acid group because residues of any preparation of this type in plants essentially consist of 2,4-D [9].

Experimental subjects and method. The in vitro experiments were conducted with blood from two clinically healthy donors with normal karyotypes, who had not been exposed to any factor capable of affecting the aberration frequency. The lymphocytes were cultured and chromosome preparations made up by the method described in the literature [10]. The 2,4-D was added to the culture 3 h after incubation was begun and exposure was continued to the end of the incubation period.

The in vivo experiments were conducted with unpedigreed male white mice weighing 18-20 g. Chromosome preparations were made up from bone-marrow cells by the method customarily employed in our laboratory [11]. The 2,4-D was administered orally with milk in a single dose. The animals were killed by decapitation 20 h after administration of the herbicide.

The chromosome analysis was carried out by the method described previously [10].

The uniformity of the experiments with respect to the aberrant-cell frequency was checked by the χ^2 method. No significant differences ($P > 0.1$) were observed in the experimental duplications, so the results of the duplicate experiments were summed. The statistical reliability of the differences between the experimental and control variants and between different dosages was determined by the ϕ method [12].

Experimental results and discussion. The cytogenetic activity of 2,4-D in a human lymphocyte culture was studied with concentrations having a cytotoxic effect (50 and 20 $\mu\text{g/ml}$) and concentrations not having a cytotoxic effect (2.0, 0.2, 0.02, and 0.002 $\mu\text{g/ml}$). The results obtained in chromosome analysis of cultures treated with different dosages of 2,4-D are given in Tables 1 and 2.

It can be seen from Table 1 that the number of aberrant metaphases differed reliably from the spontaneous level for all 2,4-D concentrations except the lowest ($P < 0.001$, $P < 0.05$). An increase in the 2,4-D concentration in the culture to more than 0.2 $\mu\text{g/ml}$ was not accompanied by a reliable increase in the number of aberrant metaphases ($P > 0.05$) although there was a tendency for the maximum cytogenetic effect to occur at a dose of 2.0 $\mu\text{g/ml}$. Large doses of the preparation, which had a cytotoxic action on the culture, obviously caused some of the aberrant cells to die or retarded their entry into mitosis, so that the total number of aberrations remained constant. A decrease in the herbicide

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Table 1
Frequency and Types of Chromosome Aberrations in Human Lymphocyte Culture With Different 2,4-D Concentrations

2,4-D concentration		Number of aberrations			Aberrations per 100 cells				
$\mu\text{g}/\text{ml}$	M	Number of metaphases examined	Frequency of metaphases with aberrations, %	total	chromatid type		chromosome type		
					single fragments	asymmet-ric ex-changes	symme-tric ex-changes	dicen-trics	total
10.000	2.5×10^{-4}	500	8.00 ± 1.213	43	6.2	0.2	0	0.4	6.6
20.000	10^{-4}	500	8.40 ± 1.241	44	7.2	0	0	0.2	7.2
2.000	10^{-4}	500	9.40 ± 1.343	58	9.8	0	0	0.2	9.8
0.200	10^{-4}	500	6.60 ± 1.253	48	6.8	0	0	0.2	6.8
0.020	10^{-4}	500	4.20 ± 0.907	22	3.8	0	0	0	3.8
0.002	10^{-4}	500	2.80 ± 0.735	14	2.0	0	0	0	2.0
Control		800	1.75 ± 0.469	14	1.1	0	0	0	1.1

concentration in the culture (starting at 0.2 $\mu\text{g/ml}$) caused a decrease in the number of damaged cells. The data obtained did not make it possible to evaluate the dependence of dosage over the range tested.

Aberrations of both the chromatid and chromosome types developed under the action of the 2,4-D, in a ratio of 4 : 1 (Table 1). Single acentric fragments predominated among the chromatid rearrangements. At the minimum preparation concentration, symmetric chromatid exchanges were observed in three metaphases (Fig. 1), i.e., this 2,4-D concentration was not "ineffective," as it would have seemed if the abnormality spectrum were not evaluated. The chromosome aberrations were principally paired acentric fragments.

It can be seen from Table 2 that the identified breaks were distributed randomly over the chromosome groups ($P > 0.05$). However, the damage was not uniformly distributed over the chromosome arms: 81.4% of the breaks were localized in the long arms. The maximum number of abnormalities occurred in the telomeric third of the long and short arms (70.6% and 74.3%).

Table 2
Distribution of Number of Breaks Caused by 2,4-D
Over Chromosome Groups

2,4-D concentration, $\mu\text{g/ml}$	Chromosome groups									
	A-1	A-2	A-3	B	C	D	E	F	G+Y	total
50,000	3	1	1	8	21	2	2	1	2	41
20,000	3	3	1	6	19	2	3	1	11	38
2,000	5	8	2	8	15	1	0	1	1	41
0,200	4	5	2	3	7	3	3	1	4	32
0,020	0	1	1	4	5	2	5	2	0	20
0,002	2	0	0	2	9	1	1	1	0	16
Total (observed number of breaks)	17	18	7	31	60	11	14	7	7	184
Anticipated num- ber of breaks (on basis of chromo- some length)	16.19	15.15	12.71	22.64	71.99	18.76	16.07	8.46	6.04	188
χ^2	0.04	0.53	2.56	1.09	0.22	3.21	0.26	0.25	0.15	10.41

Note. $\chi^2 = 10.31$, 8 degrees of freedom, $P > 0.05$

The cytogenetic activity of 2,4-D in mice was investigated in doses of 300 mg/kg (LD_{50}), 100 mg/kg ($\text{LD}_{50}/3$), 50 mg/kg ($\text{LD}_{50}/6$), and 10 mg/kg ($\text{LD}_{50}/30$). The data obtained in chromosome analysis of bone-marrow cells from these mice are given in Table 3, whence it can be seen that exposure to the preparation in doses of 10 and 50 mg/kg, which did not cause visible symptoms of intoxication, produced an aberrant-cell frequency identical to that in the control. The number of aberrant metaphases differed reliably from the spontaneous level after administration of 2,4-D in doses of 100 and 300 mg/kg, which caused pronounced symptoms of intoxication ($P < 0.05$, $P < 0.001$). The increase in aberration frequency was accompanied by a rise in the average number of abnormalities per subject and per aberrant metaphase, principally as a result of appearance of cells with multiple aberrations (Fig. 2). Single acentric fragments predominated among the induced abnormalities.

Our investigations thus showed that the herbicide 2,4-D is capable of damaging the somatic-cell chromosomes of animals and man. However, a cytogenetic effect developed in mouse bone-marrow cells only under the action of toxic doses of this preparation, so that 2,4-D can obviously be regarded as a weak mutagen for mice. The preparation induced chromosome aberrations in human lymphocytes exposed to concentrations that did and did not have a cytotoxic action.

Human chromosomes in vitro are thus more sensitive to the injurious action of 2,4-D than mouse bone-marrow chromosomes in vivo. These data again emphasize the importance of subject specificity in research on induced chemical mutagenesis.

It is known from the data in the literature on the distribution of 2,4-D in the

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allian organism that this preparation is not metabolized, is excreted unaltered, enters
gonads, and can pass through the placental barrier [13,14], which probably accounts
its teratogenic effect [13-15].

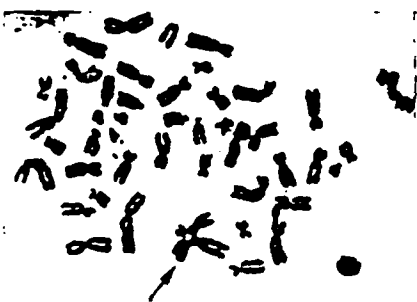


Fig. 1. Symmetric chromatid exchange between chromosome A-1 and C-group chromosome. 2,4-D, in vitro, 0.002 µg/ml, magnification of 10 x 90.



Fig. 2. Multiple aberrations, 2,4-D, in vivo, 300 mg/kg, magnification of 10 x 90.

This herbicide may be distributed in similar fashion in the human body. This hypothesis is supported by data obtained with volunteers given the herbicide 2,4,5-trichloroacetic acid (2,4,5-T), a preparation differing from 2,4-D in having an extra chlorine atom [15]. After a single oral administration of 2,4,5-T, the herbicide was detected in the blood and was excreted unaltered in the urine for three days. If the fate of 2,4-D in the human body is similar, this preparation presents a genetic hazard as a mutagenetically active compound, so that it is necessary to prevent its uptake by man from various environmental objects.

Table 3
Frequency and Types of Chromosome Aberrations in Mice Poisoned with Different Doses of 2,4-D

2,4-D dosage, mg/kg	Number of animals	Number of metaphases examined	Frequency of aberrant metaphases, %	Frequency of cells with multiple chromosome aberrations		Number of aberrations			Types of aberrations per 100 cells		
				% of number of cells investigated	% of aberrant cells	total	per metaphase investigated	per aberrant cell	single fragments	paired fragments	translocations
10	6	1200	0.333 ± 0.165	0	0	4	0.0033	1.00	0.250	0.083	0
50	6	1200	0.833 ± 0.264	0.08	10.0	14	0.0117	1.40	1.000	0.083	0.083
100	6	1200	1.750 ± 0.378	0.16	9.5	25	0.0208	1.19	1.833	0.250	0
300	6	1200	3.083 ± 0.499	1.28	43.3	114	0.0950	3.08	8.583	0.75	0.167
Control	10	1000	0.700 ± 0.264	0	0	7	0.0070	1.00	0.700	0	0

Conclusions. The cytogenetic action of the herbicide 2,4-D was investigated in vitro (in lymphocyte cultures from human peripheral blood) and in vivo (in bone-marrow cells from unpedigreed white mice). It was shown that human chromosomes in cultures are more sensitive to the injurious action of this preparation. The results obtained enable us to assign the herbicide 2,4-D to the class of substances presenting a potential genetic hazard.

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21 June 1973

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Polymers, and Plastics of the Ministry of
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LEUKEMIA AND FARM PRACTICES IN IOWA¹

LEON F. BURMEISTER, STEPHANIE F. VAN LIER AND PETER ISACSON

Burmeister, L. F. (Dept. of Preventive Medicine and Environmental Health, University of Iowa, Iowa City, IA 52242), S. F. Van Lier and P. Isacson. Leukemia and farm practices in Iowa. *Am J Epidemiol* 1982;115:720-8.

Death certificate analyses of 1675 white, male Iowans over age 30 years who died of leukemia in 1964-1978 were completed. Each case was matched to two controls on age (within two years) at death, county of usual residence and year of death. Consideration of usual occupation, as recorded on the death certificate, resulted in an odds ratio for leukemia mortality among farmers of 1.24 ($p < 0.05$). The highest odds ratios for farmers were observed in those born after 1890, those dying after 1970, and those dying at age 65 years or younger. Odds ratios for farmers were also elevated in counties with high soybean and corn production per acre for those born between 1890 and 1900. For those born after 1900, odds ratios for farmers were increased in counties with the greatest numbers of egg-laying chickens and the largest number of acres treated with herbicides. The types of leukemia causing elevated mortalities in Iowa farmers were chronic lymphatic and unspecified lymphatic. Mortality from unspecified lymphatic leukemia was associated with corn per acre, number of milk cows and number of egg-laying chickens.

agricultural workers' diseases; death certificates; leukemia; mortality

During the past two decades, several studies (1-6) have concluded that farmers are subject to increased mortality from leukemia. The studies have been based on a wide range of geographic areas, including Great Britain (5), the entire United States (1, 6) and the western United States (2-4). Of particular concern are the upper midwestern states because of the importance of farming in these states and because of the identification of high-rate leukemia mortality counties in this area (6).

More recent studies (7) have continued to indicate that leukemia mortality rates are elevated in the midwestern states. Although mortality from all cancers was

lower in Iowa farmers, leukemia was one of six cancers with statistically significant elevated mortality (8). A study of Nebraska death certificates by Blair and Thomas (9) also indicated an increased mortality from leukemia in farmers. The Nebraska study is extremely important since it attempts to identify farming practices associated with leukemia. The farming practice in Nebraska most strongly associated with leukemia mortality on a county basis is corn production.

In contrast to the suggestion that farming practices peculiar to corn production may be associated with leukemia, the possibility that dairy farming may be associated with leukemia has also been suggested (10-16). Not all epidemiologic studies evaluating the association of dairy cattle and leukemia have been positive, however (17, 18). Therefore, further research to identify suspected farming practices is necessary.

Because of its high corn and dairy pro-

Received for publication August 31, 1981, and in final form November 3, 1981.

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This work was supported by Public Health Service grant 1 RO1-CA24302-01-EDC from the National Cancer Institute.

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duction, Iowa provides an excellent opportunity to compare the association of suspected farming practices with leukemia. Iowa ranked first in corn production by state in 1950 and 1960, compared to fifth in 1950 and third in 1960 for Nebraska (19, 20). Although Iowa's dairy production (number of cows and heifers two years old and over kept for milk) did not rank as high nationally (fifth in both 1950 and in 1960) as did corn production, it is much higher than that of Nebraska (19th and 18th in 1950 and 1960, respectively). It may be that Nebraska's dairy production is not sufficiently large to allow any association with leukemia mortality to be detected; therefore, the Iowa death certificate study was completed to determine which farming practices are associated with leukemia mortality rates.

MATERIALS AND METHODS

The methods utilized in the Nebraska study were duplicated whenever possible to assure comparability of the two studies. The Nebraska study was based on deaths in 1957-1974, whereas the Iowa study was based on deaths 1964-1978. The following steps, however, are common to the two studies:

- 1) The records of all white males, aged 30 years or more at time of death from leukemia as classified by the Seventh (code 204) and Eighth (codes 204-207) Revisions of the International Classification of Diseases (ICD) (21, 22), were abstracted from computer listings.

- 2) For each leukemia death (1675 in Iowa compared to 1084 in Nebraska), two nonleukemic deaths were selected as controls. The controls were matched by county of usual residence, age at death ($\pm$ two years) and calendar year of death. When more than two eligible controls were identified for a case, the two controls included in the study were selected randomly. Only white males were included in both studies.

- 3) The usual occupation indicated on

the Iowa death certificate was coded according to the 1960 Census (23) for the years 1964-1970 and according to the United States Bureau of Labor (24) for 1971-1978. The entire Nebraska study was based on occupations defined by the Bureau of the Census. However, both studies combined all "non-farmer" occupations.

- 4) Farm owners, tenants and laborers were all considered "farmers."

Iowa counties were ranked according to 1949 crop and livestock production provided by the Iowa Crop and Livestock Reporting Service and by pesticide usage provided by the 1964 agricultural census (25), which is the only year for which pesticide usage data are available. Crop and livestock production figures from 1949 were used to provide a 15-year lag period from time of production until the first year included in the death certificate analyses. However, agricultural production in Iowa counties has changed very little during the past three decades. Spearman rank correlation coefficients for Iowa counties ordered for each of the major agricultural production figures in 1949 and 1974 were highly significant ($p < 0.001$).

The geographic distributions of the highest producing 33 counties (of 99 counties) for selected commodities are indicated in figure 1. Ratios of production of the median county in the highest producing 33 counties to the median county in the lowest producing 66 counties ranged from 1.52 for acres in oats to 3.49 for acres in soybeans.

Estimated relative risks and associated confidence intervals were computed as suggested by Miettinen (26). All computations utilize the matching of two controls to each case.

RESULTS

Heart disease, stroke and circulatory disease accounted for 43.5 per cent of the control deaths in Iowa (compared to 54.2

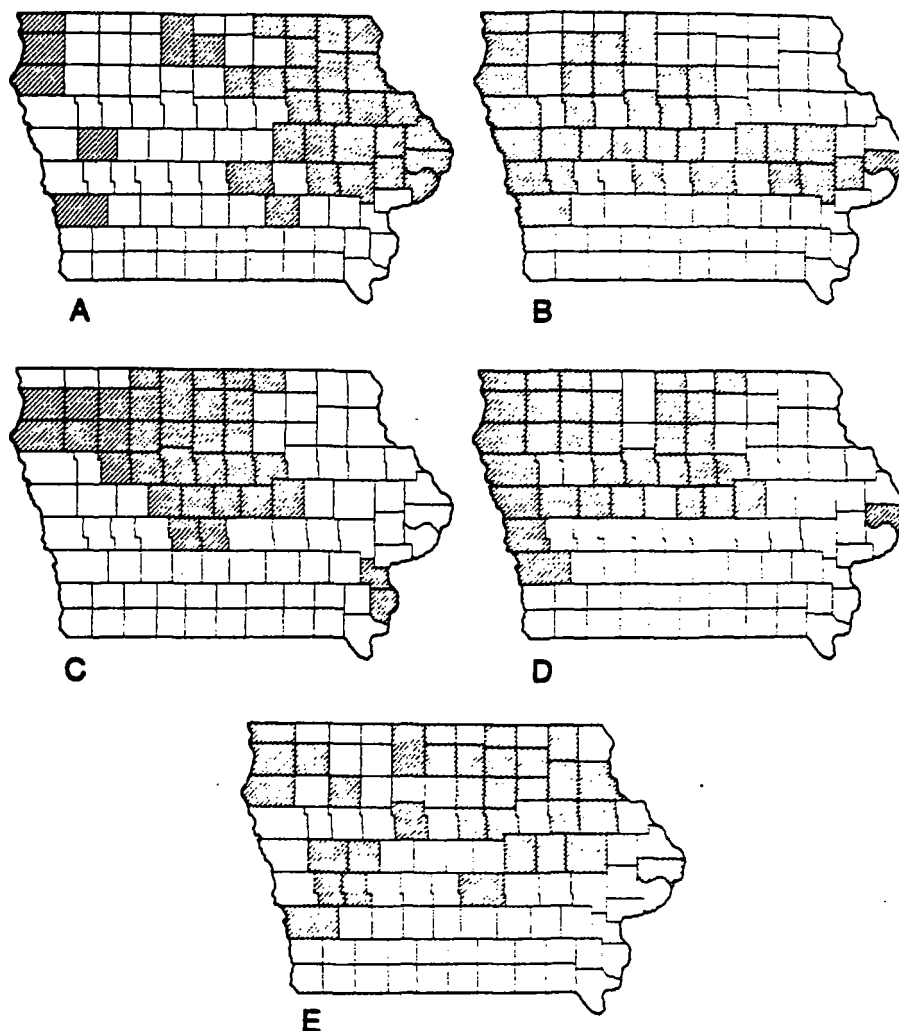


FIGURE 1. Geographic distributions of highest producing 33 Iowa counties for selected agricultural production characteristics. A, milk cows; B, corn; C, soybeans; D, herbicides; E, egg-laying chickens.

per cent in Nebraska). Cancer deaths other than leukemia totaled 18.9 per cent in Iowa (compared to 10.3 per cent in Nebraska).

The distributions of usual occupation for both cases and controls are quite similar in Iowa and Nebraska (table 1). Also similar are the elevated risks of leukemia mortality for farmers. An odds ratio of 1.25 (95 per cent confidence limits of 1.05 and 1.49) was computed for Nebraska. The odds ratio for farming in Iowa was

1.24 with 95 per cent confidence limits of 1.09 and 1.42.

Table 2 summarizes the odds ratios for leukemia mortality computed for separate strata according to year of birth, year of death and age at death. Iowa farmers born after 1890 and those whose age at death was less than or equal to 65 years have odds ratios significantly greater than 1. These results are similar to those found in Nebraska where farmers born after 1900 and those aged 65 years or less

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TABLE 1

Distributions of usual occupation, by death certificate analysis, of leukemia deaths and matched controls, white males over 30 years of age, resident in Nebraska dying 1957-1974, and resident in Iowa dying 1964-1978

Occupational group	Cases				Controls			
	Iowa		Nebraska		Iowa		Nebraska	
	No.	%	No.	%	No.	%	No.	%
Teachers	17	1.0	9	0.8	37	1.1	12	0.6
Engineers, scientists	49	2.9	25	2.3	64	1.9	66	3.0
Farmers	661	39.5	433	39.9	1184	35.3	781	36.0
Clerks, salespersons	116	6.9	84	7.7	230	6.9	163	7.5
Carpenters, woodworkers	89	5.3	31	2.9	183	5.5	52	2.4
Printers	12	0.7	3	0.3	8	0.2	9	0.4
Machinists, mechanics	71	4.2	33	3.0	162	4.8	77	3.6
Laborers	116	6.9	49	4.5	298	8.9	126	5.8
No occupation listed	5	0.3	65	6.0	19	0.6	161	7.4
Other	539	32.2	352	32.5	1165	34.8	721	33.3
Total	1675		1084		3350		2168	

TABLE 2

Odds ratios for leukemia mortality in white, male Iowa farmers over 30 years of age, according to year of birth, year of death and age at death, 1964-1978

Stratum	Cases		Controls		Odds ratio	95% CL*
	No. of farmers	% Farmers	No. of farmers	% Farmers		
Year of birth						
1869-1889	166	49.7	392	52.0	0.89	0.67-1.18
1890-1900	290	47.2	488	39.9	1.36	1.10-1.68
1901-1947	205	28.2	304	22.2	1.39	1.11-1.73
Year of death						
1964-1970	344	40.4	640	37.6	1.15	0.96-1.39
1971-1978	317	38.5	544	33.0	1.36	1.11-1.66
Age (years) at death						
≤65	116	24.1	166	18.5	1.36	1.02-1.80
≥66	545	45.7	1018	41.5	1.21	1.04-1.41

* CL, confidence limits.

at death had increased odds ratios. The odds ratio for farming was also elevated for those dying after age 65 years in Iowa, whereas it was not elevated in Nebraska. The odds ratio for years of death in 1971-1978 was elevated in Iowa; however, the odds ratio for the years of death 1957-1965 was markedly higher in Nebraska.

As noted in table 2, the greatest risk for leukemia mortality in Iowa farmers appears to be in those born after 1890. Therefore, analyses stratified by counties according to selected county production

figures were completed by year of birth of the cases. The results are summarized in table 3.

As might be expected from the low odds ratio for Iowa farmers in those born before 1890 (table 2), there are no significantly elevated risks in this cohort. Soybeans per acre and corn per acre are associated with increased leukemia mortality risks among farmers for those born from 1890 to 1900. However, neither association is statistically significant for those born after 1900. The relatively low livestock producing counties have increased odds

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TABLE 3

Odds ratios for leukemia mortality in white, male Iowa farmers over 30 years of age, according to selected county crop and livestock production, 1964-1978

Production categories by counties	Year of birth (of case)					
	Before 1890		1890-1900		After 1900	
	Odds ratio	95% CL*	Odds ratio	95% CL	Odds ratio	95% CL
Soybeans/acre						
33 highest	0.672	0.415-1.088	1.594	1.129-2.250	1.405	0.979-2.016
Others	1.032	0.727-1.465	1.233	0.940-1.616	1.376	1.038-1.824
Corn/acre						
33 highest	0.831	0.554-1.247	1.634	1.168-2.285	1.384	0.980-1.954
Others	0.947	0.638-1.406	1.201	0.912-1.582	1.389	1.039-1.857
Milk products sold						
33 highest	0.906	0.586-1.401	1.187	0.835-1.685	1.302	0.926-1.829
Others	0.877	0.605-1.271	1.474	1.126-1.929	1.454	1.084-1.950
Cattle						
33 highest	0.969	0.632-1.485	1.287	0.921-1.798	1.231	0.879-1.722
Others	0.831	0.570-1.213	1.414	1.072-1.864	1.522	1.131-2.049
Hogs						
33 highest	0.782	0.512-1.193	1.246	0.873-1.778	1.400	1.006-1.949
Others	0.987	0.675-1.446	1.429	1.095-1.865	1.376	1.019-1.857
Milk cows						
33 highest	0.954	0.623-1.461	1.171	0.827-1.658	1.446	1.027-2.035
Others	0.841	0.576-1.228	1.490	1.136-1.953	1.345	1.004-1.802
Egg-laying chickens						
33 highest	1.105	0.683-1.788	0.954	0.659-1.380	1.532	1.053-2.229
Others	0.792	0.557-1.125	1.627	1.250-2.118	1.314	0.997-1.732
Fertilizer						
33 highest	1.260	0.786-2.018	1.089	0.767-1.548	1.340	0.929-1.934
Others	0.730	0.512-1.042	1.548	1.183-2.026	1.414	1.070-1.870
Insecticides						
33 highest	0.731	0.420-1.271	1.323	0.922-1.900	1.129	0.762-1.673
Others	0.954	0.686-1.327	1.381	1.061-1.797	1.526	1.166-1.998
Herbicides						
33 highest	0.767	0.462-1.273	1.104	0.773-1.575	1.595	1.105-2.301
Others	0.951	0.676-1.337	1.528	1.171-1.994	1.278	0.966-1.691

* CL, confidence limits.

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ratios. None of the agricultural production figures evaluated in Nebraska led to increased risk among farmers in the 1890-1900 cohort.

It is for those born after 1900 that the Iowa and Nebraska studies have the greatest inconsistencies. The odds ratios for farmers in Nebraska were significantly greater than 1 in those counties with the highest production of corn, cattle and hogs and highest number of acres treated with insecticides. None of these farming practices were associated with leukemia mortality in Iowa. Only acres treated with herbicides and egg-laying chickens per county were statistically significant at the 5 per cent level.

The odds ratios for Iowa farmers for specific leukemia cell types are summarized in table 4. Only those dying in 1968-1978 are included in table 4 since the ICD Seventh Revision (used prior to 1968) may not separate acute lymphatic and acute myeloid leukemias. Both

chronic lymphatic and unspecified lymphatic leukemias cause increased mortality in Iowa farmers. The odds ratios for chronic lymphatic leukemia are elevated in those born after 1890 (table 5). Although the odds ratios for unspecified lymphatic leukemia are greater than 1 for each birth cohort, none is statistically significant, due in part to small numbers in each cohort.

Odds ratios for chronic and unspecified leukemias according to county agricultural production figures associated with combined leukemia types are summarized in table 6. Chronic lymphatic leukemia is elevated in both the high and low producing counties for the five county characteristics investigated. The strongest associations, both in magnitude of the odds ratios and differences in the high and low producing counties, are with soybeans per acre and acres treated with herbicides. Unspecified lymphatic leukemia mortality in farmers is associated with corn per

TABLE 4
Odds ratios for leukemia mortality in white, male Iowa farmers over 30 years of age for specific leukemia types, 1968-1978

Leukemia type	ICD No.	Cases		Controls		Odds ratio	95% CL*
		No. of farmers	% Farmers	No. of farmers	% Farmers		
Acute lymphatic	204.0	28	28.9	69	35.6	0.68	0.37-1.23
Chronic lymphatic	204.1	132	45.8	207	35.9	1.70	1.22-2.38
Unspecified lymphatic	204.9	64	51.2	102	40.8	1.66	1.03-2.68
Acute myeloid	205.0	86	30.7	168	30.0	1.04	0.74-1.48
Chronic myeloid	205.1	46	32.6	90	31.9	1.04	0.65-1.65
Unspecified myeloid	205.9	36	36.7	80	40.8	0.80	0.45-1.41
Chronic myeloid	206.0	10	32.3	19	30.1	1.07	0.44-2.59
Leukemia unspecified	207.9	31	41.3	60	40.0	1.07	0.58-1.97

* CL, confidence limits.

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TABLE 5
Odds ratios (ORs) for leukemia mortality in white, male Iowa farmers over 30 years of age for selected leukemia types and year of birth, 1968-1978

Leukemia type	ICD No.	Year of birth					
		Before 1890		1890-1900		After 1900	
		OR	95% CL*	OR	95% CL	OR	95% CL
Chronic lymphatic	204.1	1.00	0.54-1.85	2.03	1.24-3.10	1.80	1.09-2.97
Unspecified lymphatic	204.9	1.58	0.65-4.54	2.30	0.97-6.97	1.25	0.64-2.55

* CL, confidence limits.

TABLE 6
Odds ratios (ORs) for leukemia mortality in white, male Iowa farmers over 30 years of age, according to selected leukemia types and selected county crop and livestock production, 1968-1978

County characteristics	Leukemia type	Highest 33 counties		Other counties	
		OR	95% CL*	OR	95% CL
Soybeans/acre	Chronic lymphatic	2.21	1.33-3.66	1.39	0.97-2.00
	Unspecified lymphatic	0.62	0.25-1.52	2.49	1.38-4.48
Corn/acre	Chronic lymphatic	1.34	0.87-2.06	1.94	1.29-2.92
	Unspecified lymphatic	4.63	1.82-11.74	1.00	0.56-1.80
Milk cows	Chronic lymphatic	1.19	0.76-1.85	2.10	1.41-3.14
	Unspecified lymphatic	4.94	1.96-12.47	0.94	0.52-1.70
Egg-laying chickens	Chronic lymphatic	1.36	0.82-2.25	1.80	1.25-2.59
	Unspecified lymphatic	2.47	1.03-5.92	1.37	0.77-2.45
Herbicides	Chronic lymphatic	1.89	1.16-3.08	1.50	1.03-2.18
	Unspecified lymphatic	1.21	0.51-2.85	1.90	1.07-3.37

* CL, confidence limits.

acre, number of milk cows and egg-laying chickens.

DISCUSSION

Mortality from several types of cancer has been shown to be elevated in farmers (2, 8). These include stomach, prostate and lip cancer, as well as lymphomas and multiple myeloma. However, leukemia is perhaps the cancer most consistently associated with farming during the past 30 years (1-9). Therefore, it is incumbent upon epidemiologists not merely to repeatedly demonstrate that such an association exists, but to diligently search for reasons for the association.

The Nebraska study of Blair and Thomas (9) represents an attempt to identify such reasons or farming practices.

Previous epidemiologic evidence has associated dairy farming with leukemia mortality in farmers (10-16). The Nebraska study is particularly important since it implicates corn production with leukemia in those born after 1900, rather than any measure of dairy production.

The results of the Iowa study lend some support to those found in Nebraska. The odds ratios for farmers based on the high producing counties are statistically significant for only corn and soybean production for those born from 1890 to 1900. Apparently, soybean production in Nebraska is not sufficient to be evaluated for association with leukemia mortality in farmers; however, the association of corn production with leukemia mortality in both states indicates that modern farming

practices used in corn production may be a cause of the higher leukemia mortality rates in farmers. This possibility is given credence by the fact that corn production is implicated only in those born after 1890 in Iowa and after 1900 in Nebraska. In addition, the number of acres treated with herbicides in Iowa and the number of acres treated with insecticides in Nebraska are associated with leukemia mortality in farmers born after 1900. These results also tend to implicate modern farming practices as possible causes of leukemia. There is no evidence linking leukemia mortality in farmers with corn production, use of herbicides or use of insecticides in either state for those born before 1890.

The fact that the number of egg-laying chickens is associated with increased leukemia mortality in farmers was not anticipated from the results of the Nebraska study. However, Milham's study (4) of Washington and Oregon death certificate data did indicate that a statistically significant association existed between farming and leukemia mortality, and that the greatest excess of leukemia mortality was in poultry farmers.

Analyses by type of leukemia indicate that chronic and unspecified lymphatic leukemias cause increased mortalities in Iowa farmers. Thus, it appears that it is the lymphatic leukemias that are of greatest concern. Sixty-three per cent of incident acute lymphatic leukemias in Iowa males in 1969-1979 occurred in individuals under age 30 years. Consequently, relatively few (table 4) acute lymphatic deaths in those over age 30 years were included in this study.

Analyses by leukemia type are also of importance because of strong associations of unspecified lymphatic leukemia with number of dairy cows and corn production per acre by county. Donham et al. (14) showed significant association between acute lymphatic leukemia incidence in Iowa and dairy farming. As noted above,

acute lymphatic leukemia mortalities were of limited number in this study; however, it is of importance to note the continued evidence of association between dairy farming and lymphatic leukemia. Since corn per acre was also highly associated with unspecified lymphatic leukemia mortality, any elements common to both corn and dairy production are worthy of further investigation.

Many agricultural innovations that have greatly increased corn production, such as extensive use of hybrids and pesticides, have been introduced since World War II. One that is particularly important is commercial fertilizer usage, increased from 8,425,000 tons in the United States in 1930 to 18,400,000 tons in 1950 (27).

The amount of nitrogenous fertilizer applied has added to the agricultural runoff problem (28). This problem is exacerbated by the fact that the nitrogenous waste of dairy animals is much greater than that of other common farm livestock (28). Although highly speculative, one mechanism of increasing the risks for farmers for leukemia and other cancers is contamination of shallow farm wells and farm ponds. This research, of course, offers no direct evidence that shallow wells might contribute to increased farmer mortality from leukemia. However, studies such as this and that of Blair and Thomas (9) are important since they go beyond identification of farming as a risk function and attempt to identify farming practices and specific mechanisms that must be closely studied if the cancer risks of farmers are to be decreased.

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DNA AND PROTEIN SYNTHESIS INHIBITION IN CHINESE HAMSTER OVARY CELLS BY DICHLOROPHENOXYACETIC ACID

(Dichlorophenoxyacetic acid; cell cycle; DNA synthesis; protein synthesis)

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(Received September 9th, 1985)

(Accepted October 10th, 1985)

SUMMARY

The effects of the herbicide dichlorophenoxyacetic acid (2,4-D) on DNA and protein synthesis were investigated in chinese hamster ovary cells (CHO) employing two different methods. The results showed that the herbicide affects DNA and protein synthesis depending on the stage of growth and method of treatment. 2,4-D action appears to concentrate the cells mainly in the G₁/S boundary of the cell cycle. The effect is expressed as an inhibition of DNA and protein synthesis. This effect was revealed not only by the chemical determination of DNA and protein synthesis but also by experiments using autoradiography, using the labelling index to detect the incorporation of [³H]thymidine into the cells. Labelling of the cell nucleus was reduced markedly when cells treated with 2,4-D were in confluency for 4 days after reaching plateau growth.

INTRODUCTION

The herbicides 2,4-D and 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T) are used extensively in modern agriculture. These compounds may be contaminants of food destined for human consumption. An investigation seemed in order to elucidate certain mechanisms of action displayed by these compounds. Previous investigations have demonstrated that the organochloride 2,4-D is capable of exerting a detrimental effect upon fertilised chicken eggs painted with a 2,4-D solution [1]. The eggs

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Abbreviations: CHO, chinese hamster ovary cells; 2,4-D, dichlorophenoxyacetic acid; 2,4,5-T, trichlorophenoxyacetic acid.

showed changes in hatchability and the chicks were born with physical defects. It has also been reported [2] that 2,4-D produces alterations in cultured lymphocytes with an increase in the rate of sister chromatid exchange and clastogenicity. 2,4-D and 2,4,5-T are also inducers of meiotic abnormalities in wheat and other related species [3]. 2,4,5-T inhibited the incorporation of [^{14}C]thymidine and [^3H]uridine into the soluble pool of L-929 cells and interfered with [^3H]leucine incorporation into the proteins. These phenomena were accompanied by a cessation of growth [4].

The results of these investigations prompted us to study the effects of 2,4-D on the cell cycle of hamster ovary cells (CHO) and to determine the biosynthesis of DNA and proteins.

MATERIAL AND METHODS

A CHO strain (acquired from Dr. Petra Martinez of the Fundacion de Genetica Humana, Buenos Aires, Argentina), kept in liquid nitrogen, was used for the investigations. The cells were grown as a monolayer using McCoy's culture medium [5] supplemented with 15% bovine fetal serum and 50 $\mu\text{g}/\text{ml}$ gentamicin. Plastic flasks with a 25-cm² surface were used for the experiments. Trypsin (1:250 Difco) 0.25% in Hepes buffer, pH 7.2 [6] was used to release the cells from the flasks. The cells were treated for 16 h with hydroxyurea (HU; Sigma) at a final concentration of 1.2 mM in the culture medium from the moment the cells reached logarithmic growth, with a population of approx. 2×10^6 cells per flask. The effect of the herbicide on cells concentrated at some point from the G₁ phase [7] was also studied by maintaining the cells for 4 additional days in the same culture medium after reaching confluency. All experiments were carried out in two series of flasks: one with the herbicide-treated cells and the other with the control cells in normal culture medium. This investigation was also carried out to determine where in the cell cycle the herbicide was exerting its effects and to measure the recovery capacity of cells treated with 1 mM 2,4-D for 24 h and subsequently changed to a normal medium. To determine recovery, the biosynthesis of DNA and protein and cell division were followed for 16 h.

As a final experiment, cells that were in confluency for 4 days were subjected to autoradiography, using [^3H]thymidine as label [8]. The labelling index was determined for both treated and untreated cells.

The synthesis of DNA and protein was determined in all cases after giving a 1-h pulse with a mixture of 1 $\mu\text{Ci}/\text{ml}$ of [methyl- ^3H]thymidine (Amersham, U.K. 58 Ci/mmol) and 0.16 $\mu\text{Ci}/\text{ml}$ of L-[U- ^{14}C]leucine (Amersham, U.K. 10 mCi/mmol). The radioactive thymidine was brought to 5 μM final concentration with cold thymidine, and the cells were incubated at 37°C. DNA and protein extraction from the cells after the pulse with the radioactive compounds was performed as follows: the culture medium was withdrawn from the flasks and the monolayer rinsed once with PBS solution A [9]. The cells were trypsinised, and released after 5 min by

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RESUL

Fig. (HU)

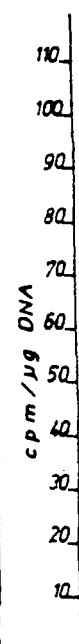


Fig. 1. was determined

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gentle shaking immediately after which 3 ml medium containing 15% serum was added to prevent clumping. The cells were centrifuged at 1000 rev./min for 2 min, the supernatant was discarded and the pellet was resuspended in 10 ml saline solution. The cells were then counted and centrifuged. DNA and proteins were isolated by the method of Munro and Fleck [10]. The DNA solution was finally obtained in a total volume of 2 ml of 0.2 M HClO_4 , and the proteins in 1 ml of 0.5 N NaOH. The DNA concentration was determined by measuring the absorbance at 260 nm in a Beckman spectrophotometer, and proteins content by the method of Lowry et al [11]. Radioactivity was determined in 0.2 ml of DNA or protein solutions, with 2.5 ml of a mixture composed of toluene/Triton X-100 (2:1) containing 0.02 g % of 1,4-bis-2-(5-phenyl-oxazolyl)-benzene; phenyl-oxazolyl phenyl-oxazolyl phenyl (POPOP) (Sigma) and 0.4 g % of 2,5-diphenyloxazole (PPO, Amersham/Searle). A Beckman liquid scintillation counter was used.

RESULTS AND DISCUSSION

Fig. 1 shows DNA synthesis in cells pretreated for 16 h with 1.2 mM hydroxyurea (HU) before transfer to a normal medium with or without 1 mM 2,4-D. The max-

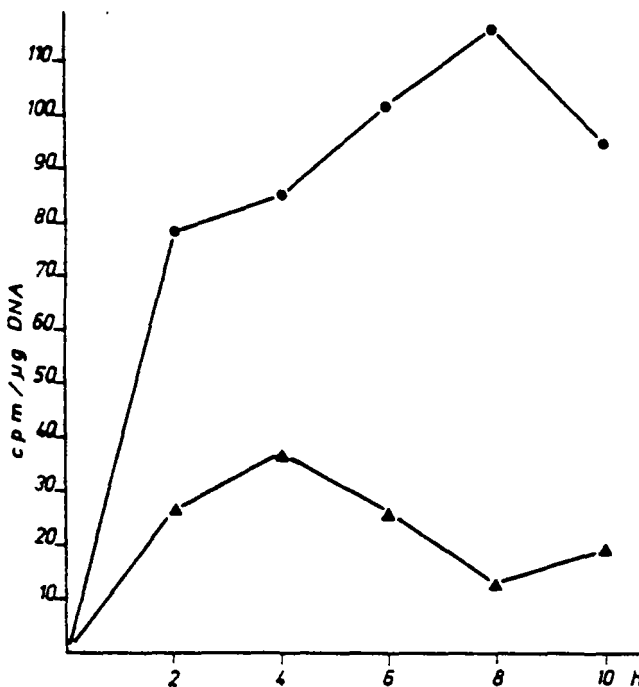


Fig. 1. The cells in logarithmic growth were treated for 16 h with 1.2 mM HU before the culture medium was changed for fresh medium with or without 1 mM 2,4-D. The DNA-specific radioactivity was determined. Δ , With 2,4-D; $\bullet$, without 2,4-D.

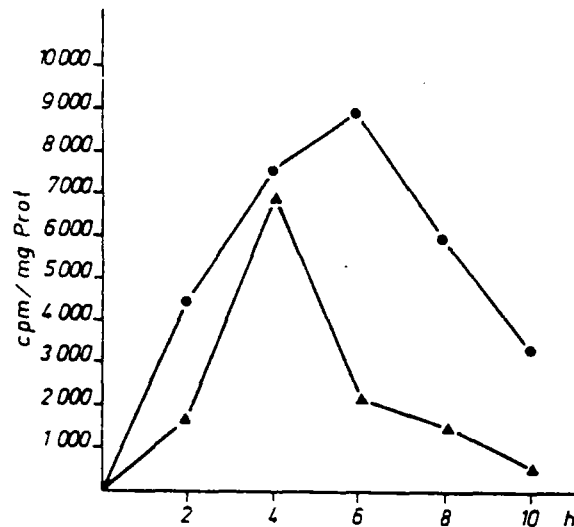


Fig. 2. Cells treated as in Fig. 1 and protein-specific radioactivity determined. Δ . With 2,4-D; $\bullet$, without 2,4-D.

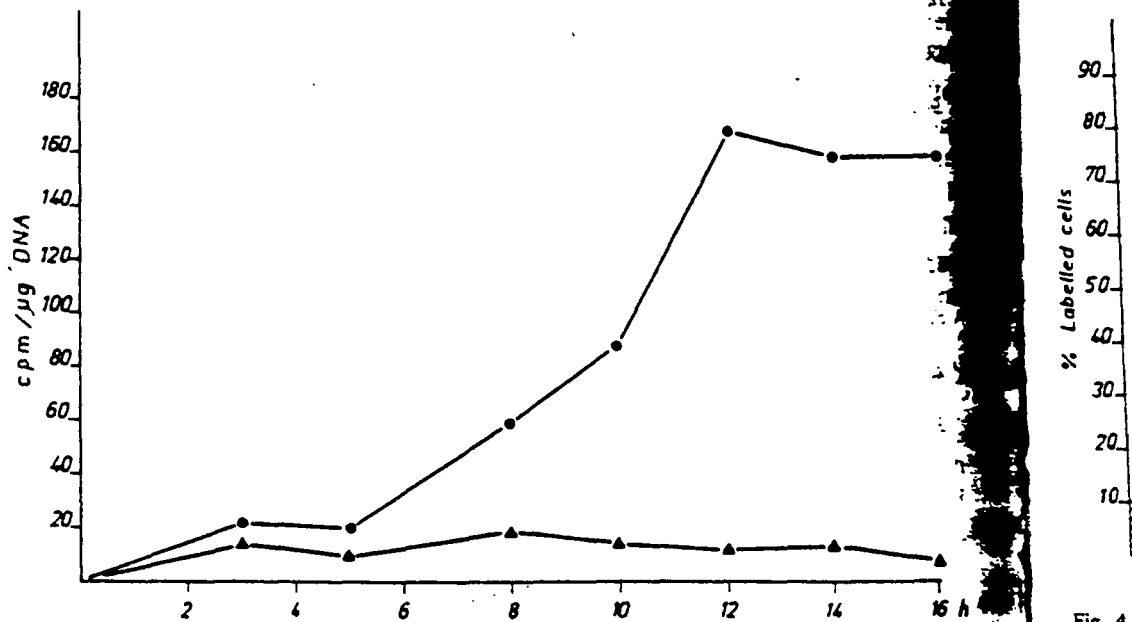


Fig. 3. Cells growing in normal culture medium were kept for 4 additional days at 37°C after reaching plateau growth. The medium was then changed for fresh medium with or without 2,4-D and the biosynthesis of DNA followed during 16 h. Δ . With 2,4-D; $\bullet$, without 2,4-D.

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imum synthesis was at 8 h in normal medium. 2,4-D produced a marked inhibition, which was almost total at 8 h. Protein synthesis (Fig. 2) peaked at 6 h in the control, while the 2,4-D-treated cells displayed a maximum at 4 h followed by a rapid fall to a minimum at 10 h. There was no change in the number of cells when the medium contained 2,4-D, but without the herbicide, cell division invariably occurred at 10 h. Fig. 3 shows the DNA specific radioactivity from 1-16 h in cells concentrated at some point of phase G₁ after 4 days' growth following confluency, and transferred to normal medium with or without 2,4-D. In normal medium there was a delay in the synthesis of DNA, which reached its maximum value at 12 h. This would suggest that the cells were in the initial stage of G₁ when the medium was changed. When the medium contained 1 mM 2,4-D, this response was virtually absent throughout the 16 h of the experiment. To verify that cells maintained in confluency for 4 days were capable of initiating DNA synthesis when treated with 2,4-D, an experiment was performed using autoradiography, and the labelling index was determined. The results are shown in Fig. 4. The cells displayed diminished capacity for the incorporation of [³H]thymidine in the presence of 2,4-D, in comparison to those without the herbicide. On the other hand, protein synthesis in cells maintained at confluency showed a rapid increase (Fig. 5) almost equal to the control, when the new medium contained 2,4-D, although it decreased after 16 h incubation. In order to establish where the herbicide was acting in the cell cycle, a culture in logarithmic growth was

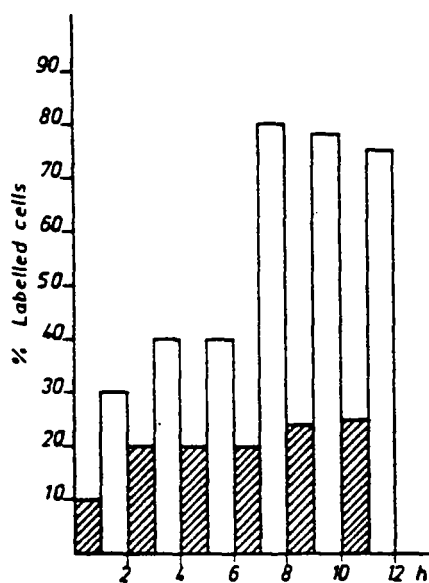


Fig. 4. Cells were incubated for 4 days after reaching plateau growth. The medium was changed for another with or without 1 mM 2,4-D, and a 10-min pulse was given with 1 μ Ci/ml of [³H]thymidine every 2 h. Autoradiography was carried out immediately. Percentage of labelled cells 12 h after changing the culture medium: open bars, control; solid bars, cells with 2,4-D.

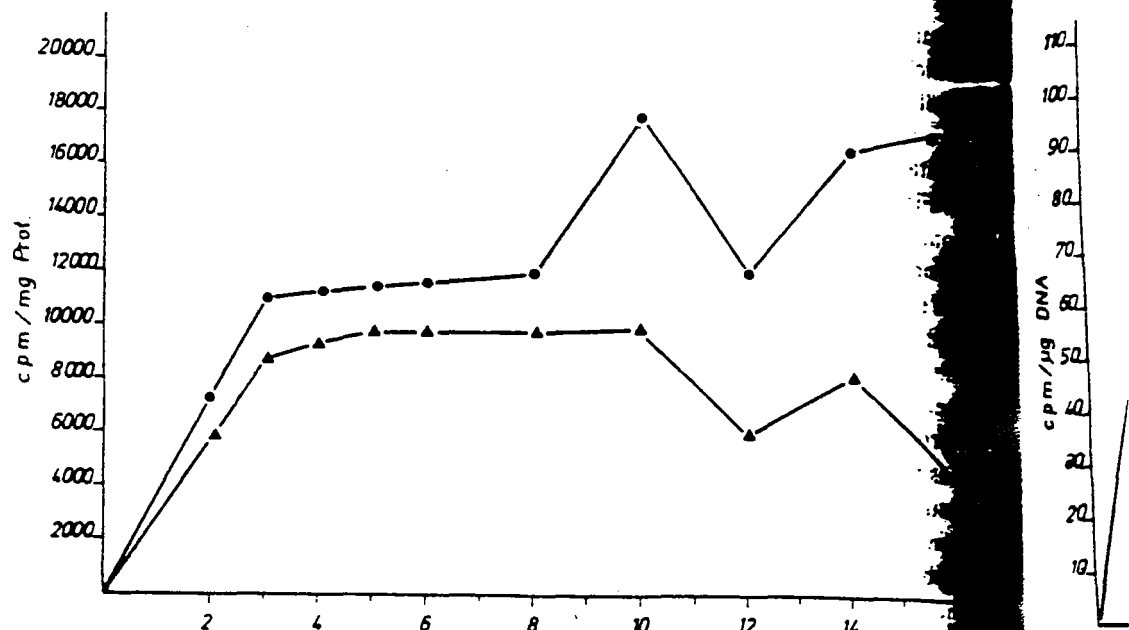


Fig. 5. Protein-specific radioactivity of cells treated as indicated in Fig. 3. ▲, With 2,4-D; ●, with 2,4-D.

exposed to the herbicide for 24 h. As can be seen in Fig. 6, DNA synthesis was initiated when the cells were treated with 2,4-D but decreased gradually, reaching a minimum at 24 h (the cells did not multiply during this time). When the original medium was removed, the cells rinsed and normal medium added, a rapid response in DNA synthesis was observed, reaching a maximum at 4 h (Fig. 6). This suggests that the cells were at the G_1/S phase. The cells divided 16 h after normal medium was added. Protein synthesis was also inhibited in cells treated with 2,4-D. Removal of the pesticide was followed by an increase in synthesis.

The above results showed that the herbicide 2,4-D affects DNA synthesis, and that this effect is expressed differently if the cells are treated with HU (Fig. 1) or are concentrated at an early stage of G_1 after confluency (Fig. 3). In the latter case, it is not certain at precisely which point of phase G_1 the cells are concentrated when maintained in the original medium after attaining a growth plateau. According to some investigators, the transformed cells accumulate in early G_1 [12]; others are of the opinion that the normal cells accumulate in early G_1 and the transformed cells in late G_1 [13]. The results presented in this investigation indicate that 2,4-D produced a cell concentration mainly in the G_1/S phase of the cell cycle, resulting in retarded cell growth. The peak in DNA synthesis 8 h after HU was eliminated from the culture medium (Fig. 1) shows cell division at 10 h. The inclusion of 2,4-D in the medium for 24 h and its subsequent removal produced a peak of DNA synthesis at

Fig. 6. 2 DNA syn: 24 h and ●, recov

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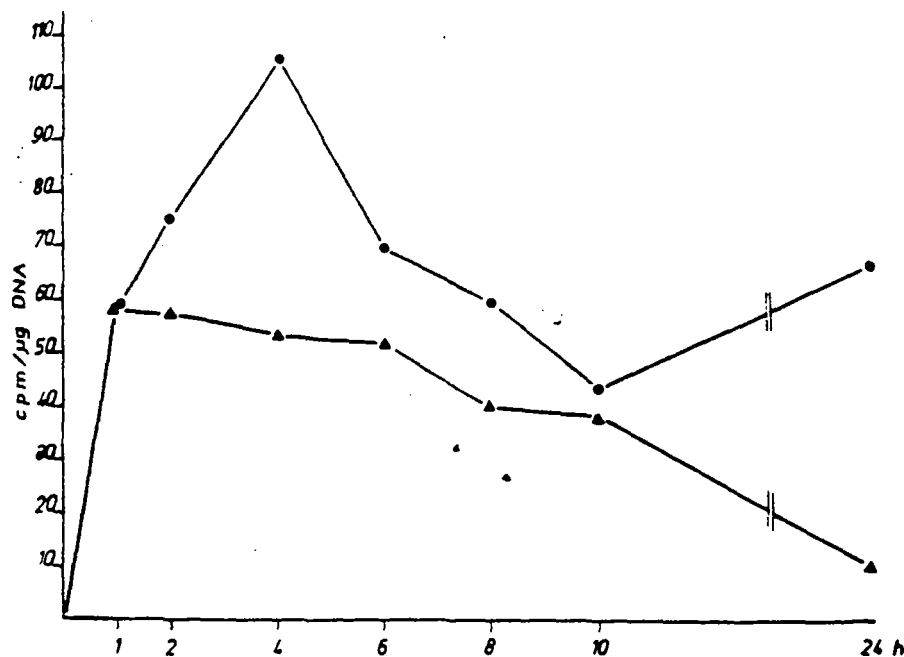


Fig. 6. 2,4-D to a final concentration of 1 mM, was added to a cell culture in logarithmic growth and DNA synthesis followed for 24 h. In other series of flasks the medium with 2,4-D was removed after 24 h and replaced by a normal culture medium and the DNA synthesis followed for 24 h. ▲. With 2,4-D; ●, recovery with normal medium.

4 h (Fig. 6), with cell division at 16 h. These observations may indicate that there was an elongation of the S or G₂ phase, or both, but the in vitro mechanisms of action of 2,4-D are little understood at present. Definite conclusions at this point would be premature due to the many factors involved in the cell cycle.

ACKNOWLEDGEMENTS

We are grateful to Mrs. Donna E.M. de Balegno for her help in preparing the manuscript and to Mr. Adalberto Allione for his technical assistance. This investigation was supported by the Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina).

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SUMMARY

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SUPPLEMENT 7

This publication represents the views and expert opinions
of an IARC *ad-hoc* Working Group on the
Evaluation of Carcinogenic Risks to Humans,
which met in Lyon, 10-18 March 1987

1987

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Limited evidence of carcinogenicity: The data suggest a carcinogenic effect but are limited for making a definitive evaluation because, e.g., (a) the evidence of carcinogenicity is restricted to a single experiment; or (b) there are unresolved questions regarding the adequacy of the design, conduct or interpretation of the study; or (c) the agent increases the incidence only of benign neoplasms or lesions of uncertain neoplastic potential, or of certain neoplasms which may occur spontaneously in high incidences in certain strains.

Inadequate evidence of carcinogenicity: The studies cannot be interpreted as showing either the presence or absence of a carcinogenic effect because of major qualitative or quantitative limitations.

Evidence suggesting lack of carcinogenicity: Adequate studies involving at least two species are available which show that, within the limits of the tests used, the agent is not carcinogenic. A conclusion of evidence suggesting lack of carcinogenicity is inevitably limited to the species, tumour sites and doses of exposure studied.

(iii) *Supporting evidence of carcinogenicity*

The other relevant data judged to be of sufficient importance as to affect the making of the overall evaluation are indicated.

(b) *Overall evaluation*

Finally, the total body of evidence is taken into account; the agent is described according to the wording of one of the following categories, and the designated group is given. The categorization of an agent is a matter of scientific judgement, reflecting the strength of the evidence derived from studies in humans and in experimental animals and from other relevant data.

Group 1 — The agent is carcinogenic to humans.

This category is used only when there is *sufficient evidence* of carcinogenicity in humans.

Group 2

This category includes agents for which, at one extreme, the degree of evidence of carcinogenicity in humans is almost sufficient, as well as agents for which, at the other extreme, there are no human data but for which there is experimental evidence of carcinogenicity. Agents are assigned to either 2A (probably carcinogenic) or 2B (possibly carcinogenic) on the basis of epidemiological, experimental and other relevant data.

Group 2A — The agent is probably carcinogenic to humans.

This category is used when there is *limited evidence* of carcinogenicity in humans and *sufficient evidence* of carcinogenicity in experimental animals. Exceptionally, an agent may be classified into this category solely on the basis of *limited evidence* of carcinogenicity in humans or of *sufficient evidence* of carcinogenicity in experimental animals strengthened by supporting evidence from other relevant data.

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Group 2B — The agent is possibly carcinogenic to humans.

This category is generally used for agents for which there is *limited evidence* in humans in the absence of *sufficient evidence* in experimental animals. It may also be used when there is *inadequate evidence* of carcinogenicity in humans or when human data are nonexistent but there is *sufficient evidence* of carcinogenicity in experimental animals. In some instances, an agent for which there is inadequate evidence or no data in humans but *limited evidence* of carcinogenicity in experimental animals together with supporting evidence from other relevant data may be placed in this group.

Group 3 — The agent is not classifiable as to its carcinogenicity to humans.

Agents are placed in this category when they do not fall into any other group.

Group 4 — The agent is probably not carcinogenic to humans.

This category is used for agents for which there is *evidence suggesting lack of carcinogenicity* in humans together with *evidence suggesting lack of carcinogenicity* in experimental animals. In some circumstances, agents for which there is *inadequate evidence* of or no data on carcinogenicity in humans but *evidence suggesting lack of carcinogenicity* in experimental animals, consistently and strongly supported by a broad range of other relevant data, may be classified in this group.

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mutagenicity in bacteria. Pentachlorophenol did not induce strand breaks in DNA from bacteriophage. It gave negative results in a host-mediated assay with mice using bacteria as indicators⁷.

2,4,6-Trichlorophenol induced somatic mutations in the spot test in mice *in vivo*. It induced mutation but not gene conversion or crossing-over in yeast and was not mutagenic to bacteria⁷.

Neither 2,3,4,6-tetrachlorophenol nor 2,4,5-trichlorophenol was mutagenic to bacteria⁷.

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CHLOROPHENOXY HERBICIDES (Group 2B)

A. Evidence for carcinogenicity to humans (limited)

In a Danish cohort study of chemical workers exposed to chlorophenoxy herbicides [particularly (4-chloro-2-methylphenoxy)acetic acid (MCPA), 2-(4-chloro-2-methylphenoxy)propanoic acid (mecoprop), 2,4-dichlorophenoxyacetic acid (2,4-D) and 2-(2,4-dichlorophenoxy)propanoic acid (dichlorprop)], as well as other chemicals, no overall increase in cancer incidence rate was observed, but there were significantly increased risks for soft-tissue sarcoma and lung cancer in some subcohorts, which were not necessarily those with the highest exposures to chlorophenoxy herbicide preparations¹.

A recently reported cohort of 5784 male employees in a UK company that manufactured, formulated and sprayed MCPA and other pesticides, but only small amounts of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), had no general excess mortality from cancer. Three potentially exposed workers died from nasal carcinoma, however. One death due to soft-tissue sarcoma approximately equalled the expected rate. No excess of lymphoma was seen².

A Finnish cohort study of brush control workers with short follow-up time showed no increased cancer risk. A small Swedish cohort study of railroad workers who sprayed herbicides showed an increased risk of cancers at all sites combined for those exposed to chlorophenoxy herbicide preparations and other herbicides. An excess incidence of all

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cancers was also reported from a very small cohort of Swedish forestry foremen exposed to chlorophenoxy herbicide preparations and other herbicides. A study of long-term pesticide applicators in the German Democratic Republic, heavily exposed to a number of chemicals, including 2,4-D and MCPA, demonstrated an increased risk of bronchial carcinoma¹.

Two population-based case-control studies conducted in northern and southern Sweden, respectively, showed a statistically significant association between exposure to chlorophenoxy herbicides, especially in forestry and agriculture, and the occurrence of soft-tissue sarcomas. An increased risk of soft-tissue sarcoma was described among highly exposed Italian rice weeders in a population-based case-control study. However, a case-control study from New Zealand did not demonstrate any increased risk of soft-tissue sarcoma in people exposed to chlorophenoxy herbicides¹. Nor did a recently reported population-based case-control study of soft-tissue sarcoma and lymphoma in Kansas, USA, find any association between soft-tissue sarcoma and exposure to 2,4-D³.

A statistically significant association between malignant lymphoma (Hodgkin's and non-Hodgkin's) and exposure to chlorophenoxy herbicides was found in a Swedish case-control study¹. The population-based case-control study of soft-tissue sarcoma and Hodgkin's and non-Hodgkin's lymphoma in Kansas showed that use of 2,4-D was associated with non-Hodgkin's lymphoma, especially among farmers who had been exposed for more than 20 days per year, among whom there was an approximately six-fold excess, and among those who had mixed or applied the herbicides themselves. Hodgkin's lymphoma was not, however, found to be associated with herbicide exposure³. No significant or consistent association was seen in a case-control study of these tumours from New Zealand, and in a Danish cohort of chemical workers exposed to chlorophenoxy herbicides there was also no significantly increased risk of malignant lymphoma^{1,4}. Farmers and forestry workers in Washington State, USA, with exposure to phenoxy herbicides had a significantly increased risk of non-Hodgkin's lymphoma. People of Scandinavian descent in the area had an increased risk of soft-tissue sarcoma in connection with phenoxy herbicide exposure, but no increased risk of non-Hodgkin's lymphoma⁵.

Three Swedish case-control studies of colon, liver, and nasal and nasopharyngeal cancer, which used the same study design and methods as in the studies on soft-tissue sarcoma and malignant lymphoma, did not demonstrate significantly increased risks, although a risk ratio of 2.1 was reached for nasal and nasopharyngeal cancer¹.

A record-linkage study using census data on occupation and cancer registry information in Sweden did not reveal any excess of soft-tissue sarcoma among agricultural and forestry workers^{6,7}. However, on the basis of occupational titles, the elevated risks seen in Swedish case-control studies of soft-tissue sarcoma and lymphoma were reduced to 1.4 or less⁸. A UK study based on data from cancer registration showed a slightly but significantly increased risk of soft-tissue sarcoma among farmers, farm managers and market gardeners, but not in other subgroups in forestry and farming⁹. No association with soft-tissue sarcoma has been found with military service in Viet Nam, despite potential exposure to phenoxy herbicides^{1,10}, although there is a case report in this respect¹.

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B. Evidence for carcinogenicity to animals (*inadequate for 2,4-D and 2,4,5-T*)

2,4-D and several of its esters were tested in rats and mice by oral administration and in mice by subcutaneous administration. All of these studies had limitations, due either to inadequate reporting or to the small number of animals used. Therefore, although increased incidences of tumours were observed in one study in which rats received 2,4-D orally and in another in which mice received its isooctyl ester by subcutaneous injection, no evaluation of the carcinogenicity of this compound could be made¹¹.

2,4,5-T was tested in mice by oral and subcutaneous administration. All of the studies had limitations due to the small numbers of animals used. Therefore, although an increased incidence of tumours at various sites was observed in one study in which 2,4,5-T (containing less than 0.05 mg/kg chlorinated dibenzodioxins) was given orally, no evaluation of the carcinogenicity of this compound could be made on the basis of the available data¹². In rats fed diets containing three different concentrations of 2,4,5-T, the incidences of all tumour types were comparable to those in the control groups, with the exception that the incidence of interfollicular C-cell adenomas of the thyroid was increased significantly in female rats receiving the lowest dose. This increase was not considered to be related to treatment since it was not dose-related and the female control group had an unusually low incidence of thyroid adenomas¹³.

A study of the incidence of small-intestinal adenocarcinoma in groups of sheep from different farms showed an association with use of phenoxy herbicides, as elicited by farmers' responses to a questionnaire. However, other herbicides were in use, and there was no documentation of exposures¹⁴.

No adequate data were available on the carcinogenicity of MCPA¹⁵.

C. Other relevant data

In single studies, lymphocytes of persons occupationally exposed to chlorophenoxy herbicides, including 2,4-D, did not show increased frequencies of sister chromatid exchanges or chromosomal aberrations. Other studies could not be assessed since workers were also exposed to other formulations. A single study of herbicide and pesticide sprayers exposed to 2,4,5-T, in which a small increase in the incidence of sister chromatid exchanges was reported, could not be assessed since workers were also exposed to other formulations. Persons occupationally exposed to MCPA did not have increased frequencies of sister chromatid exchanges (one study) or chromosomal aberrations in their lymphocytes¹⁶.

2,4-D did not induce dominant lethal mutations, micronuclei or sister chromatid exchanges in rodents treated *in vivo*. Pure 2,4-D did not induce chromosomal aberrations in human lymphocytes *in vitro*, whereas a commercial formulation did. 2,4-D induced sister chromatid exchanges and unscheduled DNA synthesis in human cells *in vitro*. It did not induce sister chromatid exchanges but did induce mutation and inhibited intercellular communication in Chinese hamster cells *in vitro*. 2,4-D induced somatic mutation in *Drosophila*, but conflicting results were obtained for induction of sex-linked recessive lethal mutations; it did not induce aneuploidy. 2,4-D caused chromosomal aberrations and was

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mutagenic in plants. It induced mutation, gene conversion and mitotic recombination in yeast. It was not mutagenic to bacteria or bacteriophage. The *n*-butyl and *iso*-octyl esters of 2,4-D were also not mutagenic to bacteria¹⁶.

2,4,5-T induced chromosomal aberrations in bone-marrow cells of Mongolian gerbils, but not in spermatogonia of Chinese hamsters, and aneuploidy in oocytes of rats treated *in vivo*. It did not induce micronuclei in mice or dominant lethal mutations in mice or rats *in vivo*. 2,4,5-T inhibited intercellular communication in Chinese hamster V79 cells *in vitro*. There was weak evidence for the induction of sex-linked recessive lethal mutations in *Drosophila*; it did not induce aneuploidy or somatic mutation. It induced chromosomal aberrations in plants. It was mutagenic to yeast, but neither 2,4,5-T nor the *n*-butyl-, *iso*-butyl or *iso*-octyl ester of 2,4,5-T was mutagenic to bacteria¹⁶.

MCPA did not induce structural chromosomal aberrations or micronuclei in mice treated *in vivo*; weakly positive results were obtained for sister chromatid exchanges in cells of Chinese hamsters treated *in vivo* and *in vitro*. It was weakly active in inducing sex-linked recessive lethal mutations but did not induce aneuploidy in *Drosophila*. MCPA and its methyl ester were mutagenic to yeast but not to bacteria¹⁶.

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CHLOROPRENE (Group 3)

A. Evidence for carcinogenicity to humans (*inadequate*)

In one study, an excess of lung and skin cancers was related to occupational exposure to chloroprene. In another investigation, no excess of lung or other type of cancer was reported among chloroprene workers. There is one case report of an angiosarcoma of the liver in a worker exposed to chloroprene¹.

B. Evidence for carcinogenicity to animals (*inadequate*)

A number of experimental studies were considered to be inadequate for an evaluation of the carcinogenicity of chloroprene¹. In a further study² in which chloroprene was given orally to pregnant rats and their offspring were treated for life by stomach tube, the total incidence of tumours was similar in treated and untreated animals.

C. Other relevant data

An increased incidence of chromosomal aberrations was found in the lymphocytes of workers exposed to chloroprene³.

Chloroprene induced dominant lethal mutations in rats and chromosomal aberrations in bone-marrow cells of mice treated *in vivo*. It induced transformation in one hamster cell line but did not induce mutation in Chinese hamster cells. It induced sex-linked recessive lethal mutations in *Drosophila* and was mutagenic to bacteria³.

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NEUROLOGICAL EFFECTS

-----Cohort Studies-----

 sprayers in New Zealand and controls.
 exposed & 352 not exposed one before or after conception.

1 defect and 0.89 risk of only in the exposed group.

 palate occurrence by county herbicide use by county based acreage. No association rved.

enital malformation and 245-T over time in Hungary. No ciation observed.

Zealand malformations in ciation with sprayingicides by area and time. Mixed lts

ralia - neural-tube defects and ying of 2,4,5-T over time. Mild tive association

and & Whales - malformations occupations with likely sure to 2,4,5-T. Facial cleft mation consistently high. bifida high in gardeners and cultural workers. Anencephaly in gardeners. Association are

ew of Vietnamese studies for paternal and maternal studies ed positive results - no clear tern

ew of reproductive effects of xins/ no definite conclusions.

Singer, Moses et al
 1982

56 workers in a 2,4-D & 2,4,5-T plant were compared with 25 unexposed controls.

Median motor, median sensory and sural nerve velocities were measured. 46% of exposed group had slowed velocities compared to 5% in the control group ($p < .001$). The mean velocities of the median motor and sural nerves were significantly slower than the controls. There was a highly significant inverse relation between the sural nerve velocity and length of employment. All these relationships remained true when adjusted for alcohol consumption, age and other parameters.

Suskind & Hertzberg
 1984

204 workers at Monsanto's Nitro, West Virginia plant exposed to dioxin and 163 workers not exposed.

Nerve conduction velocities in ulnar and peroneal nerves was non-significantly reduced in exposed group. Sural nerve conduction was slightly reduced in unexposed.

ANIMAL STUDIES

SHEEP AND SMALL INTESTINAL ADENOCARCINOMA

Newell, Ross & Renner

Sheep from 88 farms in New Zealand, 20,678 female sheep/ 125 cases (6/1000) from 61 farms. Exposure to phenoxy herbicides, picolinic herbicide and combined.

Significant positive trends for treatment of feed with either herbicide or both combined, and with how recently the feed had been treated before consumption.

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REPRODUCTIVE OUTCOMES

-----Cohort Studies-----

Smith, Fischer, Pearce
& Chapman 1982

548 sprayers in New Zealand and
441 controls.
427 exposed & 352 not exposed one
year before or after conception.

Exposed group had 1.19 RR of congenital defect and 0.89 risk of
miscarriage. Stillbirths (3) occurred only in the exposed group.

-----Other Studies-----

Nelson et al
1979

Cleft palate occurrence by county
with herbicide use by county based
on rice acreage. No association
observed.

Thomas
1980

Congenital malformation and 245-T
use over time in Hungary. No
association observed.

Hanify et al
1980

New Zealand malformations in
association with spraying
herbicides by area and time. Mixed
results

Field & Kerr
1979

Australia - neural-tube defects and
spraying of 2,4,5-T over time. Mild
positive association

Balarajan & McDowall

England & Wales - malformations
and occupations with likely
exposure to 2,4,5-T. Facial cleft
malformation consistently high.
Spina bifida high in gardeners and
agricultural workers. Anencephaly
high in gardeners. Association are
soft.

Erikson et al
1984

Review of Vietnamese studies for
both paternal and maternal studies
Mixed positive results - no clear
pattern

Hatch
1984

Review of reproductive effects of
dioxins/ no definite conclusions.

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TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	

SOFT TISSUE SARCOMA (STS)

-----Case-Report-----

Cook 1981			Case report/ one more STS case discovered in the Dow cohort described in Cook, Townsend & Ott.
Moses & Selikoff 1981			Case report/ one more STS case discovered in the Monsanto cohort.
Johnson, Kugler & Brown 1981			Case reports/ two more STS cases with work histories at Monsanto/ not identified a part of above cohorts.

-----Other Studies-----

Milham 1982	1.2		Proportional Mortality Death certificate study/ 49 STS deaths/ looked at occupations with possible 2,4-D exposure including farming and forestry.

TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	

SOFT TISSUE SARCOMA (STS)

-----Cohort Studies-----

Lynge 1985	2.72	0.0	Based on 5 male cases. Based on 0 female cases.
	3.33	0.0	Based on 1 male case in phenoxy acid manufacturing and packing. Based on 0 female cases in phenoxy acid manufacturing and packing.
	5.19*	0.0	Based on 3 male cases in manual services. Based on 0 female cases in manual services.
	1.38	0.0	Based on 1 male case in other chemical manufacturing and packing. Based on 0 female cases in other chemical manufacturing and packing.
Zack & Gaffey 1983	+		Based on 1 male death in plant.
	+		PMR based on 1 male death to a 245-T exposed worker.
Riihimaki et al 1982		0.0	Based on 0 male deaths.
Axelsson et al 1980	+	0.0	Based on 1 male death.
		0.0	Based on 0 male deaths with only phenoxy acid exposure.
		0.0	Based on 0 male deaths with phenoxy acid & amitrole exposure.
	+		Based on 1 male death with only amitrole exposure (with ten year latency period).
	(+)		
Ott et al 1980		0.0	Based on 0 male deaths.
Honchar & Halperin 1981	41.4*		Summary of the 4 USA studies (one unpublished at the time)/ total deaths=105/ three STS cases.

* = Significant at the p=0.05 level.

+ = Unquantified excess risk.

TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	
SOFT TISSUE SARCOMA (STS)			
-----Case-Control Studies-----			
Hardell & Sandstrom 1979	5.3*		46 cases and 201 controls. Controls were from the general population. Cases & controls with chlorophenol exposures were excluded.
Eriksson, Hardell et al 1981	6.8*		110 cases & 220 controls. Controls were from the general population Cases & controls with chlorophenol exposures were excluded.
Smith, Pearce et al 1984	1.3		82 cases and 92 controls. Controls were selected from males with other cancers. Case & controls with chlorophenol exposures were excluded.
Hoar, Blair et al 1986		0.9	71 cases and 948 controls. Controls were from the general population Exposure was based on reported herbicide use.
Woods et al 1987		0.99 (0.0) (-)	576 cases and 694 random controls from the general population: ever exposed. (forestry herbicide applicator - no cases). ((15 years exposure 15 years prior to diagnosis - a latency response was demonstrated))

* = Significant at the p=0.05 level.

- = No association (number not reported).

TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	

NON-HODGKIN'S

-----Cohort Studies-----

Riihimaki et al 1982	0.0	Based on 0 male deaths.
Axelsson et al 1980	0.0	Based on 0 male deaths.
Ott et al 1980	0.0	Based on 0 male deaths.

TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	≤1.0	
NON-HODGKIN'S			
-----Case-Report-----			
Hardell 1979			Pilot study of 17 cases. 14 cases had employment consistent with exposure (farming, forestry, sawmill, painting and building).
-----Case-Control Studies-----			
Hardell, Eriksson et al 1981	4.8*		169 cases of malignant lymphoma (including 109 non-Hodgkins lymphomas) and 338 controls. Controls were from the general population. Cases and controls with exposure to chlorophenol were excluded. A dose response was observed. SMR is reported for the entire group - it was reported that there was no observable difference in risk between the Hodgkin's and non- Hodgkin's cases.
Hardell 1981	5.5*		169 malignant lymphoma cases (including 109 non-Hodgkins lymphomas) and 154 controls. This is the same case population as above (Hardell & Eriksson 1981), but new controls were chosen from males with colon cancer. A dose response observed. SMR is reported for the entire cohort.
Hoar, Blair et al 1986	1.6 (6.0*)		170 cases and 948 controls. Controls were from the general population. Exposure was based on reported herbicide use. (SMR increased to a significant 6.0 for herbicide use of at least 20 times per year). A dose response was demonstrated.
Pearce, Smith et al 1986	1.4		83 cases matched with two sets of controls - 168 controls with other cancers and 228 controls from the general population.
Woods et al 1987	1.07 (4.80*) ((1.71*))		576 cases and 694 random controls from the general population: ever exposed. (forestry herbicide applicator). ((15 years exposure 15 years prior to diagnosis - a latency response was demonstrated))

* = Significant at the p=0.05 level.

H Human Health Risk Assessment

TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	
HODGKIN'S			
-----Cohort Studies-----			
Riihimaki et al 1982		0.0	Based on 0 male deaths.
Axelson et al 1980	+		Based on 2 male deaths
	+		Based on 1 male death w
	(+)		only phenoxy acid expos
			(with ten year latency
		0.0	
			phenoxy acid & amitrole
	+		Based on 1 male deaths
	(+)		only amitrole exposure
			(with ten year latency
Ott et al 1980		0.0	Based on 0 male deaths.

+ = Unquantified excess risk.

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TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	
HODGKIN'S			
-----Case-Control Studies-----			
Hardell, Eriksson et al 1981	4.8*		169 cases of malignant lymphoma (including 60 Hodgkins lymphomas) and 338 controls. Controls were from the general population. Cases and controls with exposure to chlorophenol were excluded. A dose response was observed. SMR is reported for the entire cohort - it was reported that there was no observable difference in risk between the Hodgkin's and non- Hodgkin's cases.
Hardell 1981	5.5*		169 malignant lymphoma cases (including 60 Hodgkins lymphomas and 154 controls. This is the same case population as above (Hardell & Eriksson 1981), but new controls were chosen from males with colon cancer. A dose response observed. SMR is reported for the entire cohort.
Hardell & Bengtsson 1983	5.0*		60 cases and 335 controls. Controls were from the general population. Cases & controls with high exposure to chlorophenols were excluded. This is a refinement of the two studies presented above (Hardell 1981 / Hardell et al 1981)
Hoar, Blair et al 1986		0.9	71 cases and 984 controls. Controls were from the general population. Exposure was based on reported herbicide use.

* = Significant at the p=0.05 level.

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TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	

LEUKEMIA

-----Cohort Studies-----

Lynge	1.11		Based on 5 male cases.
1985	2.08		Based on 2 female case.
Manufacturer Cohort			
	1.35		Based on 1 male case in phenoxy acid manufacture and packaging.
	4.0		Based on 1 female case in phenoxy acid manufacture and packaging.
Riihimaki et al		0.0	Based on 0 male deaths with ten year latency period.
1982			
Herbicide Applicators			
Axelsson et al	+		Based on 2 male deaths.
1980			
Railroad Sprayers	+		Based on 1 male deaths with only phenoxy acid exposure.
	(+)		(with a ten year latency period)
	+		Based on 1 male death with phenoxy acid and amitrole exposure.
	(+)		(with a ten year latency period)
Ott et al		0.0	Based on 0 male death.
1980			
Manufacturer Cohort			

* = Significant at the p=0.05 level.

+ = Unquantified excess risk.

TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	
STOMACH CANCER			
-----Cohort Studies-----			
Lynge 1985 Manufacturer Cohort	1.29	0.68	Based on 12 male cases. Based on 1 female case.
	1.36	0.0	Based on 2 male cases in phenoxy acid manufacture and packaging. Based on 0 female cases in phenoxy acid manufacture and packaging.
Zack & Gaffey 1983 Manufacturer Cohort		0.63	Based on 1 male death.
		0.0	PRM based on 0 male deaths among 2,4,5-T exposed workers.
Riihimaki et al 1982 Herbicide Applicators	1.1		Based on 4 male deaths with ten year latency period.
Axelsson et al 1980 Railroad Sprayers	2.2		Based on 3 male deaths.
	3.1 (6.1*)		Based on 2 male deaths with only phenoxy acid exposure. (with a ten year latency period)
	3.1 (5.6)		Based on 1 male death with phenoxy acid and amitrole exposure. (with a ten year latency period)
		0.0	Based on 0 male deaths with only amitrole exposure.
Ott et al 1980 Manufacturer Cohort		0.0	Based on 0 male death.

* = Significant at the p=0.05 level.

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TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	
LUNG CANCER			
-----Cohort Studies-----			
Lynge	1.19		Based on 38 male cases.
1985	2.21		Based on 6 female cases.
Manufacturer Cohort	2.06*		Based on 11 male cases in phenoxy acid manufacture and packaging.
	1.28		Based on 1 female case in phenoxy acid manufacture and packaging.
Zack & Gaffey	1.41		Based on 14 male deaths.
1983			
Manufacturer Cohort	1.68		PRM based on 6 male deaths among 2,4,5-T exposed workers.
Riihimaki et al	1.1		Based on 12 male deaths with ten year latency period.
1982			
Herbicide Applicators			
Axelson et al	1.4		Based on 3 male deaths.
1980			
Railroad Sprayers		0.0	Based on 0 male deaths with only phenoxy acid exposure.
	1.9		Based on 1 male death with phenoxy acid and amitrole exposure.
	(2.9)		(with a ten year latency period)
	3.2		Based on 2 male deaths with only amitrole exposure.
	(2.6)		(with a ten year latency period)
Ott et al	+		Based on 1 male death.
1980			
Manufacturer Cohort			

* = Significant at the p=0.05 level.

TOXICITY/ STUDY	POINT ESTIMATE OF RELATIVE RISK		COMMENT
	>1.0	<=1.0	
OVERALL CANCERS			
-----Cohort Studies-----			
Lynge		0.99	Based on all 159 male cases.
1985		0.88	Based on all 49 female cases.
Manufacturer Cohort			
	1.05		Based on 28 male cases in phenoxy acid manufacture and packaging.
		0.87	Based on 13 female cases in phenoxy acid manufacture and packaging.
Zack & Gaffey	1.13		Based on all 35 male deaths.
1983			
Manufacturer Cohort		0.82	PRM based on 9 male deaths among 2,4,5-T exposed workers.
Riihimaki et al		0.71	Based on all 26 male deaths.
1982			
Herbicide Applicators		0.82	Based on 20 male deaths with ten year latency period.
Axelson et al	1.4		Based on all 17 male deaths.
1980			
Railroad Sprayers	1.1		Based on 6 male deaths with only phenoxy acid exposure.
	(1.9)		(with a ten year latency period)
	2.1		Based on 6 male deaths with phenoxy acid and amitrole exposure.
	(3.4*)		(with a ten year latency period)
	1.5		Based on 5 male deaths with only amitrole exposure.
	(1.5)		(with a ten year latency period)
Ott et al		0.28	Based on the 1 male death.
1980			
Manufacturer Cohort			

* = Significant at the p=0.05 level.

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IV. Presentation of Epidemiology Studies by Type of Cancer

Summaries of all cohort studies and relevant case-control studies are presented below for several types of cancers. Relative risks (risks compared to a general population) are presented when available. Relative risks greater than one represents a risk greater than that expected in the general population.

All the cohort studies have been included for each cancer to provide completeness. In some cases, several small cohort studies, with little information on their own, combine to present possible patterns of disease.

Zack & Gaffey 1983 USA Manufacturer Cohort	884 white male hourly workers at Monsanto in Nitro, West Virginia employed at least one year. Exposure to 2,4,5-T was determined only for deceased
Total observed deaths = 163	Study reports SMR's for the entire cohort and PMR's for the deceased by exposed and unexposed. Only 58 of the 163 deaths were 2,4,5-T exposed.
Riihimaki et al 1982 Finland Herbicide Applicators	1,971 male herbicide applicators of four employers with at least two weeks exposure to 2,4-D or 2,4,5-T 75% worked less than eight weeks total.
Total observed deaths = 144	
Axelsson et al 1980 Sweden Railroad Sprayers	348 RR herbicide sprayers with exposure > 45 days Study reports SMR's for the total cohort and three distinct subgroups: phenoxy acid, amitrole and combined exposure.
Total observed deaths = 45	
Ott et al 1980 USA Manufacturer Cohort	204 male workers at Dow Chemical who worked in a 2,4,5-T area for at least one month - 157 worked less than one year.
Total observed deaths = 11	

III. Case Control Studies

Various case-control studies have been conducted to look at risk factors for specific cancers. All the case control studies reported in this section were specifically concerned about associations between phenoxy acid exposures and the cancer being studied.

The case control studies are summarized under the headings of the specific cancers being evaluated.

8. Reproductive Effects

There are no good epidemiology studies of reproductive outcomes associated with exposure to phenoxy herbicides. Much of the information comes from studies in Vietnam where research conditions and records are poor. The results of the Vietnamese studies, as well as those of U.S. soldiers exposed in Vietnam and the few other studies, are generally inconsistent.

The mixed results of studies on reproductive effects could be expected, as these effects are very difficult to study. The possibility of some reproductive effects has been raised and should be of concern.

9. Neurologic Effects

While only two small studies are presented, there are numerous case reports of neurologic effects with 2,4-D exposure. 2,4-D should be considered a potential human neurotoxin.

II. Tables of Cohort Studies

The following five cohort studies look at cancer deaths (or incidence) among groups of workers exposed to phenoxy acids. One also evaluates a group exposed to Amitrole. These studies will be referred to throughout this section as they pertain to the specific cancer being evaluated. They are presented here in more detail.

The studies are ordered according to the total number of deaths or cases observed. These studies include fairly small cohorts and some rarer diseases may not be represented in their findings.

All the studies except that by Lynge (1985) look only at mortality. Lynge used information on the incidence of cancer in his cohort.

COHORT STUDIES

Lynge 1985	4,459 workers at two factories in Denmark
Denmark	3,390 males and 1,069 females
Manufacturer Cohort	940 worked in mfg & pkg of phenoxy herbicides
Total observed	1,226 worked in manual service functions
cancer incidence	1,667 worked in mfg & pkg of other chemicals
= 208 among	Remainder worked office and unspecified jobs
200 individuals	59% males and 50% females worked less than 1 year.
	Study reports results by department and for the entire cohort. Little TCDD contamination.

A number of small manufacturer cohorts also reported individual cases. A review by Honchar & Halperin (1981) estimated an excess risk of over 40 fold based upon three cases in four cohorts and compared to national statistics. Additional case reports claim to have found additional cases who worked in manufacture, some possibly from these four cohorts. A total of seven cases diagnosed by pathologists have been reported.

STS is a difficult diagnosis even for pathologists. The National Institute of Occupational Safety and Health (Fingerhut et al, 1983) reviewed these cases. Two pathologists familiar with STS concurred in the diagnosis in only five cases.

In addition to the difficulty of diagnosis, there are problems coding STS on death certificates. The International Code for Diseases (ICD) is site oriented. Thus, an STS of the stomach may be coded as a stomach cancer. This may be an explanation of the increased stomach cancers noted in some of the cohort studies.

Of more immediate concern is that the two Swedish case-control studies selected their cases using primarily histopathologic characteristics, and did not limit selection by site. The New Zealand and U.S. studies identified their cases using the more site specific ICD classification of 171 (malignant neoplasm of connective and other soft tissue). Thus, while all the studies used cancer registries and cases confirmed by pathology examination, the Swedish studies probably included more sites (such as STS of the stomach). The differences between these studies could well be due to different diagnostic criteria.

The problems with both diagnosis and coding of STS mean that comparisons using death certificates must be questioned. Thus, while there is some variability of the data, there are some clear difference in technique which could explain these differences. Both case control and cohort studies in various countries have found associations with STS and phenoxy acid exposures. We conclude that the possibility of risk for Hodgkin's disease with exposure to phenoxy herbicides has been raised and should be of concern.

7. Summary of Cancer Associations

Suggestions of association with at least five types of cancer have been found in the epidemiology literature. Each of the five cancers has had both statistically significant associations in some studies and negative findings in others. While there is no conclusive demonstration of any individual association, the suggestion is that phenoxy herbicides in some way initiate or promote cancers, and that this is done at a level of exposure experienced in various work settings.

One observational studies on sheep exposed through feed treated with herbicide demonstrated a dose-response relationship with intestinal cancer.

3. Leukemia

The association between leukemia and phenoxy herbicide exposure has not been explicitly studied. Several of the cohort studies have reported cases of leukemia, but no clear pattern emerges.

4. Hodgkin's Disease

Several case-control studies have looked specifically at the occurrence of Hodgkin's disease and exposure to phenoxy herbicides. Two studies (Hardell, Eriksson et al, 1979 and Hardell & Bengtsson, 1983), both done in Sweden on separate populations, reported statistically significant five fold risks. A recent study in the U.S. (Hoar, Blair et al, 1986) found no excess risk. The differences for this disparity is not clear. The studies all appear to have sufficient quality to be given credibility.

Given the variability of the data, we conclude that the possibility of risk for Hodgkin's disease with exposure to phenoxy herbicides has been raised and should be of concern.

5. Non-Hodgkin's Lymphoma

Several case-control studies have looked specifically at the occurrence of Non-Hodgkin's Lymphoma and exposure to phenoxy herbicides. Two studies, one in Sweden (Hardell, Eriksson et al, 1981) and one in the U.S. (Hoar, Blair et al, 1986) reported statistically significant five to six fold risks. A recent study in New Zealand (Pearce, Smith et al, 1986) found a non-significant mild increase of risk around 1.4 fold.

The authors of the New Zealand study felt that their findings were not consistent with the other studies, because their study population was likely to have high exposure.

Given the variability of the data, we conclude that the possibility of risk for Non-Hodgkin's Lymphoma with exposure to phenoxy herbicides has been raised and should be of concern.

6. Soft Tissue Sarcomas

Several case-control studies have looked specifically at the occurrence of Soft Tissue Sarcomas (STS) and exposure to phenoxy herbicides. Two studies (Hardell, Eriksson et al, 1979 and Hardell & Bengtsson, 1983), both done in Sweden on separate populations, reported statistically significant five to seven fold risks. Two recent studies, one in the U.S. (Hoar, Blair et al, 1986) and one in New Zealand (Smith, Pearce et al, 1984) found little or no excess risk.

STS, a fairly rare tumor, was seen in four of the five cohort studies. In each case this represented an excess. A statistically significant excess of five fold was reported by Lynge (1985) for workers in the manual services (maintenance) category.

define an exposed population and look for any disease (in this case any cancers) that might occur more frequently than expected. Case-control studies, on the other hand, define the study population by the type of disease (cancer) being studied, and then look to see if subjects with this disease had more than expected exposure to the chemical (herbicide) of concern.

The five cohort studies look at cancer deaths and incidence among groups of workers exposed to phenoxy acids. One also evaluates a group exposed to Amitrole. These studies will be referred to repeatedly throughout this section as they may be used to evaluate any number of cancers. They will be presented in greater detail at the beginning of the following charts, and will be referenced later simply by the name of the author.

The cohort studies are ordered according to the total number of deaths or cases observed. These studies include fairly small cohorts and some rarer diseases may not be represented in their findings. All the studies except that by Lynge (1985) look only at mortality. Lynge used information on the incidence of cancer in his cohort.

The other studies will be referred to and described only under the heading of the cancer being evaluated in the tables below.

D. Evaluations of Association

The following evaluations are based upon all the studies described above and listed in the table below. Due to the fact that very few of the studies evaluated exposure to 2,4-D or 2,4-DP separately from other associated exposures, the extension of these findings to these herbicides must be done with care.

Nevertheless, those studies which specifically looked at 2,4-D exposure did not differ greatly in results from the other studies. There is no evidence here that 2,4-D is any less or more toxic than other phenoxy herbicides. A cautious observer would have to conclude that the evidence is suggestive of some carcinogenic effect.

1. Lung Cancer

Based upon fairly small studies, there is a suggestion that exposure to phenoxy acids and/or dioxins may cause lung cancer. One difficulty of applying these findings to the use of 2,4-D and 2,4-DP is the question of the role of the TCDD dioxin. It is very difficult to clearly separate these exposures. However, the only statistically significant increase in lung cancer was reported by Lynge, a study with only minor exposure to 2,4,5-T and the TCDD dioxin.

2. Stomach Cancer

Based upon very small studies, there is a suggestion that exposure to phenoxy acids and/or dioxins may cause stomach cancer.

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Most of the studies involved mixed exposure to various phenoxy herbicides, chlorophenols and/or other chemicals. Exposure to TCDD, not associated with 2,4-D or 2,4-DP, is of concern in these studies. However, several studies involve only minimal confounding with dioxins. These include the following:

Lyngé (1985): a cohort study of workers exposed primarily to 2,4-D and other phenoxy herbicides not contaminated with TCDD.

Eriksson et al (1981): a case control study independently analyzed for 2,4,5-T exposure.

Hoar et al (1987): a case-control study independently analyzed for 2,4-D use.

In addition, an observational animal study showed positive results which were unchanged by analysis for herbicides contaminated with TCDD and those not contaminated (Newell et al, 1984).

Other studies looked primarily at mixed 2,4-D and 2,4,5-T exposures. These include the Swedish studies (Hardell, 1981; Hardell & Bengtsson, 1983; Hardell et al, 1981; Hardell & Sandstrom, 1979), as well as others (Pearce et al, 1986; Riihimaki et al, 1982; Smith et al, 1984; Smith et al, 1982; Woods et al, 1987; Singer et al, 1982).

Still other studies looked primarily at 2,4,5-T exposures (Ott et al, 1983; Smith et al, 1982; Suskind & Hertzberg, 1984; Zack and Gaffey, 1983), or mixtures of chemicals including phenoxy herbicides (Axelson et al, 1980).

Finally, reproductive effects were looked at in several ecological studies (Nelson et al, 1979; Thomas, 1980; Field & Kerr, 1979; Hanify et al, 1981; Balarajan & McDowall, 1983). These studies look at the experience of a general population over time and area, and compare these results to herbicide use levels over the same time and area.

The concern about confounding cannot be overcome in many of these studies. However, 2,4-D and 2,4-DP are contaminated with chlorinated dioxins other than TCDD or may have toxic effects of their own. The assumption that all the toxicity of phenoxy herbicides is only associated with TCDD exposure does not necessarily follow, and there is evidence that other dioxins may be important factors (Woods, 1987). To ignore the observed human health effects of this group of herbicides based upon the assumption that all effects are attributable to TCDD would be overly simplistic and not consistent with a conservative approach to assessing human health.

C. Study Descriptions

The studies evaluated include five worker cohort studies, a number of case-control studies, and a few miscellaneous studies. The worker cohort studies

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Observational Epidemiology

I. Discussion

A. Strengths & Weaknesses

Almost all the human epidemiology information on health effects of pesticides is from observational studies. These studies take real life exposure situations for evaluation (such as groups of workers) rather than controlled and deliberate exposures (as in animal experiments). This approach has its strengths and weaknesses.

The most important strengths in these studies are as follows. First, actual human, as opposed to animal, health effects are being observed. Second, exposures levels that actually occur in the environment and workplace are being evaluated, as opposed to the very high exposures used in animal studies. And third, exposures to total commercial products, and not just one active ingredient, are evaluated. Thus, the questions about "inerts" are reduced, and the need for extrapolation to a different species at much lower exposure levels are eliminated.

On the other hand, humans are much less homogeneous than laboratory animals. They differ greatly both in genetic makeup and life environment. The actual exposure being evaluated is often associated with other exposures which can confound the results. Thus, it is very unlikely that a worker using or manufacturing pesticides will come into contact with only one pesticide.

One of the major concerns in studies relating to the phenoxy herbicides 2,4-D and 2,4-DP is confounding by other phenoxy herbicides, in particular 2,4,5-T. The latter is contaminated with significant amounts of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), a highly toxic compound. The herbicides 2,4-D and 2,4,5-T were frequently used together and manufactured at the same facilities.

Finally, human studies involve many more subjects, take a long time and can be expensive. Almost all of the sixteen herbicides under consideration have not been evaluated in exposed human populations. The only herbicide group with considerable information is the phenoxy acid herbicides (including 2,4-D and 2,4-DP).

B. The Scope of the Studies

The studies presented here all involve phenoxy acid herbicides. One study also looks at workers exposed to amitrole. Only for the phenoxy acid herbicides have sufficient human studies been identified to make even a tentative evaluation.

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Appendix H

Human Health Risk Assessment (Qualitative)

Section 6

Data for Evaluation of Human Epidemiology

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Agricultural Chemical Use and Cancer Mortality in Selected Rural Counties in the U.S.A.*

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Abstract — The relationship between agricultural chemical use and five major categories of cancer is examined for a sample of rural U.S. counties. County acreages treated with insecticides, herbicides and fertilizers are the variables of primary analytic interest. Findings suggest that agricultural chemical use is related to county cancer mortality. For three of the five categories of cancer included, agricultural chemical use was the best predictor of cancer mortality. Although limitations common to ecological analyses require caution in interpreting results, the findings are highly suggestive of the need for additional research on possible links between agricultural chemical use and county cancer mortality.

Introduction

A recent article in *Rural Sociology* described rural-urban trends and differentials in cancer mortality for the United States between the early 1950s and 1970s (Greenberg, 1984). Rural areas have traditionally had lower total cancer rates and lower rates of most site-specific cancers. During these two decades, historic rural-urban differences in cancer mortality diminished greatly and the trend toward convergence occurred among almost every type of cancer and among the most rural counties. Although several possible explanations for this convergence have been advanced, Greenberg (1984, p. 149) notes that describing '... what has happened is easier than explaining why it happened'. An explanation of such trends and differentials would likely be advanced by additional research on factors influencing cancer mortality within both rural and urban environments.

The purpose of this study is not to explain the convergence of rural-urban cancer mortality differentials, but to examine the hypothesized impact of

factors which may account for variation in cancer mortality *within* the rural sector. Work has begun to focus on the possible effects of agricultural activities, type of farming and the resulting exposure to possible carcinogenic substances as factors in the rural environment (Burmeister, 1983; Clark *et al.*, 1982; Blair and Thomas, 1979).

One of the obvious exposures connected to rural residence in many localities is agricultural chemical use. The amount of chemicals used in agriculture has increased greatly since the early 1950s, resulting in documented gains to agricultural production (Schaub, 1985). U.S. Department of Agriculture researchers have documented this trend noting, for example, that in 1952, 11% of the corn acreage was treated with herbicides; by 1976, 90% of the corn acreage received treatment and in 1982, 95% was treated (Eichers *et al.*, 1978; Schaub, 1985). Herbicide use increased from 70.5 million pounds of active ingredient (a.i.) in 1964 to 420.4 million pounds a.i. in 1982 (Schaub, 1985, p. 17). Similarly, the use of insecticides has expanded substantially. The use of chemicals to control insects and diseases on corn and tobacco acreages grew from 1% and 47%, respectively, in 1952, to 38% and 76% in 1976 (Eichers *et al.*, 1976, p. 14).

Earlier research has described the short range impact of agricultural chemical use on the health of rural populations. The more immediate deleterious effects of improper exposure to agricultural chemi-

*An earlier version of this paper was presented at the annual meeting of the Rural Sociological Society, Salt Lake City, Utah, 30 August 1986. The authors express their appreciation to Michael K. Miller, William B. Clifford, Kenneth P. Wilkinson, Rex H. Warland, Charles W. Pitts and Daniel T. Lichter for helpful comments on an earlier draft. Interpretations of data and any remaining errors are the sole responsibility of the authors.

cals has been well documented (Morgan *et al.*, 1980; Swartz, 1975; West, 1964). Reports have indicated a large number of pesticide-related illnesses in field-workers (Swartz, 1975; West, 1964), while individual case studies and medical reports illustrate the sometimes fatal results of incorrect exposure during application (West, 1964). Recognition of these hazards has resulted in a ban on certain substances, product labelling, licensing of those prepared to apply chemicals and the initiation of training sessions by Cooperative Extension personnel in correct handling and application procedures. Additional studies continue to monitor chemically treated fields to determine acceptable re-entry times for workers (Woodrow *et al.*, 1977).

The more immediate effects of these chemicals clearly indicate a need for precautions in application and exposure, but there have also been concerns about the possible long-range effects of exposure since a number of agricultural chemicals have been classified as carcinogenic (Epstein, 1979). What are the long-range effects of these chemicals on the cancer mortality of rural populations? This paper reports the relationship between agricultural chemical use and cancer mortality rates of selected rural counties in the US. Agricultural chemical use is examined within a model of county cancer mortality that includes socioeconomic factors implicated in earlier studies.

Prior to the convergence in rural and urban cancer mortality rates, total cancer rates among farm residents have been lower than among urban populations, and some reduced site-specific rates have also been documented (Correa and Haenszel, 1978; Fasal *et al.*, 1968; Wan and Wright, 1973). Conversely, some higher site-specific cancer rates have also been observed in farm populations and have persisted after factors such as age, sex, race and socioeconomic status were controlled. Some of these unexpected results revealed increased risks of certain site-specific cancers for farm workers, higher than expected rates among farm residents and higher than expected rates in some rural counties and regions.

Studies of U.S. farmers and farm workers in Washington, Oregon, Iowa, Nebraska and Texas, have all suggested elevated rates for certain types of cancers (Milham, 1971, 1976; Burmeister, 1983; Blair and Thomas, 1979; Agu *et al.*, 1980). Higher than expected mortality rates include leukemia, myeloma, stomach, pancreas and prostatic cancers. Elevated rates of leukemia (Fasal *et al.*, 1968) and cancers of the central nervous system (Choi *et al.*, 1970) in farm residents have also been reported. For some farm regions, increased rates of lung cancer

(Clark *et al.*, 1977, 1982) and of stomach cancer (Hoover *et al.*, 1975a,b) have been found. Such findings are not restricted to the United States. Zaldivar and Robinson (1973) found excess stomach cancer rates among Chilean farmers and cite similar findings for rural and farm populations in Iceland, Wales, Mexico and Puerto Rico. In Japan, Hirayama (1976) classified farming as a high-risk occupation for stomach cancer and leukemia. Rural areas in Finland exhibit increased rates of lip cancer (Lindqvist, 1979). Bulgarian farmers constitute a disproportionate percentage of bladder cancer patients (Chernozemsky *et al.*, 1977), and testicular cancer rates reveal a higher incidence in predominantly agricultural and rural districts in England, Wales and The Netherlands (Talamanca *et al.*, 1974; Lipworth and Dayan, 1969). Swedish research has also suggested a link between herbicide exposure and soft-tissue sarcoma, Hodgkin's disease and non-Hodgkin's lymphoma (Hardell and Sandstrom, 1979, as cited in Hoar *et al.*, 1986).

Connections between these cancer patterns and agricultural chemical use have been suggested in some cases, but have not been adequately tested (Burmeister, 1981; Clark *et al.*, 1977; Milham, 1971; Lipworth and Dayan, 1969). Agricultural chemical application on a county level was included in one prostate cancer mortality analysis, but no statistically significant relationship was reported (Blair and Fraumeni, 1978). Other studies have inferred relationships between chemical use and site-specific cancers using crop production patterns as a proxy variable, but little research has attempted to test directly the relationship between use of agricultural chemicals and county cancer mortality (Burmeister *et al.*, 1981; Clark *et al.*, 1982). A notable exception is the recent case-control study in Kansas which reported a significant link between herbicide use and non-Hodgkin's lymphoma (Hoar *et al.*, 1986).

Procedures

Sample counties

To test the possible contribution of agricultural chemical use to cancer mortality rates in rural counties, we attempted to identify a set of rural counties whose populations would likely be exposed to varying amounts and types of chemicals. The criteria utilized were also designed to reduce the effects of other environmental and technological factors. After reviewing a variety of measures of rural counties containing substantial agricultural activities and estimating the correlations among a series of these measures, three criteria were used to identify rural counties to be included. Non-metro-

politan counties which met any *one* of the following criteria were initially included in the analysis: the number of employed persons working in agriculture was equal to or greater than the mean number for all counties; the county had a mean value or greater for land used in farming; the county had a mean value or greater for the dollar value of all agricultural products sold. Eliminating counties with incomplete or unmatched data, 1497 non-metropolitan counties met one or more of the criteria and were included among the sample counties.¹

Measurement of variables

Data for the study were compiled by the National Cancer Institute from data provided by the National Center for Health Statistics (Mason and McKay, 1975). These data contain information on the total number of cancer deaths and age-adjusted cancer mortality rates by race, sex and site of cancer for each county in the contiguous U.S. over the 20-year period, 1950–1969. Such data overcome some of the methodological problems intrinsic to the study of degenerative disease. For example, site-specific mortality rates fluctuate widely over short periods of time, particularly among sparsely populated rural areas in which random fluctuations can appear to represent unusually elevated or depressed rates. Partially to offset this problem, 20-year age-adjusted mortality rates for 1950 to 1969 were used as dependent variables. The 20-year mortality rates were further grouped into five major categories of related sites (Table 1) to help compensate for both the small number of cancer deaths and small population bases in many rural counties, and the resulting large standard errors associated with their rates. Grouping site-specific cancers results in the

loss of some etiological information because combining cancers at related bodily sites may not succeed in grouping causally-related illnesses. Nonetheless, the rate stability problem is partially addressed through such a procedure (Greenberg, 1983; 1984). Further, grouping site-specific cancers does recognize the possibility of different etiologies across the five major categories of cancer employed, a distinction not possible when all cancer deaths are combined. Finally, to compensate further for the very small number of cancer deaths in some counties, only those counties reporting 50 or more deaths from a given type of cancer were included in the final analysis.

It should be noted that studies of mortality rates tend to underestimate the disease experience of a population because the actual number of people with the disease at any given time is greater than the number dying from it. This has not been an extensive problem for many cancers (Epstein, 1979; Bush, 1984), particularly in comparison to other causes of death. While declines in some site-specific cancers have occurred, statistical reports of increased survival rates may reflect earlier diagnosis rather than longer survival after onset of the disease (Bush, 1984). In the absence of incidence data for the time period and units of analysis employed, mortality rates were used.

Because sex and race are both recognized factors in cancer etiology, only rates for white males are used in this analysis (Cutler and Young, 1975; Epstein, 1979; Greenberg, 1983; Preston, 1976). The small number of non-whites in most rural counties outside the south precluded their inclusion in this study, and the greater occupational exposure of rural males led to the decision to examine female cancer mortality in a subsequent analysis.

Table 1. Major groups of cancer

Type of cancer	ICD code*
Genital	Prostate (177); testis (178)
Urinary	Kidney (180); bladder (181)
Lymphatic and hematopoietic	Hodgkin's disease (201); lymphosarcoma and reticulosarcoma, other forms of lymphoma (reticulosis) and mycosis fungoides (200, 202, 205); multiple myeloma (203); leukemia and aleukemia (204)
Respiratory	Nose, nasal cavities, middle ear and accessory sinuses (160); larynx (161); trachea, bronchus and lung specified as primary; and lung bronchus, unspecified as to whether primary or secondary (162, 163)
Digestive	Esophagus (150); stomach (151); large intestine except rectum (153); rectum (154); biliary passages and liver stated as to be primary site (155); pancreas (157)

* Source: World Health Organization (1948) *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death*, 6th edn. Vol. 1. Geneva, Switzerland.

The dependent variables then represent average annual age-adjusted mortality rates (per 100,000) for the 1950-1969 period (Mason and McKay, 1975). Subsequent work will examine lagged models in which cancer rates are viewed as dependent upon chemical use in earlier periods. However, the latency period for many types of cancer has been estimated at 20-40 years (Greenberg, 1984). Thus, data availability limit efforts to test many lagged models, even if the appropriate time interval were known. For example, Census of Agriculture data on county-level chemical use other than fertilizers are not available before 1964, shortly after the midpoint of the period for which the cancer rates are calculated. While earlier measurements on this crucial independent variable would have been desirable, the present effort represents a preliminary attempt to test the hypothesized link between chemical use and cancer mortality in an ecological model. Moreover, the consistency of county agricultural production patterns from year to year suggests that these indicators of chemical use would likely be strongly related over time.

Data for the central explanatory variables, agricultural chemical use, were obtained from the 1964 Census of Agriculture. Three categories of chemical use were reported: (1) acres of land treated with dry and liquid fertilizers, (2) acres of crops sprayed for control of insects and diseases (insecticides),² and (3) acres of crops or land treated during the year for control of weeds, grass, and brush (herbicides) (U.S. Bureau of Census, 1966). The percentages of the total county farmland acreage treated with each type of chemical (fertilizer, insecticide, herbicide) serve as the measures of agricultural chemical use. While it would have been preferable to have direct measures of the amount of each chemical that was used, such data were not available. Similarly, the number of applications to a given plot was not known. Thus, the measures are conservative estimates of chemical use during the period under study and undoubtedly underestimate the use of these three categories of chemicals. Although we would prefer more detailed and precise information on the types and quantities of agricultural chemicals used, the conservative nature of the chemical use data biases the findings toward null results. While no bias is ideal, a conservative bias is clearly preferable to one biased in favor of the research hypothesis.

Although the primary focus of this study is on the influence of agricultural chemical use, other factors have been identified as important in earlier research on cancer. The possible effect of manufacturing industries on cancer rates has been widely noted (e.g. Hoover *et al.*, 1975; Greenberg, 1983). To assess the relative contribution of this variable to

county cancer mortality, the proportion of each county's total 1960 employed population that was employed in manufacturing was calculated (U.S. Bureau of Census, 1962). Similarly, mining has been identified as a high-risk occupation for certain site-specific cancers (Hoover *et al.*, 1975; Page *et al.*, 1976). Census data on the proportion of county employees who in 1960 worked in mining industries were also obtained.

Environmental contaminants previously identified as contributing to explanations of cancer mortality have often been associated with urban locations (Greenberg, 1983). The selection of non-metropolitan counties controlled part of the possible effects of urban residence. To further control the impact of urban influence, a measure of rurality was constructed using the size of largest place within the county and adjacency to a metropolitan area. Using 1960 SMSAs, counties were coded from those with most urban influence to those that were most rural. The categories were: (1) adjacent to a metropolitan county and with an urban place of 10,000 or more, (2) adjacent and with an urban place of 2500-9999, (3) adjacent but entirely rural, (4) non-adjacent but with a place of 10,000 or more, (5) non-adjacent with an urban place of 2500-9999, and (6) non-adjacent and entirely rural.

Other variables frequently included in studies of cancer mortality include socioeconomic status and ethnicity. Socioeconomic status has been identified repeatedly as an important factor in individual-level analyses (Correa and Haenszel, 1978; Cutler and Young, 1975; Graham, 1969; Kitagawa, 1977). A variety of measures of this variable have been used, including occupation, education, and income, as well as indices devised from these characteristics. The potential influence of occupation was included as a risk factor represented by the manufacturing and mining variables. The impacts of education and income were measured through two separate indicators. Census data on males' median educational levels and median family income (1960) were selected as indicators of county-level socioeconomic status.

Finally, several studies have found ethnic background to be associated with certain site-specific cancer rates (Graham, 1969; Hoover *et al.*, 1975b). Consequently, the proportion of the total county population that was foreign stock was included. Foreign stock refers to the proportion of the population that is foreign-born plus those who are native-born of foreign parentage.

Multiple regression models are estimated separately for each of the five categories of cancer included.

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Ordinary least squares equations are estimated using a linear specification in the absence of more complete information as to expected functional form.

Findings

The models estimated in Table 2 support the decision to examine separately cancer deaths at related sites. With the exception of the mining and rurality variables that are positively related to cancer mortality in each case where they are statistically significant, the remaining variables reveal contrasting signs, depending upon the cancer site being examined.

Among the agricultural chemical variables, the percentage of farmland treated with herbicides is the most consistently related to cancer mortality. In four of the five models, herbicide use is significantly related to cancer rates. The standardized partial regression coefficients indicate that herbicide use is the strongest predictor in the genital and lymphatic cancer regressions and the second best predictor in the digestive cancer equation. Herbicide use is positively and significantly related to each of these categories of cancer. Surprisingly, herbicide use is also significantly related to respiratory cancer, but in a negative direction, a finding for which we have no ready explanation. It is interesting to note, however, that in the one equation where this reversal of expected sign occurs, the coefficient for insecticide use is large and positive.

Insecticide use is not only significantly and positively related to respiratory cancer ($\text{Beta} = 0.46$), it is the best predictor of this type of cancer of the nine variables considered. Use of insecticides is unrelated to urinary, lymphatic or digestive cancers. Genital cancer mortality is negatively related to insecticide use, contrary to expectations. Similar to the respiratory equation in which the anomalous negative effect of one chemical occurred in the presence of a strong positive impact of another, herbicide use emerges as the strongest predictor of genital cancer ($\text{Beta} = 0.32$). Whether these two findings reflect a particular combination of agricultural practices, types of farming, soil types, or other exposures which may be related to elevated rates of genital or respiratory cancer could not be ascertained. Given the modest correlation between insecticide and herbicide use (0.3), this finding does not appear to be a statistical artifact of collinearity.³

As a further check on these unanticipated findings, particularly the negative sign for herbicides in the respiratory cancer equation and the negative impact of insecticides in the genital cancer equation, two

additional analyses were run (data not shown). First, the limitation to counties reporting 50 or more deaths was dropped and the models were reestimated on the approximately 1500 counties included in the original sample. Secondly, in an attempt to ascertain whether similar results would obtain within more homogeneous agricultural regions, separate models were also estimated for all counties in seven mid-west states in which corn and soybeans predominate and where similar chemical use patterns might be expected.⁴

The findings were consistent with those reported in Table 2. The unexpected signs of the coefficients in the genital and respiratory equations remained the same for the entire sample of counties and for the midwest subsample, although the magnitude of coefficients and levels of significance varied. The consistency of these findings across the different sample configurations suggest that these results are not merely a function of the counties included nor the decision rules employed.

Fertilizer use was largely unrelated to cancer mortality. It failed to exert a significant impact in four of the five regressions, and in the one case where it was statistically significant (digestive cancer), it was negatively related and of marginal size ($\text{Beta} = -0.09$).

Manufacturing employment is significantly related in the digestive cancer equation, indicating that an increase in the percentage of the labor force in manufacturing is positively related to this cause of death. It is unrelated in any other regression, perhaps reflecting the small proportion of the labor force employed in manufacturing in this sample of rural counties. Mining, by contrast, was positively related to genital, respiratory and digestive cancer. Its largest impact, as expected, was on respiratory cancer. Notably, however, the impact of mining ($\text{Beta} = 0.11$) in the respiratory equation was only about one-fourth that of insecticide use ($\text{Beta} = 0.46$).

The rurality measure was positively related to urinary and lymphatic cancer rates, but not significantly related to the more frequently occurring cancers. The coefficients for income and education are significant in both the respiratory and digestive equations. In each case, their impact is of opposite sign. Education is negatively related to respiratory and digestive cancer, while income exerts a positive influence. Conversely, income reveals a negative coefficient for genital cancer, while education is positively related to lymphatic cancer. Neither variable is significant in the urinary cancer regression.

Table 2. Summary of OLS regressions of county — white male cancer mortality rates for specific types of cancer on agricultural chemical use and selected ecological variables*

Variable	Genital		Urinary		Lymphatic		Respiratory		Digestive	
	b	β	b	β	b	β	b	β	b	β
Insecticide	-10.129†	-0.186	-3.490	-0.109	-4.646	-0.117	57.488†	0.455	3.463	0.026
Herbicide	12.630†	0.320	-0.315	-0.012	7.009†	0.221	-19.151†	-0.178	21.529†	0.216
Fertilizer	-1.286	-0.057	2.406	0.169	-0.529	-0.030	-4.298	-0.072	-5.405†	-0.092
Manufacturing	0.639	0.024	1.080	0.066	-1.507	-0.072	-5.635	-0.075	8.690†	0.119
Mining	10.295†	0.091	-6.533	-0.052	-1.640	-0.018	23.610†	0.108	12.330†	0.054
Rurality	0.102	0.051	0.314†	0.225	0.223†	0.134	0.105	0.020	0.140	0.029
Median family income	-0.001†	-0.237	0.001	0.174	-0.000	-0.046	0.002†	0.283	0.001	0.173
Median educational level	0.255	0.098	0.318	0.150	0.299†	0.149	-0.168†	-0.185	-0.719†	-0.110
Foreign stock	7.968†	0.227	6.612†	0.275	1.308	0.046	-28.861†	0.298	42.850†	0.490
Adjusted R^2	0.119		0.156		0.078		0.229		0.363	
F-ratio	8.348†		4.055†		4.558†		24.993†		67.673†	

*For counties with at least 50 deaths due to specified type of cancer. Mean cancer mortality rates and number of counties included are: genital cancer (19.7, $n = 489$), urinary cancer (11.0, $n = 150$), lymphatic cancer (18.1, $n = 381$), respiratory cancer (33.7, $n = 727$) and digestive cancer (48.7, $n = 1055$).

† $P = \leq 0.05$.

‡ $P = \leq 0.01$.

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The coefficients for the percentage of the population classified as foreign stock are substantial and significant in four of the five equations. The impact is particularly noticeable for digestive cancer where foreign stock is the strongest predictor in the equation ($\text{Beta} = 0.49$) and where the best fitting model is found ($\hat{R}^2 = 0.36$). This finding again confirms the likely influence of ethnicity on digestive cancer (Hoover *et al.*, 1975). Foreign stock is also significant in the genital, urinary and respiratory regressions. The moderately strong negative coefficient in the respiratory regression contrasts with the positive signs in the other models, again supporting the decision not to examine total cancer mortality rates, but rather to group cancers at related sites. Whether the negative impact of foreign stock on respiratory cancer reflects different patterns of cigarette consumption or other factors cannot be determined from these data, but the findings are suggestive of delimited areas for further research.

Discussion

Significant associations were found between agricultural chemical use and four of the five categories of cancer examined. For three of the five models, agricultural chemical use was the best predictor of cancer mortality. Herbicides were positively and significantly associated with genital, lymphatic and digestive cancer. Insecticides had a strong positive relationship to respiratory cancer. In two instances, insecticides in the genital cancer regression and herbicides in the respiratory regression, signs of the coefficients were contrary to expectations. In each of these anomalous cases, a much stronger and positive relationship was exhibited with the other major pesticide. Fertilizer use was largely unrelated to cancer mortality with the exception of a modest negative association with digestive cancer.

Of the remaining social, economic and demographic variables, foreign stock exhibited the largest and most consistent influence. Foreign stock was the strongest predictor of digestive cancer, suggesting that ethnicity was positively related to this cause of death. Similarly, foreign stock exhibited positive impacts on genital and urinary cancer, but negative effects on respiratory cancer.

Income and education were both significant in respiratory and digestive cancer, but of opposite sign. As expected, mining was important to respiratory cancer, but it also was positively related to genital and digestive cancer. Manufacturing employment was significant in one instance (digestive cancer), while rurality exhibited positive effects on urinary and lymphatic cancer.

Although mixed, the findings are highly suggestive of the need for additional research on possible links between agricultural chemical use and county cancer mortality. However, several limitations of the study must be recognized. Common to ecological studies, direct links between persons exposed to agricultural chemicals and those who died of cancer cannot be made. Thus, as Clark *et al.* (1982) note, those who died may not have been involved in farming. Conversely, there are multiple pathways through which chemicals are dispersed in the environment and farm workers are clearly not the only persons exposed to potential risks (Glotsfelty, 1985; Severn, 1985; Sieber, 1985). Nonetheless, caution must be exerted in interpreting these results.

A second problem relates to the appropriate time referent for the cancer rates given the long latency periods for many types of cancer. If a 20+ year latency period characterizes the cancer rates examined here, then this analysis may well underestimate the influence of agricultural chemicals. Clark *et al.* (1982, p. 4) used a 20-year lag because they "... thought that ... was the only time period for which an association with the use of OC (organochlorine) pesticide could be observed". Our results indicate that significant associations may be found within shorter time periods. As data for the 1980-1985 period become available, more appropriately lagged models can be estimated. In the interim, we are currently attempting to estimate lagged models for the 1975-1980 period.

An additional problem of the study is the lack of detailed data on the types, quantities and frequency of chemical applications, as well as behavioral practices in their application, e.g. use of masks, aerial spraying, etc. In the absence of such data, some investigations have used the proportion of harvested land in a given crop as a surrogate measure of the intensity of chemical use (Clark *et al.*, 1982). Such procedures are several steps removed from the indicators necessary to measure exposure more directly. The measures of agricultural chemical use in this study, percentages of total farmland acreage treated with insecticides, herbicides or fertilizers, are subject to similar problems. Census of Agriculture data on county-level chemical use are extremely limited and, as noted, may bias findings toward null results. The finding of significant relationships where the epistemic correlations between concepts and measures are likely to be modest encourages further work. In that regard, the consistency between our findings and those of Clark *et al.* (1982) indicate that observed relationships are not likely to be simply artifacts of the methods employed.

Finally, county-level behavioral data on lifestyle factors such as diet, smoking or alcohol consumption are not available for this period. Such factors could possibly confound some of the associations observed in this study. Controls for foreign stock, rurality and socioeconomic status of the population partially address this issue. Moreover, some have argued that similar patterns of alcohol consumption, cigarette smoking and nutrition now characterize both rural and urban America (Greenberg, 1984). Nonetheless, lifestyle differences may remain which are not accounted for in these ecological models. Unless one posits systematic relationships between such lifestyle factors and the variables of primary analytic interest to this study, relationships to our knowledge not yet examined empirically, lifestyle differences remain a possible alternative explanation of indeterminant plausibility.

The contribution of agricultural chemicals to farm production is well established (Schaub, 1985). With one estimate of pre- and postharvest commodity losses caused by insects in the United States in 1981 over 20 billion dollars (Klassen and Schwartz, 1985, p. 280), their use is likely to continue. While evaluations of the toxicity and possible carcinogenicity of the substances involved is the proper purview of biological and medical researchers (Epstein, 1977), ecological studies involving demographic, socioeconomic and agricultural factors can and should be monitored by social scientists. Environmental sociologists, demographers, geographers and rural sociologists would all appear to have a role to play.

Notes

1. This procedure produced a much larger number of counties than would have resulted if a more restricted definition of agriculturally-based employment activities had been used (Brown and Beale, 1981). For example, restricting the sample to only those counties with 20 or 25% of the total employed population in agriculture would have identified counties in which agriculture was a dominant industry, but it would also have significantly reduced the sample size. Moreover, farm workers and those in agriculturally-related industries are not the only persons exposed to agricultural chemicals in the rural environment. Thus, the more inclusive approach was deemed more appropriate to this exploratory effort.
2. Although we use the term insecticides to refer to this category of chemicals, a number of other pesticides are also included.
3. In addition to the modest correlation between these two variables, the SAS collinearity diagnostic procedures revealed no collinearity problems involving the chemical variables. Other than the expected correlation between income and education, there was little evidence of harmful or degrading collinearity in the data matrix.

4. The seven states were Ohio, Indiana, Illinois, Iowa, Minnesota, Michigan and Wisconsin. Counties with 50 or more deaths were included in order to increase the stability of rates within the region.

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GENETIC TOXICOLOGY

An Agricultural Perspective

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STUDY OF PESTICIDE GENOTOXICITY

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INTRODUCTION

With a limited supply of arable land supporting an ever-increasing human population, the threat of crop loss to agricultural pests becomes continually more acute. Thus pesticides have become an essential component of modern agriculture. As competing organisms evolve resistance to commonly used agents, new and more effective poisons and repellants must constantly be developed. The fundamental problem in pesticide development is to produce chemicals that act specifically against certain organisms without adversely affecting others. Because of the similarities in the structural, metabolic and genetic components of all life forms, absolute species specificity is frequently difficult to attain. Furthermore, such toxic chemicals improperly used may engender biological effects beyond those for which they were originally manufactured.

Table 2. Genotoxicity Bioassays Employed

Descriptor	Organism	Property Examined	Reference
<u>Point/Gene Mutations in Prokaryotes</u>			
SAL*	<u>S. typhimurium</u> (5 strains)	Reverse mutation	(1)
WPU*	<u>E. coli</u> WP2 <u>uvrA</u>	Reverse mutation	(2)
<u>Point/Gene Mutations in Eukaryotes</u>			
YER	<u>S. cerevisiae</u> D7	Reverse mutation	(27)
LST	Mouse lymphoma L5178Y cells	Forward mutation	(5)
SRL	<u>D. melanogaster</u>	Recessive lethality	(25)
<u>Primary DNA Damage in Prokaryotes</u>			
REP*	<u>E. coli</u> <u>polA</u>	Differential toxicity	(21)
REW*	<u>B. subtilis</u> <u>rec</u>	Differential toxicity	(13)
SAR	<u>S. typhimurium</u> <u>uvrB</u> , <u>rec</u>	Differential toxicity	(1)
<u>Primary DNA Damage in Eukaryotes</u>			
YE3*	<u>S. cerevisiae</u> D3	Enhanced mitotic recombination	(4)
YEH	<u>S. cerevisiae</u> D7	Gene conversion and crossing-over	(28)
UDH*	Human lung fibroblasts WI-38	Unscheduled DNA synthesis	(19)
<u>Chromosomal Effects</u>			
SCC	Chinese hamster ovary cells	Sister-chromatid exchange	(16, 22)
MNM	Mouse bone marrow and cardiac blood	Chromosome breakage (micronuclei)	(17)
DLM	Mouse	Dominant lethality	(18)

*A bioassay from the initial battery of screening tests.

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Table 4. Genotoxicity Bioassay Results for Herbicides

Compound	Point/Gene Mutation					DNA Damage						Chromosomal Effects		
	Prokaryote		Eukaryote			Prokaryote			Eukaryote			SCC	MNM	DLM
	SAL	WPU	YER	L5T	SRL	REP	REW	SAR	YE3	YEH	UDH			
Bromacil	-	-	-	+	+	-	-	-	-	-	-	-	-	-
Cacodylic acid	-	-	+	+	-	NT	NT	-	+	+	-	-	+	
Diallate	+	*	-	+	+				+	*	-			
Dicamba	-	-			-	+	+	-	-		-			
Dinoseb	-	-			-	+	+	+	-		-			
DSMA	-	-				-	-		-		-			
Monuron	-	-	-	+	-	-	-		-	-	-	+	*	+
MSMA	-	-			-	-	-		-		-			
Pentachlorophenol	-	-				-	+		+					
Propanil	-	-				-	+	+	-		-			
Siduron	-	-			-	NT	NT		-		-			
Simazine	-	-	-	+	+	NT	NT	-	-	-	-	-	-	
Sulfallate	+	*				-	-		-					
Triallate	+	*	-	+	-				+	*	-			
Trifluralin	-	-			-	-	-		-		-			
2,4-D	-	-				-	+	-	-		-			
2,4-DB	-	-				+	-	-	-		-			
2,4,5-T	-	-				-	+		-					

STUDY OF PESTICIDE GENOTOXICITY

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Primary DNA Damage. Although 29 of the 35 positive pesticides caused primary DNA damage only 16 caused primary DNA damage but not point/gene mutation. A unique group of 10 pesticides was found that caused DNA damage only in prokaryotic systems (Table 11); however, testing for gene mutation and chromosomal damage by these compounds is not complete. A large number of these compounds are chlorinated aromatics (Figure 10). The halophenoxy herbicides 2,4-D, 2,4-DB and 2,4,5-T (Figure 11) form a subgroup of chlorinated compounds; evidence of positive eukaryotic activity for the phenoxy herbicides has been presented elsewhere (26).

Although testing is incomplete, m-dichlorobenzene and pentachlorophenol were positive only for DNA damage in a prokaryotic and a eukaryotic system, and four pesticides (ethyl chrysanthemate, mancozeb, maneb, and zineb) were positive only for DNA damage in eukaryotic systems (Table 12). The last three chemicals in this group have similar structures (Figure 12) and are classified as ethylenebisdithiocarbamate fungicides. Since the data in Tables 7 and 8 suggest that the positive results obtained in the *S. cerevisiae* D3 assay (YE3) may be confirmed in the L5T system, the five chemicals in Table 12 should be evaluated further for gene mutation in eukaryotes.

Chromosomal Damage. Although the initial test battery did not include tests for chromosomal damage, nine pesticides (Tables 7 and 8) were observed to display this effect. Eight of these chemicals caused a positive response for sister-chromatid exchange in CHO cells (SCC) but only three, cacodylic acid, monuron, and benomyl, caused micronuclei formation in developing erythrocytes of the mouse (MMN). Each of these compounds also caused point/gene mutations or DNA damage, or both. The active gene mutagens, acephate, demeton, monocrotophos, and trichlorfon, were positive in eukaryotic gene mutation and primary DNA damage assay systems except SRL. The five other compounds, disulfoton, methyl-parathion, cacodylic acid, monuron, and benomyl, were positive in eukaryotic gene or DNA damage assays but were negative (or were not tested) in the prokaryotic point/gene assays. All nine of these chromosome-damaging compounds were positive in the L5T system. Negative results were obtained for ten pesticides evaluated in the mouse dominant lethal test. Six of these compounds were positive in at least two eukaryotic assays. The six are the insecticides azinphos-methyl, methyl-parathion, and monocrotophos, the herbicide bromacil, and the fungicides captan and folpet.

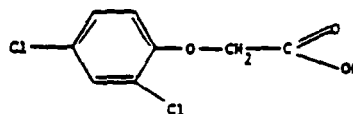
Comparison of Bioassay and Carcinogenicity Data

A comparison of the genotoxicity test results with carcinogenicity studies of 15 pesticides is shown in Table 13. Four herbicides (diallate, monuron, sulfallate, and trifluralin) and one fungicide (captan) evaluated in the present study cause tumors in

Table 11. Pesticides Positive only for DNA Damage in Prokaryotic Systems

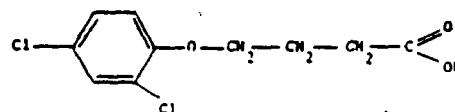
Compound	Point/Gene Mutation					DNA Damage					
	Prokaryote		Eukaryote			Prokaryote			Eukaryote		
	SAL	WPU	YER	L5T	SRL	REP	REW	SAR	YE3	YEH	UDH
Chlorpyrifos (I)	-	-			-	+	+	+	-		-
Chrysanthemic acid (I)	-	-				-	+		-		-
o-dichlorobenzene (I)	-	-				+	-		-		
2,4-D (H)	-	-				-	+	-	-		-
2,4-DB (H)	-	-				+	-	-	-		-
Dicamba (H)	-	-			-	+	+	-	-		-
Dinoseb (H)	-	-			-	+	+	+	-		-
Propanil (H)	-	-				-	+	+	-		-
2,4,5-T (H)	-	-				-	+		-		
sec-butylamine (F)	-	-				+	-		-		

2, 4-D Acid



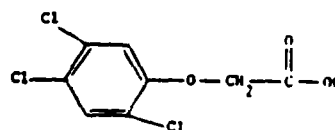
REW

2, 4-DB Acid



REP

2, 4, 5-T



REW

Fig. 11. Three phenoxy herbicides that elicited prokaryotic DNA damage.

Table 13. Comparison of Genotoxicity and Carcinogenicity Test Results

Pesticides	Genotoxicity	Carcinogenicity		
		Mice m/f	Rats m/f	Ref.
<u>Positive Carcinogenicity</u>				
Captan (F)	+: SAL, WPU, LST, SRL, REP, REW, SAR, YE3 -: UDH, DLM	+/-	-/-	(9)
Diallate (H)	+: SAL, LST, SRL, YE3 -: WPU, YER, YEH	+/+	±/±	(10)
Monuron (H)	+: LST, SCC, MNM -: 9 tests	+	±	(11)
Sulfallate (H) (mutagenicity testing incomplete)	+: SAL -: 4 tests	+/+	+/+	(9)
Trifluralin (H)	-: 7 tests	-/+	-/-	(9)
<u>Possible Carcinogenicity</u>				
Azinphos-methyl (I)	+: LST, YE3 -: 10 tests	-/-	±/±	(9)
Fenthion (I)	-: 5 tests	±/-	-/-	(9)
Parathion (I)	-: 8 tests	-/-	±/±	(9)
<u>Negative Carcinogenicity</u>				
Diazinon (I)	-: 4 tests	-/-	-/-	(9)
Endrin (I)	-: 6 tests	-/-	-/-	(9)
Malathion (I)	-: 8 tests	-/-	-/-	(9)
Methoxychlor (I)	-: 5 tests	-/-	-/-	(9)
Methyl-parathion (I)	+: LST, YE3, SCC -: 8 tests	-/-	-/-	(9)
PCNB (F)	-: 6 tests	-/-	-/-	(9)
2,4-D and esters (H)	+: REW, REP -: 5 tests	-	-	(12)

+ = positive response, ± = equivocal, - = negative response (under conditions of bioassay; not necessarily non-carcinogenic).

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Herbicides and Non-Hodgkin's Lymphoma: New Evidence From a Study of Saskatchewan Farmers

Aaron Blair

The lifestyle of farmers is usually perceived as healthy because it includes hard work, clean air, fresh food, and avoidance (at least to some degree) of unhealthy habits such as tobacco and alcohol use. The epidemiologic literature supports this perception and has consistently shown that farmers have a more favorable mortality experience than the general population (1). Despite a lower mortality from all combined causes and from most major causes of death, farmers may experience elevated risks for certain cancers, particularly cancers of the stomach, connective tissue, skin, brain, prostate, and lymphatic and hematopoietic system. Although some investigators disagree whether the factors in the agricultural environment may account for these excesses (2), potential exposures to herbicides have received considerable attention (3-8), particularly in regard to lymphoma and soft-tissue sarcoma.

In this issue of the Journal, Wigle et al. (9) present results from a mortality study of 69,513 Saskatchewan farmers, age 35 years or older, which provide further evidence that the use of herbicides is associated with the risk of non-Hodgkin's lymphoma. Mortality among Saskatchewan farmers was considerably lower than that of the general population. Deficits were also observed for diseases of the circulatory system, all malignant neoplasms, accidents, poisoning, and violence. Although no cancer showed a statistically significant excess among farmers overall, Poisson regression modeling indicated that acres sprayed with herbicides and expenditures on fuel in 1970 were independently associated with non-Hodgkin's lymphoma. Further, relative risks rose to over twofold among those farmers who spent \$900 or more on fuel or among those farmers who sprayed 250 or more acres, e.g., among farmers with operations of less than 1,000 acres. These excesses could not be explained by education, income, ethnic background, production of specific crops, or use of fertilizers or insecticides.

This investigation makes a substantial contribution to the understanding of cancer mortality patterns and various agricultural practices for several reasons. First, the association between the use of herbicides and the risk of non-Hodgkin's lymphoma among farmers seen in this cohort study, despite reliance on relatively crude census and mortality data, is consistent with findings from most (3-7), but not all (8), case-control studies designed to investigate this issue.

Second, mortality from non-Hodgkin's lymphoma rose significantly with increasing number of acres sprayed with herbicides,

particularly on smaller farms where the farmer is more likely to have personally engaged in herbicide application. This exposure-response gradient persisted despite study limitations in exposure assessment that would tend to mute any exposure-response effect. For example, acres sprayed is only a surrogate measure for delivered dose—a farmer's use of herbicides in 1970 may not be representative of use in other years, and a large proportion of subjects are likely to have ceased farming since 1970.

Third, the exposure information available in this cohort, although less than that available in case-control studies, would be less affected by accuracy of respondent recall, a major criticism of case-control studies. In the cohort study presented here, the information on herbicide use in 1970 is probably reasonably accurate, but it is unclear how well herbicide use during this year represents farmers' use in other years. The results from the cohort study are also unlikely to be due to case-response bias, an issue often raised in regard to case-control studies. When based on analysis of deaths that occurred after 1981, the association between the use of herbicides and the risk of non-Hodgkin's lymphoma among farmers persisted for years after the determination of exposure in 1970. This minimizes the possibility that the results are due to response bias among non-Hodgkin's lymphoma cases.

Finally, the association was specific. Among these farmers, an association with herbicide use was limited to non-Hodgkin's lymphoma and could not be explained by education, income, ethnicity, expenditures on fuel, or use of fertilizers or insecticides.

Wigle et al. (9), through prudent use of readily available data resources, have provided new information that supports the hypothesis that contact with herbicides increases the risk of non-Hodgkin's lymphoma among farmers. Case-control studies have observed non-Hodgkin's lymphoma associated with phenoxyacetic acid herbicides (3-7) and, in particular, the phenoxyacetic acids 2,4-D (3,4). This study did not contain information on the specific herbicides used by the study subjects; therefore, it was impossible to directly evaluate risks associated with potential exposure to specific chemicals. The authors note, however, that the phenoxyacetic acid herbicide 2,4-D accounted for 75% of the weight of all herbicide-active ingredients used agriculturally in Saskatchewan in 1970 and a greater percentage in 1960.

Excesses of non-Hodgkin's lymphoma have been reported among farmers in various countries (1). The epidemiologic evidence points toward involvement of phenoxyacetic acid herbicides and, in particular, 2,4-D, but there are inconsistencies. The experimental evidence is unimpressive. The International Agency for Research on Cancer concluded that the evidence for carcinogenicity of 2,4-D and 2,4,5-T in animals is inadequate (10). This presents a dilemma to the scientific community in how to draw conclusions regarding carcinogenicity of a substance when the epidemiologic and experimental data do not agree, especially in situations where the epidemiologic evidence is positive and experimental evidence is not.

Received February 27, 1990; accepted February 28, 1990.

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As our research focus in carcinogenesis turns from substances that damage the DNA to those that may operate through epigenetic mechanisms, perhaps we should anticipate more and more situations as with phenoxyacetic acid herbicides that show experimental and epidemiologic inconsistencies. The challenge in the future will be to design studies in the laboratory that mimic the human condition and to incorporate biochemical procedures into epidemiologic studies to obtain information on mechanisms. Experimental investigations of pesticides should utilize dermal exposure, the principal route of occupational exposure in humans. Although epidemiologic studies that incorporate biochemical measures are needed to improve assessment of exposure, the study by Wigle et al. (9) demonstrates that traditional approaches linking data collected for other purposes can be valuable, particularly when they include some surrogate for dose.

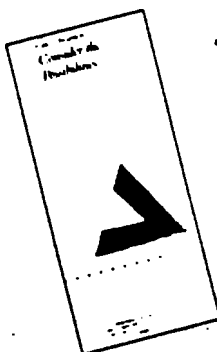
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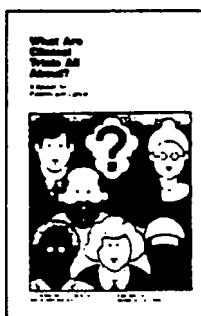
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Environmental Health Monthly

Vol. 2, No. 6

March, 1990

ABSTRACT

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Since the 1950s, marked differences between cancer mortality rates in rural and urban areas have been diminishing. One explanation is the dramatic increase in agricultural chemical use since the early 1950s. In this paper, C. Shannon Stokes and Kathy D. Brace examine the relationship between agricultural chemical use and five major categories of cancer mortality in rural U.S. counties.

The authors identified and selected 1497 counties whose populations were likely to be exposed to agricultural chemicals if they met any one of the following factors: 1) the number of employed persons working in agriculture was equal to or greater than the mean number for all counties; 2) the county had a mean value or greater for land used in farming; or 3) the county had a mean value or greater for the dollar value of all agricultural products sold.

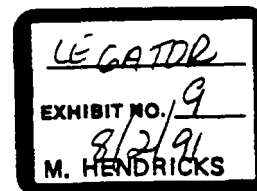
Cancer rates for the 20-year period 1950-1969 were selected from data compiled by the National Cancer Institute from data provided by the National Center for Health Statistics. Cancers were grouped into 5 categories: genital; urinary; lymphatic and hematopoietic; respiratory; and digestive. Only rates for white males were used in this study.

Different variables were analyzed for each county including total acreage treated with insecticides, herbicides and fertilizers; percentage of labor force in mining; in manufacturing; rurality; median family income; median educational level; and the percentage of the total county population that was foreign-born.

Findings indicate that agricultural chemical use is related to cancer mortality. For three of the five cancer categories, agricultural use was the best predictor of cancer mortality.

Herbicides were positively and significantly associated with genital, lymphatic and digestive cancer; insecticides had a strong positive relationship to respiratory cancer; fertilizer use was largely unrelated to cancer mortality with the exception of a modest negative association with digestive cancer.

The authors discuss limitations in their study but also point out that cancer mortality rates tend to underestimate the disease experience of a population because the actual numbers of people with the disease at any given time is greater than the number of people who have died from it. These limitations do not diminish the primary findings that there is a significant relationship between agricultural chemical use and cancer mortality.



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JOURNAL

OF THE NATIONAL CANCER INSTITUTE

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Volume 82 Number 7

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Mortality Study of Canadian Male Farm Operators: Non-Hodgkin's Lymphoma Mortality and Agricultural Practices in Saskatchewan

Donald T. Wigle,* Robert M. Semenciw, Kathryn Wilkins, Dieter Riedel,
Leonard Ritter, Howard I. Morrison, Yang Mao

A cohort study of the mortality experience (1971–1985) of male Saskatchewan farmers has been conducted. This study involved linkage of records of the almost 70,000 male farmers identified on the 1971 Census of Agriculture and the corresponding Census of Population to mortality records. Pesticide exposure indices for individual farm operators for the year 1970 were derived from the 1971 Census of Agriculture records. Although the cohort as a whole had no excess mortality for any specific causes of death, including non-Hodgkin's lymphoma, significant dose-response relationships were noted between risk of non-Hodgkin's lymphoma and acres sprayed in 1970 with herbicides, as well as with dollars spent on fuel and oil for farm purposes in 1970. Using Poisson regression modeling, we found that relative risks for the highest level of herbicide use (≥ 250 acres sprayed) and dollars purchased in 1970 ($\geq \$900$) on farms less than 1,000 acres total area were 2.2 (95% confidence interval = 1.0–4.6) and 2.3 (95% confidence interval = 1.1–4.7), respectively. [J Natl Cancer Inst 82:575–582, 1990]

As an occupational group, farmers experience low overall mortality (1). However, farmers and rural populations have been reported to be at increased risk of developing cancers of the stomach, prostate, lip, brain, and skin; Hodgkin's disease; leukemia; multiple myeloma; and non-Hodgkin's lymphoma (2–14). Farmers are exposed to a number of potential health hazards that require evaluation. These include zoonotic viruses, solvents, fuels and oils, paints, farm machinery, dust and molds, waste gases, etc. In addition, farmers are the largest population with direct occupational exposure to pesticides.

Excess risk to farmers for non-Hodgkin's lymphoma has been reported from several studies (4–6,11–14). Death certificate case-control studies from Wisconsin (6) and New Zealand (5) found that risk was highest among younger farmers, while case-control studies in Iowa (8) and Tasmania (9) found the opposite. Of particular interest in this context is the case-control study of Schumacher (12), which indicated that the lymphocytic form of non-Hodgkin's lymphoma accounted for most of the risk in older farmers. A recent case-control study of Kansas farmers found a significant relationship between exposure to chlorophenoxy herbicides and risk of non-Hodgkin's lymphoma.

The purpose of the Mortality Study of Canadian Male Farm

Operators is to investigate the relationships between various farming practices and specific cancers. The cancers selected for study were those that have been implicated in previous investigations of farmers and other workers exposed to agricultural pesticides. Using data for Saskatchewan males, this initial paper presents analyses that focus on the relationship between agricultural substances and practices and the risk of death from non-Hodgkin's lymphomas. Saskatchewan was the first province in this Canada-wide study for which data were produced; mortality analyses for other Canadian provinces are under way.

Methods

Data Sources

The four key data bases used in this linkage study were the 1971 Census of Agriculture, the 1971 Central Farm Register, the 1971 Census of Population, and the Canadian Mortality Data Base.

The Census of Agriculture is an inventory of Canadian agriculture taken every 5 years. In 1971, all farm, ranch, or other agricultural holdings of 1 acre or more with sales of agricultural products of at least \$50 in the year previous to the census were included. A farm operator was defined as the person directly responsible for the agricultural operation of the farm, regardless of whether that individual was the owner. In cases of partnership, only one partner was considered to be the operator. The total number of farm operators in Saskatchewan in 1971 was 76,668, of whom 73,538 were male.

The 1971 Census of Agriculture included some questions applicable to 1970. These questions included the number of acres

Received June 26, 1989; revised November 27, 1989; accepted December 22, 1989.

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We thank Dr. David Bray, John Silins, Martha Fair, Deborah Jordan-Simpson, and Christine Poliquin of the Health Division, Statistics Canada; Ray Bollman, formerly of the Agriculture Division, Statistics Canada; Dr. John Davies and Joan Lindsay of the Bureau of Chronic Disease Epidemiology, Laboratory Centre for Disease Control, Department of National Health and Welfare; Diane Robson of the Saskatchewan Cancer Registry; and the Provincial Registrars of Vital Statistics.

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sprayed with herbicides and insecticides, and expenditures paid for pesticides and for fuel and oil for farm operations. Questions in the Census of Agriculture applicable to 1971 related to the total acreage of land operated, the number of acres of crops planted and acres fertilized, amount of livestock holdings, and farm machinery owned.

Data on direct exposure to pesticides were not available from the 1971 Census of Agriculture. Surrogates used were: (a) number of acres sprayed for the control of insects; (b) number of acres sprayed for the control of weeds; and (c) cost of agricultural chemicals purchased.

The 1971 Central Farm Register was created as a mailing list for agricultural questionnaires. It contains all farm operators identified on the 1971 Census of Agriculture. In addition to several agricultural variables used to target surveys, the Central Farm Register contains personal identifying information. Similar registers were created for the 1976 and 1981 Censuses of Agriculture. Linkage to the 1981 register allowed a live follow-up of farmers who had been identified on the 1971 Census of Agriculture.

The Census of Population is a complete inventory of Canada's population taken every 5 years. The 1971 Census of Population consisted of two types of questionnaires: form 2A (short) and form 2B (long). The short form was administered at random to two thirds of the population, with the remaining one third receiving the long form. The short form contained 19 questions; six of these concerned population variables. The long form, in addition to the 19 questions found on the short form, included 50 questions related to socioeconomic conditions and 20 questions related to housing. Variables selected from the 1971 Census of Population included age and mother tongue (2A) and education and income (2B).

The Canadian Mortality Data Base is a computerized file that contains information on all deaths that have occurred in Canada since 1950. Some information is also received that relates to Canadian residents who die in the United States.

Record Linkage

The assemblage of data related to the mortality experience of the farmer cohort involved the computerized record linkage of data from the Central Farm Register, the Census of Agriculture, the Census of Population, and the Canadian Mortality Data Base using the Generalized Iterative Record Linkage System (15) (GIRLS) of Statistics Canada. This linkage involved three steps:

1. Linkage of the 1971 Census of Agriculture, the 1971 Census of Population, and the 1971 Central Farm Register to unite agricultural, population, and personal identifying information on cohort members.
2. Linkage of the 1971 Central Farm Register to the 1981 Central Farm Register as a live follow-up of cohort members.
3. Linkage of the cohort file to the Mortality Data Base (1971-1985) to determine mortality.

The objective of the live follow-up by linkage of the 1971 Central Farm Register to that of 1981 was primarily to improve the accuracy of the probabilistic death linkage. The rules for linkage incorporated the occurrence of any discrepancies in vital status between information in the Mortality Data Base and information in the 1981 Farm Register. The overall likelihood of

a linkage being "true" would thus be lowered if the Mortality Data Base contained a record of a farm operator's death before 1981 while the Farm Register of 1981 contained information pertaining to the farm operator.

Statistical Analysis

Results of this report are based on the mortality experience of male Saskatchewan farmers identified in the 1971 Censuses of Agriculture and Population, whose age was at least 35 years at some point during the follow-up period (June 1971 through December 1985). A total of 69,513 men met these criteria. The age 35 limit was imposed because there were no deaths due to non-Hodgkin's lymphoma among younger farm operators. Also, only 6% of such deaths among all Canadian males occurred before age 35.

Standardized mortality ratios (SMRs) were calculated using external (Saskatchewan males) age-specific mortality rates with confidence intervals (CIs) based on the Poisson distribution (16). Internal comparisons used the Mantel-Haenszel risk ratio with CIs based on Cornfield's method (17,18). Tests for trend in relative risk (RR) with increasing exposure were performed by regressing the observed minus expected differences in exposure (16). Four exposure categories were created for continuous variables based on either exposure quartiles or no exposure plus exposure tertiles.

Models were fitted to the grouped data using Poisson regression analyses (19,20). This method models the logarithm of the mortality rate as a linear regression of the independent variables including interactions if necessary. The regression coefficients provide estimates of the RRs for the independent variables.

Age and year of death were considered a priori to be confounding variables. A number of farm practices other than herbicide use or fuel expenditures and sociodemographic variables were evaluated for confounding, although none was known to be an independent risk factor. Farm practice variables that were evaluated included the following: (a) acreage sprayed with insecticides, (b) acreage treated with fertilizers, (c) expenditures on agricultural chemicals, (d) number of agricultural workers employed, (e) acreage in small grains, (f) acreage in hay and fodder, and (g) total animal holdings.

Results

Farming Practices

Major crop groups planted in Saskatchewan in 1971 included, in order of acreage, small grains, hay, other fodder crops, canola, and mustard seed. About 75% of farms reported growing 130 or more acres of small grains (table 1). Hay and other fodder crops as well as canola and mustard seed were reportedly grown in that year on about 35% of farms.

Only 5% of farms reported spraying insecticides in 1970, whereas 49.4% of farms reported spraying herbicides. For farms over 300 acres, about 30% reported spraying herbicides in 1970 on more than 20% of total acreage (table 2). No expenditure for pesticides was reported by 46% of farms.

Mortality: Overview

After the Central Farm Register and the linkage of the Censuses of Agriculture and Population were preprocessed, records of

Table 1. Distribution of acres planted in major crop groups, Saskatchewan, 1971

Acres	Farms	%
<i>Small grains</i>		
<130	17,592	25.1
10-229	17,298	24.7
230-379	17,964	25.6
380+	17,245	24.6
<i>Hay and other fodder crops</i>		
None	45,844	65.4
<30	9,679	13.8
30-69	7,222	10.3
70+	7,354	10.5
<i>Canola and mustard seed</i>		
None	46,232	66.0
<65	8,902	12.7
65-119	7,632	10.9
120+	7,333	10.5

70,099 male farm operators were available for the mortality linkage (95.3% of the male farm operators active in Saskatchewan in 1971). Mortality rates among the 69,513 farm operators aged 35 or more for major causes of death were significantly below those for males in the province as a whole (table 3), with an SMR for all-cause mortality of 0.74. The observed numbers of deaths among the farm operators were not significantly higher than expected for melanoma, brain cancer, multiple myeloma, and non-Hodgkin's lymphoma with SMRs of 1.05, 1.03, 1.02, and 0.92, respectively.

Non-Hodgkin's Lymphoma

RR estimates for such sociodemographic variables as mother tongue, education, and income and non-Hodgkin's lymphoma were calculated (table 4). The RR for German as mother tongue was 1.4 (95% CI, 0.9-2.3), and for Ukrainian the RR was 1.6 (95% CI, 0.9-2.7). Lower RRs were observed for the two thirds

Table 2. No. of farms by % of total area sprayed with herbicide and total farm size, Saskatchewan, 1970*

Total farm size (acres)	% total area sprayed						Total
	0	1-19	20-39	40-59	60-79	80+	
0-49	958 (96.0)	1 (0.1)	2 (0.1)	4 (0.4)	2 (0.2)	31 (3.1)	998 (100.0)
50-299	4,963 (68.8)	418 (5.8)	943 (13.1)	664 (9.2)	141 (2.0)	87 (1.2)	7,216 (100.0)
300-599	11,307 (52.2)	3,101 (14.3)	4,786 (22.1)	2,096 (9.7)	275 (1.3)	81 (0.4)	21,646 (100.0)
600-999	10,776 (46.0)	4,974 (21.3)	5,658 (24.2)	1,761 (7.5)	183 (0.8)	53 (0.2)	23,405 (100.0)
1,000+	7,458 (44.3)	4,577 (27.2)	3,618 (21.5)	1,015 (6.0)	116 (0.7)	50 (0.3)	16,834 (100.0)
All farms	35,462 (50.6)	13,071 (18.6)	15,007 (21.4)	5,540 (7.9)	717 (1.0)	302 (0.4)	70,099 (100.0)

* Values in parentheses = % of farms.

Table 3. Observed and expected No. of deaths among Saskatchewan farmers aged 35 years or more, 1971-1985

Cause of death	Observed	Expected*	SMR	95% CI	
				Lower limit	Upper limit
All causes	11,829	16,042.9	0.74	0.72	0.75
Infective and parasitic	27	66.7	0.41	0.27	0.59
All malignant neoplasms	3,198	3,953.2	0.81	0.78	0.84
Stomach	246	274.5	0.90	0.79	1.02
Trachea, bronchus, lung	833	1,169.4	0.71	0.67	0.76
Connective tissue	18	20.2	0.89	0.53	1.40
Melanoma	24	22.8	1.06	0.68	1.56
Prostate	441	462.0	0.96	0.87	1.05
Brain	96	93.6	1.03	0.83	1.25
Lymphoid†	191	200.0	0.96	0.83	1.10
Non-Hodgkin's lymphomas‡	103	112.1	0.92	0.75	1.11
Leukemias§	138	156.2	0.88	0.74	1.04
Multiple myeloma	70	68.5	1.02	0.80	1.29
Diseases of the circulatory system	5,864	7,895.5	0.74	0.72	0.76
Accidents, poisonings, violence	866	1,098.7	0.79	0.74	0.84

* Expected No. of deaths based on age- and period-specific mortality rates for Saskatchewan males, 1971-1985.

†ICD (International Classification of Disease)9, 200-203.

‡ICD9, 200, 202.

§ICD9, 204-206, 207.0, 207.2, 207.8, 208.

Table 4. Analysis of sociodemographic variables and non-Hodgkin's lymphomas, based on internal standardization, for Saskatchewan farmers aged 35 years or more, 1971-1985

Variable	Person years	Observed deaths	RR*	95% CI	
				Lower limit	Upper limit
1970 Income (\$)					
<7,500	76,352	9	1.0		
7,500-23,999	80,025	14	0.77	0.38	1.54
24,000-47,999	70,490	17	0.60	0.27	1.31
48,000+	78,105	13	0.84	0.41	1.76
Unknown	573,006	50	0.43	0.25	0.74
Education (grades completed)					
12+	95,672	12	1.0		
9-11	162,916	30	1.15	0.59	2.24
<9	46,384	11	0.88	0.36	2.19
Unknown	573,006	50	0.52	0.28	0.98
Mother tongue					
English	510,436	51	1.0		
French	38,932	3	0.78	0.26	2.35
German	140,794	22	1.43	0.86	2.33
Ukrainian	95,177	16	1.56	0.89	2.71
Other	92,640	11	0.96	0.50	1.83

* Mantel-Haenszel RR estimate adjusted for age and calendar yr.

of persons for whom information on education and income was not available. The RR for unknown income was 0.4 (95% CI, 0.3-0.7). However, the internal SMR for unknown income or education (those farmers who filled out the 2A census form) for all causes of death was 0.97.

The results of univariate analyses of the risk of death due to non-Hodgkin's lymphoma, based on internal standardization, according to farm practices are presented in table 5. The RR

estimates according to dollars spent in 1970 on fuel and oil for farm purposes indicated a significant trend with increasing expenditures. The RR was 1.8 in the category \$900 or more. No increase was noted according to the number of acres fertilized or to the number of acres in small grains, hay-other fodder crops, or canola-mustard (data not shown).

RR estimates of 1.1, 1.5, and 1.3, respectively, were observed for the categories 1-99, 100-249, and 250 or more acres sprayed

Table 5. Dose-response analysis of 1970-1971 farming practices and non-Hodgkin's lymphomas, based on internal standardization, for Saskatchewan farmers aged 35 years or more, 1971-1985

Farming practice	Person years	Observed deaths	RR*	95% CI	
				Lower limit	Upper limit
Acres sprayed with herbicides, 1970†					
0	438,341	46	1.0		
1-99	112,446	14	1.11	0.62	2.00
100-249	197,199	28	1.47	0.94	2.41
250+	129,992	15	1.34	0.74	2.38
Dollars spent on pesticides, 1970‡					
0	394,322	44	1.0		
1-49	150,443	15	0.88	0.49	1.57
50-109	170,616	25	1.49	0.92	2.45
110+	162,597	19	1.19	0.70	2.04
Dollars spent on fuel and oil for farm purposes, 1970§					
<360	205,209	22	1.0		
360-599	217,872	23	1.18	0.66	2.13
600-899	221,555	27	1.45	0.81	2.55
900+	233,342	31	1.83	1.03	3.25

* Mantel-Haenszel RR estimate adjusted for age and calendar yr.

† Test for trend chi-square (1 df (degree of freedom)) = 2.31, one-sided $P = .064$.

‡ Test for trend chi-square (1 df) = 1.11, one-sided $P = .146$.

§ Test for trend chi-square (1 df) = 5.78, one-sided $P = .008$.

with herbicides. The use of insecticides was limited and only two non-Hodgkin's lymphoma deaths were observed in the group that reported spraying. Interaction was noted between size of farm and acres sprayed with herbicides. An insignificant decreased risk was noted for operators of farms greater than 1,000 acres. A

itive dose-response relationship between acres sprayed with herbicides and risk of dying of non-Hodgkin's lymphoma was evident when the analysis was restricted to farms under 1,000 acres. The test for trend with increasing acres sprayed with herbicides was significant (one-sided P value = .002) (table 6).

To further study the relationship between non-Hodgkin's lymphoma mortality and acres sprayed with herbicides, we calculated attributable risks. On farms smaller than 1,000 acres, the amount of non-Hodgkin's lymphoma associated with herbicide spraying among farm operators was 27% and on all farms it was 22% (21).

To adjust for the possible effects of joint confounding, we used Poisson regression modeling. Data presented are based on a model including strata for the following categories: number of acres sprayed with herbicides, area of farm, expenditures on fuel and oil, age of farm operator, and calendar year. The multiplicative model provided a superior fit compared to an additive model and was consequently used for the Poisson regression analyses.

RR estimates for farms of less than 1,000 acres are presented in table 7. Estimates for 100-249 and 250 or more acres sprayed with herbicides were 1.9 (95% CI = 1.2-3.3) and 2.2 (95% CI = 1.0-4.6), respectively. The highest fuel and oil expenditures category was associated with an RR of 2.3 (95% CI = 1.1-4.7). Trend tests obtained using a continuous exposure variable were significant for the number of acres sprayed with herbicides [chi-square (1 df) = 6.5, one-sided P = .005] and cost of farm fuel and oil [chi-square (1 df) = 10.99, one-sided P < .001]. In the time period 1981-1985, the RR was 1.6, which was higher, but not significantly, than in the time periods

Table 7. RRs (95% CI) from multivariate Poisson regression analysis of non-Hodgkin's lymphoma, restricted to farms less than 1,000 acres, Saskatchewan farmers, 1971-1985

	RR	95% CI
Variable fuel cost, 1970		
<\$360*	1.0	
\$360-\$599	1.28	0.69, 2.39
\$600-\$899	1.87	0.98, 3.58
\$900+	2.29	1.11, 4.73
Acres sprayed with herbicide, 1970		
0*	1.0	
1-99	1.31	0.70, 2.43
100-249	1.93	1.15, 3.25
250+	2.17	1.02, 4.62
Year		
1971-1975*	1.0	
1976-1980	0.96	0.51, 4.62
1981-1985	1.64	0.93, 2.89
Area of farm, 1971		
<300 acres*	1.0	
300-599 acres	0.65	0.34, 1.23
600-999 acres	0.50	0.25, 1.04

*Reference category.

1971-1975 and 1976-1980. RR estimates for acres sprayed with herbicides on farms of 1,000 acres or more were less than 1.0.

A test for multiplicative interaction showed the interaction of the RR estimates according to expenditures on agricultural chemicals with farm size to be weaker than the interaction between acres sprayed with herbicides and farm size, and was insignificant. When restricted to farms under 1,000 acres, the dose-response relationship remained insignificant. For all farms, the RR estimates for the third and fourth quartiles were 1.4 (95% CI = 0.9-2.4) and 1.2 (95% CI = 0.7-2.1), respectively.

Models were also constructed to include sociodemographic variables (education, income, and mother tongue). Results were similar to those in which these terms were dropped. Accordingly, as they were not found to confound the exposure-disease relationship, the final models dropped these variables in order to increase precision.

Mortality rates for other cancers (as listed in table 3) were examined at the four levels of the two variables: number of acres sprayed with herbicides and expenditures for fuel and oil. No other positive associations were observed. Significant negative trends in lung cancer mortality were observed with increasing levels of numbers of acres sprayed with herbicides and with increasing fuel expenditures.

Discussion

In this study of Saskatchewan farm operators, overall death rates were considerably lower than for males in the general population of the province. This result is consistent with previously reported lower overall mortality rates among farmers (1). This finding probably reflects several factors: a "healthy worker" effect, the low prevalence of smoking among Canadian farmers (unpublished tabulations from the National Farmers Survey, 1984, Statistics Canada Agriculture Division), and a failure to identify all deaths in the Mortality Data Base. It was assumed that if the record of a person's death was not found through comput-

Table 6. Observed deaths and RR* due to non-Hodgkin's lymphoma 1971-1985, by farm size and acres sprayed with herbicides in Saskatchewan, 1970-1971

Acres sprayed	Farm size		All farms
	<1,000 acres	>1,000 acres	
0			
Deaths	35	11	46
RR	1.0	1.0	1.0
1-99			
Deaths	14	0	14
RR	1.31	0.00	1.11
(95% CI)	(0.71, 2.40)	(0.00, 2.85)	(0.62, 2.00)
100-249			
Deaths	28	0	28
RR	1.92	0.00	1.47
(95% CI)	(1.18, 3.18)	(0.00, 1.01)	(0.94, 2.41)
250+			
Deaths	10	5	15
RR	2.14	0.60	1.34
(95% CI)	(1.05, 4.24)	(0.22, 1.68)	(0.74, 2.38)
Chi-square for trend (one-tailed)	8.32	1.00	2.31
	.002	.159	.064

*Mantel-Haenszel RR estimate adjusted for age and calendar yr.

erized record linkage in the Mortality Data Base, then the person was still alive. This might be false because either the person died outside of Canada and his death record was not forwarded to Statistics Canada, or, more likely, inadequate personal identifiers on the census records resulted in the failure to link mortality records to input records. From the results of a recent evaluation of linkage error in another study, based on the number of personal identifiers available (22), we expect that in the present study we missed up to 10%–15% of the deaths that occurred. However, because internal comparisons were used to further study mortality patterns, incomplete follow-up should not have affected the results because there is no reason to expect that loss to follow-up was associated with the variables of interest.

Investigation of mortality patterns within the group of farm operators revealed a significant dose–response relationship between exposure to certain farming-related practices in 1970–1971 and subsequent death due to non-Hodgkin's lymphoma. Non-Hodgkin's lymphoma mortality was significantly associated with increases in levels of two exposure variables: the number of acres sprayed with herbicide and expenditures on fuel and oil in 1970. While increased risks were associated with increased numbers of acres sprayed for weeds, increased risks were not noted in relation to total expenditure on agricultural chemicals. This inconsistency might be due to the crudeness of the latter as an index of herbicide exposure. In addition, agriculture production statistics indicate that wheat production in Saskatchewan in 1970 was 52% lower than in 1969; sales of herbicide and fertilizer materials, for example, were correspondingly below the level of 1969, reflecting the decrease in seeding and production for 1970 (22–24).

Throughout the 1960s and 1970s, respectively, the chlorophenoxy compound 2,4-D constituted over 90% and 75%, by weight of all herbicide active ingredients used agriculturally in Saskatchewan. The herbicide 2,4,5-T was apparently used infrequently in agriculture in Saskatchewan at this time, although it was in regular use for brush control on non-crop land (25,26). Until the 1950s, sodium chlorate, sodium arsenite, sulfuric acid, and dinitrophenols were also used as agricultural herbicides. Herbicide treatments in grain crops have also included other chemicals such as bromoxynil, cyanazine, dicamba, linuron, metribuzin, and propanil (27). Furthermore, solvents such as kerosene have been used in some herbicide formulations (26).

The use of tractors or other automotive equipment in spraying operations would result in the simultaneous exposure of the applicators to exhaust emissions as well as to pesticide-laden dust or pesticide spray droplets. This dual exposure, along with the limited spraying indices available in this study, makes it difficult to assess the separate contribution of each to the outcome. It is noteworthy, however, that there was no elevation of risk of non-Hodgkin's lymphoma mortality associated with fertilizer application, most of which is done by tractor. In addition, no increase in lung cancer mortality was associated with the surrogate variable for fuel exposure, as might have been expected from the findings of other studies (28,29).

Interpretation of the findings of the present study is somewhat complicated by the lack of consistent results of animal experimentation. An increased incidence of splenic malignant lymphoma has been observed among rats exposed to diesel exhaust fumes (30). Also, 1,6-dinitropyrene, a diesel fuel combustion product, has caused malignant fibrous histiocytomas in mice

(31). However, in a series of studies on rats exposed to diesel exhaust or fractions thereof, most did not show any evidence of lymphoid malignancies (32). Similarly, no increase in lymphoid tumor incidence occurred among rats exposed to the 2,4-D acid used in herbicides, although the incidence of astrocytoma brain tumors increased (Serota DG, et al: unpublished data in the report, "Combined toxicity and oncogenicity study in rats—2,4-dichlorophenoxyacetic acid," submitted to Industry Task Force on 2,4-D Research Data, May 29, 1986).

The differential effect of herbicide spraying according to farm size raises several questions related to farming practices. The RR of non-Hodgkin's lymphoma as a function of farm size declined sharply for farms larger than 1,000 acres, although on farms smaller than 1,000 acres there was a significant increase in risk for non-Hodgkin's lymphoma when expressed as a function of acres sprayed for weeds. The causal significance of these observations cannot be fully assessed due to the paucity of data on the use of hired applicators to carry out weed spraying operations. Moreover, on large farms, an appreciable proportion of pesticides might be applied by aircraft.

The major limitation of this study is the potential to misclassify exposure status. Several factors may have contributed to this limitation. Analysis was based only on self-reported farming exposure data from 1970–1971, though about 25% of the farm operators also reported income from off-farm work in that year. However, there was not a significant difference in the SMR of non-Hodgkin's lymphoma deaths between those farm operators who reported working off the farm and those who did not.

Departure from farming and year-to-year variation of farm practices also contributed to misclassification of exposure. It is estimated that 30% of males who were farm operators in Saskatchewan in 1966 had left farming by 1976 (33). In addition, herbicide use was lower in Saskatchewan in 1970 than in the years prior to and following that year due to a grain surplus and federal incentives to reduce production (24,25). Therefore, the extent to which the 1970 exposure estimates reflect long-term environmental exposure responsible for the observed elevated risks is not known. Fifty percent of the farm operators reported no use of herbicides in 1970, but it is virtually certain that many of these men did use herbicides in previous and subsequent years.

The effect of non-differential misclassification of exposure is to bias the RR estimate toward unity. The true risk to farm operators, then, is likely to be larger than that observed. Missed mortality links would result in lower estimates for the cohort as a whole but should not cause a bias in comparisons within the cohort.

Misclassification with regard to disease status was considered, as ascertainment was by way of death certificates rather than through histologically confirmed incident cases. In order to check for "false positives" among the 103 deaths attributed to non-Hodgkin's lymphoma, the non-Hodgkin's lymphoma death records used in this study were linked to records of the Saskatchewan Cancer Registry. In 98 of the 103 cases, diagnosis of non-Hodgkin's lymphoma was noted in the registry records. Of the remaining five persons, lymphoid leukemia had been diagnosed for two, and a variety of other cancers were noted in the records of the other three. Therefore, in the present study, false positive misdiagnosis would not be expected to affect more than about 5% of the deaths attributed to non-Hodgkin's lymphoma.

Efforts were also made to check, at least partially, for the possibility of "false negatives," i.e., deaths due to non-Hodgkin's lymphoma that were misdiagnosed as another cancer. All records attributing death to chronic lymphoid leukemia, a disease with which non-Hodgkin's lymphoma might reasonably be diagnostically confused, were compared with cancer registry records for possible diagnoses of non-Hodgkin's lymphoma. No such diagnoses were recorded for the 44 males in the analytic file whose death was attributed to chronic lymphoid leukemia. Thus, it seems reasonable to conclude that misclassification with regard to disease status was not a major source of bias in this study.

Several previous investigations have been carried out as case-control studies and can be criticized for possible recall bias. The design of the present investigation as a cohort study obviates recall bias as a concern. There is little reason to believe that the extent of herbicide- or fuel-related exposure, or the accuracy of reporting such exposure-related information in the 1971 census, would have been affected by the subsequent mortality experience within this cohort. Case response bias would occur if exposure were differentially reported by farm operators with prevalent non-Hodgkin's lymphoma in 1971. However, in the period 1981-1985, the risk estimate was actually higher than in the earlier periods, and restriction of the analysis to deaths that occurred after 1976 resulted in increasing the magnitude of the risk estimates. These results suggest that the reported level of herbicide exposure was not associated with the prevalence of disease.

An increased risk of non-Hodgkin's lymphoma to farmers has been reported by several studies from Australia, Canada, Europe, New Zealand, and the United States (4-6,11-14). A case-control study conducted in western Washington found RRs of incident cases of non-Hodgkin's lymphoma of 1.3 (95% CI = 1.0-1.7) among men who had worked as farmers (11), though no association between increased risk and exposure to herbicides was observed. A study carried out in Kansas, however, found a strong dose-response association between frequency of herbicide use and incident non-Hodgkin's lymphoma, increasing from an odds ratio of 1.4 among farmers exposed between 1 and 5 days per year to 6.0 among those exposed for 21 days or more per year (4). The percentage of non-Hodgkin's lymphoma risk attributable to herbicide exposure was calculated as 11%, which was somewhat lower than the attributable risk estimates in the present study of 27% and 22%, respectively, among farmers on farms smaller than 1,000 acres and on all farms. In contrast to findings of the present study, no association was observed in the Kansas study between non-Hodgkin's lymphoma risk and acreage sprayed with herbicides. Perhaps such discrepancies in results between the two studies reflect differences in design.

A subsequent investigation in Nebraska revealed a non-significant 50% increase in risk of non-Hodgkin's lymphoma among men who had used the herbicide 2,4-D in agriculture (34). In a case-control study in New Zealand, the case group contained a significant excess of the occupational category involving agriculture and forestry (odds ratio = 1.3, 95% CI = 1.0-3.0) (5). No association was seen in the New Zealand data, however, between non-Hodgkin's lymphoma and either duration or frequency of phenoxy herbicide use (35). A Swedish case-control study of non-Hodgkin's lymphoma noted increased risks to workers exposed to phenoxyacetic acid herbicides and chlorophenols (36).

A more recent study confirmed the association with phenoxy acids and also identified occupational exposure to solvents, creosote, and wood-working as risk factors (37).

The Kansas study revealed a rising risk of non-Hodgkin's lymphoma with increasing time since first exposure to herbicides (4). The authors noted that it is not known whether this risk pattern reflects a long induction period between exposure and disease, possibly dependent on the presence of carcinogenic impurities in the early formulations of herbicide, or a shorter induction period combined with increased herbicide exposure during recent years. Unfortunately, latency issues could not be addressed in the present study because year of first exposure and length of exposure were not available.

On the whole, the findings of this and previous studies are consistent with a hypothesis of increased risk of non-Hodgkin's lymphoma in association with spraying herbicide formulations. This is the first study to report an association between non-Hodgkin's lymphoma and exposure to fuel and oil. On this basis, it would seem prudent to educate farm families in the safe handling of these substances.

The magnitude of risk for Saskatchewan farmers is probably greater than that reflected in the estimates in this study, due to the likelihood of misclassification of exposure. There is a particular need for further studies in this area to improve the quantification of farming-related exposures, and to study the exposure history of individuals who develop non-Hodgkin's lymphoma.

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Highly Specific Prediction of Antineoplastic Drug Resistance With an In Vitro Assay Using Suprapharmacologic Drug Exposures

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Bayes' theorem has been used to describe the relationship between the accuracy of a predictive test (posttest probability) and the overall incidence of what is being tested (pretest probability). Bayes' theorem indicates that laboratory assays will be accurate in the prediction of clinical drug resistance in tumors with high overall response rates (e.g., previously untreated breast cancer) *only* when the assays are extremely (>98%) specific for drug resistance. We developed a highly specific drug-resistance assay in which human tumor colonies were cultured in soft agar and drugs were tested at high concentrations for long exposure times. Coefficients for concentration $\times$ time exceeded those reported in contemporaneous studies by about 100-fold. We reviewed 450 correlations between assay results and clinical response over an 8-year period. Results were analyzed by subsets, including different tumor histologies, single agents, and drug combinations. Extreme drug resistance (an assay result $\geq$ SD below the median) was identified with greater than 99% specificity. Only one of 127 patients with tumors showing extreme drug resistance responded to chemotherapy. This negligible posttest probability of response was independent of pretest (ex-

pected) probability of response. Once this population of patients with tumors showing extreme drug resistance had been identified, posttest response probabilities for the remaining cohorts of patients varied according to both assay results and pretest response probabilities, precisely according to predictions based on Bayes' theorem. This finding allowed the construction of a nomogram for determining assay-predicted probability of response. [*J Natl Cancer Inst* 82:582-588, 1990]

Perhaps the major reason cancer chemosensitivity testing has not become routine clinical practice is the perception that the

Received November 7, 1989; revised December 18, 1989; accepted December 26, 1989.

Supported by Public Health Service grant CM-57710 from the National Cancer Institute, National Institutes of Health, Department of Health and Human Services, and by the Veterans Administration.

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We thank Ian Tannock and Donna Neuberger for their helpful suggestions.

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Federated Mutual began investigating the fire and notified LPC that it intended to pursue subrogation claims. When Federated Mutual later tried to examine the equipment that had allegedly caused the fire, it learned that the equipment had been discarded.

Federated Mutual did not pursue the subrogation claim. However, it sued LPC and its insurer's attorneys, who had arranged for storage of the destroyed equipment. Plaintiff alleged, in part, negligent and intentional spoliation of evidence. Defendants moved to dismiss, claiming that Minnesota did not recognize a cause of action for spoliation of evidence. The trial court denied the motion. However, it certified to the state supreme court the question of whether claims for negligent or intentional spoliation of evidence could be brought in the state.

The Supreme Court of Minnesota declined to recognize the torts given the procedural posture of the case. Noting that a tort does not become actionable until wrongful conduct causes an injury, the court concluded that a party bringing a spoliation action must first adjudicate its underlying claim to prove that it has sustained a cognizable injury. The court reasoned that it would be inappropriate to award damages for the destruction of evidence that would not have been helpful in establishing a claim.

Moreover, the court observed that a party can sometimes avoid injury by using traditional remedies for the destruction of evidence. As an example, it cited an evidentiary rule permitting a fact finder to infer that evidence destroyed while in one party's possession was adverse to that party. Here, the court reasoned, plaintiff might have prevailed on its subrogation claim had it used that adverse inference and other traditional remedies.

Given the lack of precedent in the state for a spoliation cause of action and plaintiff's failure to first adjudicate the subrogation claim, the court concluded that the trial court should have dismissed the case.

Nonmedical expert witness with adequate training, education, and experience could express novel cancer-causation theories.

Rubanick v. Witco Chem. Corp., 576 A.2d 4 (N.J. Super. Ct. App. Div. 1990).

Two men died from colon cancer after they were exposed to PCBs at work. Their survivors sued their employer and the company that had sold the PCBs. In support of their claim that the PCBs had caused the cancer, plaintiffs planned to call Balis, a biochemist who had done extensive research in cancer causation.

At an in limine hearing addressing challenges to Balis' competence and qualifications, the court determined that Balis could only give his opinion as to human carcinogenesis in general. Because he was not a physician, the court found that he was not qualified to testify about the

cause of the men's cancers because he lacked the requisite education, training, and experience. Moreover, the court ruled that he could not testify that PCBs had caused the cancers because his theory was a novel scientific opinion that had not been accepted by at least a substantial minority of the scientific community. The court then granted defendants' summary judgment motion, concluding that plaintiffs would be unable to prove their case without this testimony.

A New Jersey appellate court reversed, finding that the trial court had improperly usurped the jury's prerogative as a fact-finder. It held that Balis' knowledge, training, and experience qualified him to testify on cancer development and related scientific matters. It determined that the jury must decide the weight given to any deficiencies stemming from his lack of a medical degree or experience in treating cancer patients.

The court also found that the jury should have been permitted to evaluate Balis' causation theory. The court said that when a qualified expert presents a well-reasoned causation theory based on his or her education, training, and experience, and developed in accordance with sound methodology, it is not necessary that the opinion be generally accepted in the scientific community. It concluded that an expert's testimony is admissible as long as the theory is not so outlandish, illogical, or totally speculative that no reasonable jury could accept it. Lack of agreement within the scientific community goes to the weight of the testimony—not its admissibility.

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Expert's testimony was admissible despite the lack of epidemiological evidence linking chemical exposure to colon cancer.

Christophersen v. Allied-Signal Corp., 902 F.2d 362 (5th Cir. 1990).

Christophersen, who was allegedly exposed to nickel and cadmium fumes at work, developed colon cancer. After he died, his survivors sued his employer and its chemical suppliers, alleging that Christophersen's cancer had been caused by the exposure. Plaintiffs' expert, Miller, prepared an affidavit supporting that causation theory. Defendants moved to dismiss, claiming that Miller's opinion, which was essential to plaintiffs' claim, was unreliable because it was not supported by epidemiological studies showing a statistically significant link between nickel and cadmium exposure and colon cancer. The trial court granted the motion.

The Fifth Circuit Court of Appeals reversed, finding that, generally, expert testimony regarding causation need not be backed by epidemiological evidence showing a sta-

tistically significant relationship between exposure and illness. The court refused to extend *Brock v. Merrell Dow Pharmaceuticals, Inc.*, 874 F.2d 166 (5th Cir. 1989), 9 PLLR 26 (Mar. 1990), which had required a plaintiff to show such epidemiological proof linking Bendectin with abnormal human development. Characterizing that case as an exception to the general rule, the Fifth Circuit observed that the *Brock* court had specifically declined to hold that epidemiological proof was a necessary element in all toxic tort cases.

Here, the court found that a medical expert's opinion in a toxic tort case is admissible as long as it is based on well-founded methodology. Noting that Miller had based his conclusion on methodologies traditionally used by physicians to determine the cause of a patient's cancer, the court held that his testimony should have been presented to a jury.

Plaintiffs' Counsel:

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[*Comment:* For a similar result, see *Donlan v. Indian Head Cranberries, Inc.* (Mass., Plymouth County Superior Court, Feb. 26, 1990) (unpublished), 9 PLLR 110 (July 1990), in which a trial court permitted toxicological studies linking pancreatic cancer with pesticide exposure over defendants' protests that the studies were not adequately supported by epidemiological data.]

Expert's failure to use a specific term did not preclude a finding that asbestos exposure had substantially contributed to a cancer death.

Abbott v. Babcock & Wilcox Co., 905 F.2d 201 (8th Cir. 1990).

Abbott was allegedly exposed to asbestos at work. After he died of lung cancer, his family sued an asbestos manufacturer, claiming that his cancer had been caused by asbestos exposure. At trial, plaintiffs' expert, Tuteur, testified that Abbott's exposure had been a "contributing factor" to his lung cancer death.

Defendant moved for a directed verdict, arguing in part that Missouri law requires that a contributing factor "substantially" contribute to a death before liability attaches. It claimed that Tuteur's testimony could only support a finding that the asbestos had been a cause and not a substantial cause of Abbott's death. The trial court denied the motion, and the jury awarded damages.

The Eighth Circuit Court of Appeals affirmed. The court stated that even if proof that a factor substantially contributed to a death is required to incur liability under Missouri law, it is not necessary for an expert to use the term "substantially contributing factor" to satisfy that standard. It was for the jury to evaluate the expert's testimony to determine whether it demonstrated that defendant's product had been a substantial cause of death. The

court concluded that Tuteur's testimony had been sufficient to support the jury verdict.

Plaintiffs' Counsel:

*Thomas H. Hart, III, Saint Croix, V.I.

[Plaintiffs' appellate brief is available through the Offerings section at p. 398, courtesy of Mr. Hart.]

FAMILY LAW

Supporting spouse was entitled to reimbursement of contributions to her husband's education that exceeded her minimum legal support obligations.

Bold v. Bold, 574 A.2d 552 (Pa. 1990).

While Mr. Bold was in college, he received about \$32,000 in educational benefits and earnings, and Ms. Bold earned about \$97,000. Shortly after Mr. Bold completed school, he asked Ms. Bold to move out of their home. When they were later divorced, the court ordered Mr. Bold to pay Ms. Bold \$33,000 as equitable reimbursement for the amount that her financial contributions to the family had exceeded his during the time he was in school.

The appellate court reversed, finding that equitable reimbursement was only available where one spouse had been unjustly enriched by the financial contributions of the other spouse that exceeded the support required by law. The court reasoned that because Ms. Bold had not paid any of Mr. Bold's academic expenses, and her contributions had not exceeded those that she was required to make, she was not entitled to reimbursement.

Reversing, the Supreme Court of Pennsylvania noted that the Bolds had separated just as Mr. Bold had begun to realize the earning potential gained from his education. The court reasoned that in such a case, a supporting spouse justifiably feels exploited and is entitled to reimbursement. However, the court found that the entitlement must be balanced against that spouse's legally imposed support obligation. Thus, the court held that a supporting spouse is entitled to equitable reimbursement to the extent that his or her contribution to the education, training, or increased earning power of the other spouse exceeded the bare minimum that the supporting spouse was legally obligated to contribute to the marriage.

The court commented that in determining whether a supporting spouse should be reimbursed, a trial court should consider the length of time that the parties were married after the supported spouse began to realize his or her earning capacity and the use to which such earnings were put during that time. It then remanded the case for a determination of the amount by which Ms. Bold's contributions had exceeded the legally imposed minimums.

Ms. Bold's Counsel:

John R. Greisamer, Allentown, Pa.

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Mortality and incidence of cancer at four factories making phenoxy herbicides

David Coggon, Brian Pannett, Paul Winter

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Abstract

To assess the possible carcinogenicity of phenoxy herbicides and related chlorophenols and dioxins, the International Agency for Research on Cancer is coordinating an international collaborative study of workers exposed to these compounds in their production or use. Four British cohorts of chemical manufacturers which have been recruited to the survey are described. They comprise a total of 2239 men employed during 1963-85. These subjects were traced to 31 December 1987 through the National Health Service Central Register and the National Insurance Index, and their mortality compared with that in the national population. Two deaths were from non-Hodgkin's lymphoma with 0.87 expected. Both deaths occurred more than 10 years after first exposure to phenoxy compounds. One further non-Hodgkin's lymphoma was registered in a living subject with probable exposure to phenoxy compounds. No cases of soft tissue sarcoma or Hodgkin's disease were recorded. A non-significant excess of lung cancer (19 deaths observed, 14.2 expected) is probably attributable to chance or a confounding effect of smoking. In one cohort only there was increased mortality from circulatory disease (34 deaths observed, 20.4 expected). A nested case-control study did not point to any occupational cause for this excess, but further evaluation will be needed during continued follow up.

The regulation of pesticides requires that the utility of products be balanced against any risks to the environment and to the health of manufacturers,

users, and those eating contaminated foods. Judgments about the toxicity of new compounds in man are usually based on extrapolation from laboratory experiments in vitro and in animals. Many pesticides have now been in use long enough, however, that it is possible to assess even their chronic effects more directly. Such assessment is important because laboratory investigation may not always reliably predict toxicity in man.

One group of compounds that have attracted particular attention are the phenoxy herbicides (for example, 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 2,4-dichlorophenoxyacetic acid (2,4-D), 2 methyl-4 chlorophenoxyacetic acid (MCPA)). Discovered in the 1940s, these chemicals have found extensive worldwide use in agriculture and forestry, as well as being sold on a smaller scale for domestic application in gardens. Initial case-control studies in Sweden suggested that exposure to phenoxy compounds and structurally related chlorophenols might carry an increased risk of soft tissue sarcoma^{1,2} and lymphoma.³ This idea was supported by the findings of four cohort studies of chemical manufacturers in the United States.⁴⁻⁷ Subsequent investigations, however, have been less conclusive.⁸⁻²² Several have shown associations between the manufacture or use of phenoxy compounds and soft tissue sarcoma or lymphoma, but risk estimates have been smaller than in the earlier studies and usually not statistically significant.

The statistical uncertainty surrounding small increases in risk for rare diseases presents a problem in evaluation. To help resolve this issue, the International Agency for Research on Cancer (IARC) has established an international collaborative survey of workers exposed to phenoxy acids and related compounds.²³ The study includes cohorts from six British companies. Data on two have already been published.^{14,24} Here we describe the other four British workforces in the IARC survey, and report their mortality and cancer incidence. The findings are relevant not only to the assessment of phenoxy compounds but also to other chemicals that have been manufactured and formulated at the same factories.

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Legator

EXHIBIT NO. 23

Cynthia Gloe

D-2649

Table 1 Definition of cohort

Factory	*Phenoxy herbicides and chlorophenols produced and formulated (unless otherwise stated, dates are for both production and formulation)	Other main products	†Definition of cohort	Number of men analysed	Number of men traced
A	2,4,5-T 1968-78 2,4-D and 2,4-DP 1954- 2,4-DB 1965- MCPA and MCPP 1954- MCPB 1970- PCPA and PAA (produced only) 1969-	Picric acid Dinitro-o-butyl phenol Dinitro-o-cresol Simazine Aminotriazole Oxyanis	All manual employees during April 1975-October 1985	1104	1082
B	2,4,5-T (formulated only) 1970-74 2,4-D, 2,4-DP and 2,4-DB 1969- MCPA and MCPP 1969- MCPB formulated 1969- produced 1975-	Dithiocarbamates Organophosphorus compounds Carbamates Dinocap Toluidine compounds Urea herbicides Imidazole compounds Phthalimide compounds	All weekly paid employees during March 1969-November 1985	271	261
C	2,4,5-T (formulated only) 1959-81 2,4,-D (formulated only) 1959-81 MCPB 1956- PBA (produced only) 1958-75	Aminophylline Metronidazole Sulphonamides Oxyanis Dinocap Asulam Sodamide Diflufenican	(1) All process workers on the phenoxy plant during January 1963-December 1984 (2) All formulators and packers during January 1982-December 1984 (3) All maintenance workers during July 1967-December 1984	345	343
D	2,4,5-T (formulated only) 1960-79 2,4-D 1949- 2,4-DP 1955- MCPA 1951- MCPP produced 1955- formulated 1965- 2,4,6-TCP (produced only) 1983-	Metallic soaps Plasticiser esters Naphthenic acid Alkyl phenols Phthalate esters	All weekly paid employees during April 1969-December 1985	519	503

*2,4,5-T = 2,4,5-Trichlorophenoxyacetic acid, 2,4-D = 2,4-dichlorophenoxyacetic acid, 2,4-DP = 2,4-dichlorophenoxypropionic acid, 2,4-DB = 2,4-dichlorophenoxybutyric acid, MCPA = 2 methyl-4 chlorophenoxyacetic acid, MCPP = 2 methyl-4 chlorophenoxypropionic acid, MCPB = 2 methyl-4 chlorophenoxybutyric acid, PCPA = parachlorophenoxyacetic acid, PAA = phenoxyacetic acid, PBA = phenoxybutyric acid, 2,4,6-TCP = 2,4,6-trichlorophenol.

†As only one woman met these criteria, the study was restricted to men.

Method

Subjects worked at four factories each of which manufactured and formulated a range of chemicals including phenoxy herbicides (table 1). The compound 2,4,5-T was produced at factory A during 1968-78, but at the other factories it was only formulated. Manufacturing processes were similar at all four factories. The relevant substituted phenol was reacted with monochloroacetic acid to produce phenoxyacetic compounds, with α -chloropropionic acid to make phenoxypropionic compounds, and with γ -butyrolactone to produce phenoxybutyric compounds. The 2,4,6-trichlorophenol was synthesised at factory D by chlorination of dichlorophenol.

Table 1 sets out the criteria for entry to the cohort. Scope for recruitment was limited by the availability of complete records from which subjects could be identified. At factories A, B, and D information was obtained from personnel or wages files. At factory C process and maintenance workers were identified

from bound registers kept by shift foremen, and formulators and packers from personnel records. For each member of the cohort we abstracted (as far as they were available) the name, date of birth, address, national insurance number, and job history.

Job histories were used to classify subjects according to their potential exposure to phenoxy compounds and chlorophenols. At factories A and D records were sufficiently detailed to distinguish jobs that entailed work with these chemicals. The few subjects who worked only in non-phenoxy plants were considered to have only "background" exposure. At factory C process operators were identified from the shift register on the phenoxy plant, and thus are known to have worked with phenoxy compounds. Maintenance workers and formulators and packers were also considered to be exposed, although a few may not have come into contact with the compounds if they only worked in the job for a short period. The employment records at Factory B

Table 2 Observed and expected mortality by cause: all subjects

Cause of death	Deaths observed	Analysis based on national rates			Expected numbers locally adjusted		
		Deaths expected	SMR	95% CI	Deaths expected	SMR	95% CI
All causes	152	136.22	112	94-131	134.73	113	96-132
Circulatory disease	74	63.76	116	91-146	63.94	116	91-145
Respiratory disease	8	11.78	68	29-134	11.74	68	29-134
Injury and poisoning	19	12.27	155	93-242	11.06	172	103-268
All cancer	37	36.84	100	71-138	36.66	101	71-139
Cancer of lung	19	14.15	134	81-210	14.21	134	80-209
Soft tissue sarcoma	0	0.18	0	0-2087	0.18	0	0-2058
Hodgkin's disease	0	0.43	0	0-855	0.38	0	0-976
Non-Hodgkin's lymphoma	2	0.87	229	28-827	0.73	272	33-983

Deaths were also observed from cancer of mouth (1), oesophagus (1), stomach (2), small intestine (1), large intestine (2), rectum (2), bowel not further specified (1), pancreas (2), larynx (1), bone (1), testis (1), and bladder (1).

did not distinguish between work on different processes, and individual exposures therefore could not be assigned with confidence. Management estimated that approximately 50% of employees would have worked with phenoxy compounds during campaign periods (January-May), but all staff were likely to walk through the production areas on occasions. No environmental or personal monitoring for phenoxy compounds, chlorophenols, or contaminant dioxins had been carried out at any of the factories.

Subjects were traced through the National Health Service Central Register and National Insurance Index up to 31 December 1987. For those who had died we obtained a copy of the death certificate with the underlying cause of death coded to the ninth revision of the International Classification of Diseases. We were also notified of any cancers registered among living members of the cohort.

Mortality ratios standardised for age (in five year bands), sex, and five year calendar period of death were calculated by the person-years method with rates for England and Wales as standard. In some analyses a second set of mortality ratios was derived with expected numbers of deaths for each factory adjusted in proportion to standardised mortality ratios (SMRs) during 1974-85 for the local authority

area in which the factory was situated. Confidence intervals for mortality ratios were based on the Poisson distribution.

Results

A total of 2256 men satisfied the criteria for entry to the cohort, but 17 had to be excluded from the analysis because their date of birth was unavailable. Of the remaining 2239 men, 2189 (97.8%) were traced, including 152 who had died and 19 who had emigrated. These 19 were followed up to the date that they left the country, while untraced subjects were considered to be at risk up to their last known date of employment. Table 1 shows the numbers of men traced from each factory.

Table 2 shows mortality by cause for the full cohort. The total of deaths observed during the follow up period was a little higher than expected from national rates, and this was due largely to excesses of circulatory disease (SMR = 116, 95% CI 91-146) and of deaths from injury and poisoning (SMR = 155, 95% CI 93-242). Overall cancer mortality was close to expectation, but there was a small excess of deaths from lung tumours (19 observed v 14.15 expected). Two deaths from non-Hodgkin's lymphoma were recorded compared with

Table 3 Mortality by factory for selected causes

Cause of death	Factory A		Factory B		Factory C		Factory D	
	Deaths observed	Deaths expected	Deaths observed	Deaths expected	Deaths observed	Deaths expected	Deaths observed	Deaths expected
All causes	62	44.70	17	11.90	22	30.13	51	49.50
Circulatory disease	34	20.42	5	5.29	12	14.31	23	23.75
Respiratory disease	1	3.41	1	1.25	0	2.33	6	4.79
Injury and poisoning	7	4.77	3	1.43	3	2.59	6	3.48
All cancer	12	12.26	5	2.83	6	8.34	14	13.42
Cancer of lung	6	4.63	3	0.99	4	3.22	6	5.30
Non-Hodgkin's lymphoma	0	0.31	0	0.07	1	0.20	1	0.29

Expected numbers are based on national rates.

Table 4 Mortality from selected causes in men at Factories A, C, and D with greater than background exposure to phenoxy compounds and/or chlorophenols

Cause of death	Subjects followed up from first exposure above background		Subjects followed up from 10 years after first exposure above background	
	Deaths observed	SMR	Deaths observed	SMR
Circulatory disease	59	117	31	110
All cancer	30	102	13	80
Cancer of lung	14	123	6	92
Non-Hodgkin's lymphoma	2	282	2	588

SMRs are based on national rates.

0.87 expected, but there were no deaths from Hodgkin's disease or soft tissue sarcoma. Adjustment for local differences in mortality had little effect on expected numbers.

Table 3 summarises mortality patterns by factory. The excesses of lung cancer and of injury and poisoning were spread across all factories, whereas the high rate of circulatory disease was confined to factory A (34 deaths observed v 20.42 expected). With adjustment for local mortality, the expected number of circulatory deaths at factory A rose to 24.49, and the excess fell just short of statistical significance at a 5% level. The two deaths from non-Hodgkin's lymphoma occurred at factories C and D.

Table 4 shows mortality ratios for subjects at factories A, C, and D with more than background exposure to phenoxy compounds or chlorophenols. Standardised mortality ratios for circulatory disease and all cancers were similar to those for the full cohort, whereas that for lung cancer was rather lower, especially after allowance for a latency of 10 years from first exposure. The two cases of non-Hodgkin's lymphoma both occurred more than 10 years after first exposure to levels above background—one man had been a packer for 21 years and the other a process operator in phenoxy acid synthesis for one month.

Only one further case of non-Hodgkin's lymphoma had been registered among living members of the cohort—a process worker at factory B. There were no registrations of Hodgkin's disease or soft tissue sarcoma.

Eight of the 19 deaths from injury and poisoning occurred while the men concerned were still working at the factories under study. Of these, two were due to accidents at work, two to accidents outside work, three to suicide or possible suicide, and one to homicide.

To investigate further the excess of circulatory disease at factory A, we carried out a nested case-control study. Each of the 34 cases at the factory was matched with four controls who were under follow up at the time that the case died, and whose date of birth was as close as possible to that of the case. Year of birth was matched to within one year for 82% of controls, and the mean year of birth of controls was one year later than that of cases. Associations with having ever worked in various departments were examined by conditional logistic regression for matched sets.²³ Table 5 summarises the findings. No individual department was clearly associated with a risk of circulatory disease. Risk was significantly increased among the aggregate of smaller departments (the 'other' category in table 5), but detailed examination did not suggest a common underlying factor.

Discussion

Although the workforces that we studied were exposed to a multiplicity of chemicals, this only presents a problem of interpretation in relation to positive findings. Any reassurance deriving from

Table 5 Risk of circulatory disease at Factory A according to department

Department	Subjects ever employed in department		Relative risk	95% CI
	Cases (n = 34)	Controls (n = 136)		
Oxynils	0	16	0	—
Nitration products	1	1	4.0	0.3-64.0
Triazines	0	4	0	—
Engineering	4	19	0.8	0.3-2.6
Effluent	2	8	1.0	0.2-4.7
Plant cleaning	2	5	1.6	0.3-8.2
Other	15	19	6.2	2.3-16.4

risks which were not increased extends to all exposures experienced by the cohort. Unfortunately, levels of exposure to specific chemicals could not be precisely estimated. In particular, no hygiene data were available for phenoxy compounds, for the chlorophenols from which they were made, or for the dioxins with which they may have been contaminated. From descriptions of processes and methods of operation provided by longstanding employees, however, we estimate that exposures during the early part of the study period would generally have been higher than more recently. Thus, any risks from current working practices at the factories are likely to be lower than those in the workers studied.

No soft tissue sarcomas or Hodgkin's lymphomas were recorded in the study cohort during the period of follow up. There were, however, two deaths from non-Hodgkin's lymphoma compared with 0.87 expected, and one further case was registered in a subject who was still alive. Expected numbers of incident cancers could not be reliably estimated because the completeness of cancer registration in Britain has varied between regions and over time, but our findings accord with those of most previous studies in suggesting that any risk of soft tissue sarcoma or lymphoma from occupational contact with phenoxy compounds is small.⁴⁻²² A more precise estimate of the risk of these rare tumours will be possible from analysis of the full IARC survey with its much larger study population.

The largest excess of cancer found was for lung tumours (19 deaths observed v 14.2 expected), and this derived from all four factories. Most of the deaths occurred, however, less than 10 years after first exposure to phenoxy compounds or in subjects with only background exposure. After allowance for a latency of 10 years from first exposure, the increased risk disappeared (table 4). This and the absence of a comparable association with lung cancer in most other cohort studies of phenoxy workers^{5,7,8,14,19,20} suggests that phenoxy compounds are unlikely to be responsible for the excess. A more likely explanation is chance or a confounding effect of smoking. Data on the smoking habits of cohort members were not available.

The only diagnostic category for which we found a clear increase in risk was circulatory disease, and this was confined to factory A where 34 deaths were observed v 24.5 expected (after adjustment for local patterns of mortality). The finding is particularly remarkable since occupational cohorts usually exhibit a deficit of cardiovascular deaths because of the healthy worker effect. The limitation of the excess to one factory and the absence of similar associations in other cohorts of phenoxy workers^{5,7,14,19,20} argue against a hazard from the phenoxy process, but it was possible that some other aspect of work at factory A might be responsible. We

therefore carried out a nested case-control study to examine other possible occupational risk factors, but could find none that would explain the observation. The excess could perhaps be due to a combination of smoking and other non-occupational causes, but it will require further evaluation during continued follow up.

Despite the limitations imposed by small numbers and the potential difficulties in unravelling the effects of multiple exposures, it is important that studies such as this are carried out. They provide an essential audit of the extrapolation from laboratory data on which most decisions for the regulation of pesticides are based. We will continue to follow up these workforces and review their mortality and cancer incidence at intervals.

We thank the staff of the NHS Central Register and the National Insurance Index for their assistance in tracing subjects and Rosemarie Kirby for her help with the computing. The study was supported by a grant from the International Agency for Research on Cancer.

Requests for reprints to: Dr D Coggon.

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Accepted 1 October 1990

Correspondence and editorials

The *British Journal of Industrial Medicine* welcomes correspondence relating to any of the material appearing in the journal. Results from preliminary or small scale studies may also be published in the correspondence column if this seems appropriate. Letters should be not more than 500 words in length and contain a minimum of references. Tables and figures should be kept to an absolute minimum. Letters are accepted on

the understanding that they may be subject to editorial revision and shortening.

The journal now also publishes editorials which are normally specially commissioned. The Editor welcomes suggestions regarding suitable topics; those wishing to submit an editorial, however, should do so only after discussion with the Editor.

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Poison in Your Backyard

By Kathyrne V. Sagan

THE PESTICIDE SCANDAL

S

ix years ago Barbara and Greg Marshall* of Sarasota, Florida, felt pressured by their neighbors to improve the look of their property. "We didn't have a nice lawn, and everybody else did," says Barbara. The man across the street suggested the lawn-care service ChemLawn.

"We hired them, and for a while we had the best-looking lawn on the block."

What they didn't know was that their 2-year-old daughter Kelly's* health would be jeopardized. Kelly ran barefoot onto the grass one hour after a lawn treatment was applied. The applicator had told them their yard would be safe by then, but within a week Kelly developed respiratory problems, a nasty rash over most of her body, had a high temperature, and her urine turned dark brown. Her pediatrician prescribed antibiotics, but the toddler's symptoms got worse—her hands and feet swelled to twice their size, blistered and peeled, and her lips turned black and bled. She also had bad headaches and muscle aches, lost weight and her appetite.

Two weeks later the Marshalls took Kelly to All Children's Hospital in St. Petersburg, where she was diagnosed as having Kawasaki disease—a rare lymph-

node disorder that usually affects Asian male children. In the opinion of the hospital doctor, the disease could have been caused by chemicals in the environment. Barbara is doubtful that Kelly, who is blond and fair, actually had the disease. But she does think her child was poisoned by pesticides.

Most of Kelly's symptoms—the breathing difficulties, skin irritations and burns, swelling, loss of weight and appetite, headaches, muscle aches and fever—are considered signs of poisoning by various pesticides, says Bettina Francis, Ph.D., a toxicologist at the Institute for Environmental Studies at the Univer-

"For the price of a green lawn, we are poisoning our children," says the mother of a sick child. Public Citizen, a consumer group based in Washington, D.C., recently found that 12 of the most commonly used lawn-care pesticides are suspected human carcinogens.

sity of Illinois, Urbana-Champaign. According to a 1989 report by Public Citizen, a Washington, D.C.-based consumer group, 36 of the 40 most frequently used lawn-care pesticides cause skin irritations, and 20 cause short-term damage to the central nervous system.

For the Marshalls and others like them, the suburban dream of a well-manicured lawn is becoming a suburban nightmare. Across the country serious health problems caused by pesticides are affecting homeowners and their children, gardeners, golfers and other outdoor sports enthusiasts. And even though the Government is aware of the (Continued)

*Names have been changed to protect the privacy of the child.

Kathyrne V. Sagan is a FAMILY CIRCLE editor-at-large.

Son in Your Backyard

THE PESTICIDE SCANDAL



still have to watch her," her mother says. "She is prone to headaches and has a 40% permanent hearing loss in her right ear, which was caused by the high fevers she suffered when she was poisoned." In 1986 the Marshalls joined about 20 other plaintiffs (alleging a wide range of illnesses—including nausea, vomiting, rashes, high fever, impairment of muscular coordination and respiratory distress) in bringing a class-action suit against ChemLawn Services Corporation, but the court dismissed the suit because the symptoms were too diverse to meet the requirements for class-action litigation. Says Barbara today, "We have the crummiest lawn on our block again, but when our neighbors saw what happened to Kelly, they canceled their ChemLawn service too."

The Marshalls are not the only family to pay a high price for a greener lawn. Barry and Jackie Veysey believe exposure to pesticides may have contributed to the death of their third child, Matthew. When Barry was turf master at the Manatee County, Florida, Department of Parks and Recreation, he sprayed the county ballparks and school yards with arsenic-based pesticides, chemicals that can cause nerve damage, and 2,4-D—a suspected carcinogen and the most frequently used lawn-care herbicide. Barry knew the chemicals were dangerous and urged county officials to provide him with proper safety gear and to allow him to post signs and to close facilities after spraying. When he met resistance, he started keeping records of what he sprayed and also of any faulty equipment he had to use.

Jackie, pregnant with their second child at the time of Barry's promotion to turf master, gave birth to a healthy daughter that summer. The following January she became pregnant again. Shortly after this, Barry

started to feel ill. He had been accidentally doused with pesticides a few times by a damaged hose and had once been sprayed in the eye. His flu-like symptoms persisted for more than six weeks



Sharon Malhotra, 36, was diagnosed with pesticide poisoning four years ago. Her neurologist suggested that she wear a gas mask whenever she thought she might be exposed to lawn-care chemicals.

The Malhotras of Pennsylvania have personally experienced the perils of pesticides.

dangers of commonly used pesticides, very little is actually being done to protect the public.

"Lawn-care companies have perpetrated a massive con job on the American people. Let's fight the deadly dandelion, they say, even if it means using deadly toxins," says Samuel S. Epstein, M.D., professor of occupational and environmental medicine at the University of Illinois Medical Center Chicago, School of Public Health.

Children are especially vulnerable to these chemicals. Kelly Marshall remained bedridden for months, her limbs and neck sometimes so swollen that her parents had to tie a sock around her neck to keep her head upright. During this time Barbara Marshall learned of two other children diagnosed with Kawasaki disease whose families had used a professional lawn-care service.

Kelly, now 8, has built up her immune system. "But we

and were accompanied by chronic muscle aches and headaches. He finally went to the doctor that spring. (Early symptoms of poisoning by some pesticides are frequently mistaken for flu.) Although tests showed arsenic in his body, the levels were apparently not high enough to harm him.

At 34, Jackie's third pregnancy proceeded normally. She felt the baby kick, and he had normal head measurements. "On the day in October when we went into the delivery room we were so excited," she says. "Then, as the delivery progressed, a quiet filled the room and my whole life changed." Matthew was born with thanatophoric dwarfism, a severe, fatal type of dwarfism. Most of his organs were not fully developed. The baby was immediately put on a respirator. Jackie got to hold her son only once before he died 23 hours later.

The Veyseys' doctor told them that this (Continued)

Poison in Your Backyard

type of birth defect was so rare that very few data exist as to its causes. He said some research indicates that a gene mutation seems to be the most likely cause, though nothing is conclusive. The Veyseys believe that the chemicals Barry was working with may have mutated his sperm, or that the fetus may have been exposed *in utero* each time Jackie laundered Barry's uniforms. Many chemicals can cross the placental barrier and harmfully affect the fetus. Arsenic is toxic to fetuses, and at least six of the pesticides Barry worked

THE PESTICIDE SCANDAL

the Chemical Producers and Distributors Association, said at a Senate hearing on lawn-care pesticides last spring, "Despite the claims that lawn-care chemicals are 'suspected human carcinogens,' nothing could be further from the truth. . . . Most of these products have a long

record of common usage, with a safety record of no adverse health effects. There should be no cause for public concern about the health effects of lawn-care chemicals."

But there is no nationwide reporting of pesticide poisoning. Although the American Association of Poison Control Centers estimates that it recorded about 48,000 pesticide exposure-related phone calls in 1989, the organization cannot pinpoint the number of calls that were lawn-care related. And as toxicologists point out, such poisoning is frequently misdiagnosed. "The symptoms of pesticide poisoning mirror other diseases and health problems," says Mark Lappé, Ph.D., a toxicologist and professor of health policy and ethics at the University of Illinois College of Medicine.

One of the biggest questions is why only *some* people—even within the same family—are affected by exposure. Says Professor Lappé, "No one knows why. There's a strong suspicion that there are genetic differences in the way people break down these chemicals. Another important factor may be body size and route of exposure." Marion Moses, M.D., president of the Pesticide Education Center in San Francisco, has another explanation: "A person's age, the type of chemical involved and the degree of exposure, among other factors, have more to do with it than genetics," she says.

Americans are overdosing their lawns. According to the National Academy of Sciences, homeowners use between 5.3 and 10.6 pounds of pesticide per acre on their lawns—many times the amount generally used by farmers. As many as 11% of single-family households hire a commercial applicator, creating a \$1.5 billion professional lawn-care industry. But of the 40 pesticides that make up 95%

of the lawn-care business, only one, metaxyl, has been completely tested and reviewed by the EPA for its full range of health effects.

Sharon Malhotra, 36, a registered nurse and mother of two, first began in late

spring of 1987 to link her bad headaches with the days her town-house lawn in suburban Pittsburgh was treated. She was at the town-house pool when she developed a headache so excruciating that she had to go home to bed. She became nauseated; her nose, tongue and arms started to tingle and go numb; her muscles were visibly twitching, and she had trouble speaking. Her husband, Narinder, a doctor, suggested she see a neurologist. The specialist found no major neurologic disorder, but he suggested that Sharon might be reacting to lawn chemicals. (Continued)



"I feel like a prisoner," says 12-year-old Kevin Ryan, who loves baseball but, unlike other kids his age, can't play the game. In fact, he seldom can go outdoors, and he fell ill after posing for this photograph.

Deborah and Kevin Ryan at their Illinois home, which they must vacate during spraying season.

with—including Aatrex, Baygon and Benlate—are suspected to cause birth defects.

"This baby died because of my job," says Barry. Adds Jackie, "If this could happen to someone who knows so much about the dangers of pesticides, what about people who go to the local hardware store, buy a two-pound bag and apply it themselves?"

The chemical and lawn-care industries consider such concerns—over what they say are minuscule amounts of toxic substances—needless. Warren E. Stickle, president of

Poison in Your Backyard

One week later the trees near the Malhotras' town house were treated for an insect problem. Sharon again developed a severe headache and also had trouble breathing. She looked outside and could see the pesticide dripping off a tree directly in front of her window. A few days later the chemical odor was still strong, so she went out and naïvely hosed the tree down with water. As she stood under the tree to water the flowers, the chemicals dripped down on her. Within minutes her left arm went numb; then her peripheral vision became blurry and her stomach cramped so severely that she was bent over in pain.

From his wife's symptoms Dr. Malhotra suspected her levels of an enzyme called cholinesterase were

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used were "practically nontoxic," were registered for use by the EPA and were not harmful to humans or pets, adding that a child "would have to ingest the amount of pesticides found in almost 10 cupfuls of treated lawn clippings to equal the toxicity of one baby aspirin."

The Malhotras assumed that EPA registration meant that the products had been tested and were therefore safe. Dr. Malhotra was shocked to learn later that although some of the pesticides Sharon was exposed to may cause temporary nerve damage, there are surprisingly few EPA studies on the chronic or long-term effects of exposure to these chemicals.

Organophosphates, the class of toxic chemicals that affected Kelly, Barry and Sharon, can cause nerve damage. They are "first cousins" to the chemicals Sarin and Tabun, developed by the Germans as weapons during

World War II (and currently stockpiled in Iraq's chemical weapons arsenal), and are one of the most widely used groups of pesticides today. Betty Gerstley, M.D., a Philadelphia internist, says it's possible that exposure to these neurotoxins contributes to diseases of neurologic

degeneration, such as Parkinson's, Lou Gehrig's (amyotrophic lateral sclerosis) and Alzheimer's disease.

Like the Marshalls, the Veyseys and the Malhotras (none of whom consider themselves chemically sensitive), many people assume that the EPA is protecting Americans from these toxins, but it is (*Continued on page 108*)



Navy Lieutenant George Prior, a casualty of Daconil at the age of 30.

The Navy did a thorough investigation of Lieutenant Prior's death. An autopsy showed that Prior died from toxic epidermal necrolysis, a severe skin reaction, the result of exposure to a fungicide used on the golf course in Virginia where he had frequently played.

being affected. (Lower cholinesterase levels indicate temporary nerve damage—a thumbprint of pesticide poisoning by organophosphates, a group of potent neurotoxins.) Acting on his hunch, Dr. Malhotra called the lawn-care company to ask what chemicals had been applied. The company sent him pamphlets stating that the chemicals

How to Protect Yourself

- Use organic alternatives whenever possible and practice "integrated pest management"—plant disease-resistant grasses, keep grass height at 3" to 4", aerate the lawn regularly and use clippings as fertilizer. When you must, use chemicals only to combat specific problems.
- When applying pesticides or weed killers yourself, follow all label directions and note the product's level of toxicity. "Caution" signifies the least toxic, "warning" is considered more toxic, and "danger" marks the most toxic chemicals.
- Wear long sleeves, pants, hat, dust mask, and gloves and shoes of the most impermeable material—rubber is better than leather or canvas.
- If clothing comes in contact with pesticides, change immediately and wash it separately. Wash gloves thoroughly before removing them.
- Keep children and pets away from treated areas for 24 hours if possible. Store products out of reach.
- When your lawn or your neighbor's lawn is being treated, close house and car windows, turn off air-conditioners and remove or cover lawn furniture, toys, swimming pools, fish ponds, hoses, pet bowls and bird feeders.
- Before choosing a lawn-care service, check to see if the company is licensed by your state and ask what specific training employees have. If treatment is recommended, ask what specific problems exist and what chemical the company plans to use before you agree to treatment.
- Stand upwind when pesticides are being applied; do not apply in winds of over 10 miles per hour.
- Dry or pellet-form pesticide is not necessarily safer than liquid as it can leak vapors into the air. Some dry fertilizers also contain pesticides.
- For more information, call the EPA's National Pesticide Telecommunications Network at 1-800-858-PEST. For "The Lawn Care Packet" send \$2 to: The National Coalition Against the Misuse of Pesticides, Dept. FC, 701 E St., S.E., Suite 200, Washington, DC 20003.

—Elizabeth Lyon

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not. At least 32 of the most commonly used pesticides were registered prior to 1984, the year stricter testing guidelines were established. These pesticides must all now be reassessed, a process that will take into the 21st century to complete. Why the delay? Mismanagement, lack of funds, low priority, industry interference—all have been suggested, by people both within the Government and outside it. Meanwhile, at garden centers and hardware stores, many of these chemicals are readily available, sharing shelf space with seed packets and watering cans.

"There's reason for concern because millions of children are being exposed to toxic chemicals, not just in lawn products but in pest strips and any number of common household products," says Dr. Moses. "If there were a little more awareness and a lot more truth in labeling, then people wouldn't bring these chemicals into their homes."

By law only "active" ingredients in pesticides must be listed on a label, although "inactive" ingredients may include such cancer-causing chemicals as dioxin, found in Dacthal. EPA testing focuses primarily on ingestion of "active" ingredients. And according to Victor J. Kimm, the EPA's deputy assistant administrator for pesticides and toxic substances, in his testimony at last spring's Senate hearing on lawn care, the EPA has no way of assessing the amount of lawn-care chemicals we inhale or absorb through our skin—the most frequent pathways of exposure.

EPA testing also doesn't take into account the cumulative effect of exposure to chemicals. By the time a child is 6 years old, his brain cells are fully developed. Even if those cells are damaged, the brain does not renew itself (as skin does, for example). The EPA also does not factor in the synergistic effect one chemical may have on another—the way ammonia interacts with bleach to form dangerous chloramine gas, for instance. And few studies have been conducted on the effects of chronic, long-term, low-dose exposure to a chemical.

Unlike the Consumer Product Safety Commission, which relies primarily on its own testing to protect Americans from unsafe products, the EPA relies on industry samples and industry testing. It merely reviews the data and test results provided by the manufacturer and forms conclusions. "If a chemical company wanted to, they could start with a desired conclusion and skew the

data, and the EPA would never know," says Dwight Welch, an entomologist in the EPA's Office of Pesticide Programs. Welch recently did a random sampling of the files of 15 pesticides and found 13 without proper reviews.

America's quest for the perfect playing field goes beyond our backyards. On sunny days people swarm to grassy expanses at local parks, baseball diamonds and golf-course fairways.

Navy Lieutenant George Prior was an avid golfer. He had played several times on the Army Navy Country Club golf course in Arlington, Virginia, in the weeks before his sudden death. Normally in perfect health, the 30-year-old officer did not feel very well during this period, but he never associated it with his golfing. Then one Saturday—after playing a full 18 holes—he abruptly got



"If there were a little more awareness and a lot more truth in labeling, then people wouldn't bring these chemicals into their homes."

desperately ill. "George became grotesquely swollen," says his brother Tom. "Enormous blisters appeared on his body. One by one his organs failed, his skin sloughed off, and he went blind. The pain was ceaseless, and after 14 excruciating days, he died."

The Navy did a thorough investigation of Prior's death. An autopsy showed that he had died from toxic epidermal necrolysis, a severe skin reaction, the result of exposure to the fungicide Daconil, which had been used on the golf course.

Prior's is an unusual case. According to Jim Snow, a national director of the U.S. Golf Association, no other instances of golfers being poisoned by pesticides have been recorded. However, as toxicologists point out, such poisoning, particularly by organophosphates, might not automatically be diagnosed.

The posting of warning signs on golf courses after pesticides have been ap-

plied is sporadic at best; the Golf Course Superintendents Association of America estimates that only about 20 states require it. Some others, like Florida, require residential lawn-care companies to post warning signs after spraying, but do not require golf courses to follow the same rule.

Golf is not the only sport to rely on chemically treated grass. For baseball fan Kevin Ryan of Arlington Heights, Illinois, playing on a Little League team is a dream that will never come true.

As a toddler in the late 1970's, Kevin played in a sandbox that bordered the next-door neighbor's property, and he had free run of the neighbor's lawn, which was regularly sprayed with pesticides. Like most people back then, his mother, Deborah, had no idea this could be dangerous.

Today Kevin, now 12, gets stomach pains, has trouble remembering things, and feels nauseated, irritable and fatigued when he is exposed to pesticides; his arms and legs tingle and go numb. He can't play outdoors with his friends and can't attend his public school because it routinely uses pesticides. "I feel like a prisoner in my own home," Kevin says. During the spring and fall—peak spraying times—his mother takes him and his younger brother to Colorado, where she believes the air is cleaner.

Schools and communities often feel no responsibility to notify people of spraying activities. Five years ago Southboro Elementary School in West Palm Beach, Florida, was forced to close for three days when 35 youngsters became nauseated after wind blew toxic insecticide fumes from a nearby park into the school's air-conditioning system.

"For the price of a green lawn," says Deborah Ryan, "we are poisoning our children." Public Citizen recently found that 12 of the most commonly used lawn-care pesticides are suspected human carcinogens. One of them—2,4-D—is found in about 1,500 products on the market.

Unfortunately, children are most at risk. According to a report published by *The Journal of Pesticide Reform*, young children's cells divide more rapidly than adults', their organs are not fully developed, their immune system is immature for the first two years, and their play habits expose them to more chemicals—they're much more likely to tumble in grass and play in dirt than adults. Neurotoxins (which include all organophosphates) can cause learning problems in children during the critical years when they must (Continued)

Pesticide Scandal

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develop motor and social skills, and learn to speak, read and write.

A National Cancer Institute study has shown that children in homes where pesticides were used both indoors and out were as much as seven times more likely than other children to develop leukemia. Children whose parents worked with pesticides were also at a higher than average risk.

Fertilizers, frequently thought to be harmless, can burn the skin severely. In the summer of 1986, two hours after a service called Mister Lawn Care had treated her lawn, Robin Dudek of Hamburg, New York, pulled her garden hose from the lawn onto her back deck, turned on the water and placed the hose in the inflatable pool with her small daughters, Amanda, 3, and Kristen, 2. Amanda started drinking from the hose but screamed that the water was burning her. Then Kristen began to scream too.

Robin took the children inside; she noticed burn marks on both of them and smelled chemicals on Amanda's breath. She immediately called her pediatrician, who instructed her to bathe the girls. But by the next morning, Amanda and Kristen woke up with fever, swollen eyes and blisters the size of grape clusters on their arms and neck. Robin took them to the emergency room at The Children's Hospital of Buffalo, where they were treated for first- and second-degree burns. It was about a month before the girls fully recovered.

"The EPA should be called the IPA—the *Industry Protection Agency*," charges Jay Feldman, national coordinator of the National Coalition Against the Misuse of Pesticides. "The chemical industry is extremely powerful and wraps the EPA in red tape."

New York State Attorney General Robert Abrams, who took ChemLawn to court for making false safety claims and won the state a \$100,000 settlement in 1990, points out, "An EPA registration number on a package is not a guarantee of safety; the registration process is a balancing act of health risks versus economic benefits, not a safety determination." In the case of lawn-care chemicals, "economic benefit" translates into greener, bug-free lawns, increased property values, better business for country clubs, lawn-care services and chemical companies.

ChemLawn spokesperson Deb Strohmaier feels the company is not

putting the public at risk. "We have a very active research and development department that is constantly looking for new and better ways to treat customers' lawns," she says. "We're as much or more concerned about health risks than the general public or the activists. The only difference is we're working through knowledge and they're working through fear."

Karen James, a postal worker in Michigan, successfully sued ChemLawn in 1988. Karen was delivering mail in her jeep along a rural route when her access to a mailbox was blocked by a ChemLawn truck. She got out of her jeep and walked past the truck to deliver the mail by hand when a hose on the truck ruptured, drenching her with liquid. The employee who was applying the chemicals said the tank contained only fertilizers. But Karen suddenly felt nauseated and her



One flea repellent's packaging warns of the product's danger to pregnant dogs but says nothing about its potential danger to pregnant women.

eyes and skin began to burn.

When she remained so sick that she couldn't return to work, Karen strongly suspected there was a link between her illness and the incident with the truck. She was vomiting and had diarrhea, felt very fatigued, and her vision was temporarily reduced in one eye. Her doctor called ChemLawn to find out what chemicals had been used and was told no pesticides were involved. It was only after Karen's body tissue was tested and the presence of the active ingredient of the organophosphate Dursban was found that ChemLawn admitted the truck's tank had contained this pesticide.

"There was some confusion about what was in the tank. We had to find the records," explains ChemLawn's Strohmaier. Nevertheless, Karen, who was out of work for six weeks, sued; a jury awarded her \$1 million.

Many other cases against lawn-care

companies and chemical manufacturers have been settled out of court. Frequently, the settlement restrains the plaintiff from talking about the incident.

The lawn-care industry has few regulations and almost no enforcement. No standard licensing requirements exist, and training varies from state to state. Once licensed, an applicator may oversee his own business and hire other applicators. These workers need not be licensed; they are required only to be registered, allowing them to go off on their own to treat property. In Florida, for example, only 4,000 of the 30,000 registered applicators are licensed.

Despite the risks, most homeowners aren't willing to give up a green, bug-free lawn. But do-it-yourselfers need to take special precautions. (See "How to Protect Yourself," page 63.) The labels on store-bought pesticides are often incomplete or misleading.

Although Federal law requires lawn-care products to carry warning labels, some of these warnings are written in doublespeak that only doctors can understand. Or a warning may list possible symptoms of exposure—like blurred vision, lightheadedness and sweating—but fail to mention that continued exposure to the product may result in permanent nerve damage.

Packaging may also imply that a chemical is harmless by displaying a picture of a man dressed in shorts applying the product. Others state the danger to animals but not to people. The flea repellent carbaryl, for example, warns of danger to pregnant dogs but says nothing about its potential danger to pregnant women.

The law does prohibit manufacturers from making safety claims on labels about pesticides, including the use of such descriptions as "safe," "nonpoisonous," "noninjurious," "harmless" and "nontoxic to humans or pets"—with or without a qualifying phrase like "when used as directed."

Yet lawn-care companies often do make false *advertising* claims or give false verbal reassurances. An investigation by the U.S. General Accounting Office (GAO) revealed that various companies made the following claims over the phone to GAO investigators posing as potential clients: "Our products are practically nontoxic—no one gets sick"; "All of our products are legal and registered at EPA as practically nontoxic"; and "The only way to be affected by 2,4-D would be to lie in it for a few days."

The GAO has taken (Continued)

Pesticide Scandal

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both the EPA and the Federal Trade Commission (FTC) to task for passing the buck on enforcement, saying, "Neither agency is acting against safety claims by pesticide applicators."

But even when the EPA bans a pesticide, industry doesn't give up. Manufacturers will often appeal the decision in court. In the meantime, the product stays on the market. The EPA's recent ban on the use of the insecticide diazinon on golf courses and sod farms is a typical case. Diazinon has been responsible for nearly 100 reports of bird kills (up to as many as 800 birds at a time) across the country. However, the ban was delayed when the chemical's major manufacturer, Ciba-Geigy Corporation, appealed. Although the EPA's ban was finally upheld, diazinon is still legal for use on home lawns. The EPA's review of studies on diazinon remains incomplete.

When the EPA moves to ban a pesticide, it may take two to eight years before products are off the shelves. Ironically, one of the EPA's own booklets, "Lawn Care for Your Home," published by EPA Region 5 in Chicago,

makes false safety claims. It states, "Look for the EPA registration number when buying a chemical product. This is your assurance that the product has been reviewed by EPA and is safe and effective when used as directed."

But reforms may be on the horizon. As this article goes to press, the EPA's Office of Pesticides and Toxic Substances is undergoing an internal investigation by the agency's inspector general. And citizens' groups like the National Coalition Against the Misuse of Pesticides are working to make people aware of the dangers of pesticides in the hope that knowledge will prevent future health problems.

For some people—like Lieut. George Prior and young Matthew Veysey—knowledge didn't come soon enough. Had the right information been available, these and other tragedies might have been averted. But as Deborah Ryan has so often sadly remarked about her son Kevin's exposure, "Who knew?" ■

Editor's note: What are your experiences with lawn-care companies or pesticides you have purchased for home use? We'd like to know. Please write to: Pesticides, FC, 110 Fifth Ave., New York, NY 10011.

(Page 75) **Catsuit**, Bettina Riedel, 212-244-0383. **Sweater**, Michael Simon, 212-575-9222. **Hoodband**, Gitano, 212-819-0707. **Shoes**, Keds, 617-491-8800.

(Page 76) **Walking shorts and tank top**, Dana Buchman, 212-703-3346. **Jacket**, Evan Picone, 212-536-9500. **Shoes**, Terra, 212-245-7070. **Earrings**, Sharent, 212-629-3161. **Handbag**, Vanessa, 212-563-2220. **Bracelet**, Erwin Pearl, 212-889-7410.

Sitting Pretty

(Pages 78-82) **Slipcovers** designed by Joe Biando, Harold Rudin Decorators, and Margaret Ahern, Stylish Home Decorators.

(Pages 78-79) **Left: Fabric** (Brant Point Stripe #656493 and #656496). **Right: Fabric** (Just Stripes #355241, Country Fair Border #356010), all from Waverly.

(Pages 80-81) **Left: Fabric** on chair (Linen Check #607265), **fabric** on ottoman and pillow (Woodland Toile #657716), both from Waverly. **Trim**, Conso. **Shoes**, Palais Royal. **Blanket**, Pearce Woolen Mills, div. of Woolrich. **Curtains**, Lace Country. **Center: Fabric** on chair (Tea Party #656070), **wallpaper** (Awning Stripe #553482), both from Waverly. **Top right: Fabric** on ottoman (Sonnet #657094), **fabric** on chair (Classic Ticking Stripe #605224, Linen Check #607260), **fabric** for piping and pillow (Classic Ticking #605221), **fabric** for pillow (Country Linen Plaid #645722), all from Waverly. **Bottom right: Lace** on chair, Quaker Lace. **Trim**, Conso. **Mirror**, Lillian Vernon.

(Page 82) **Bottom left: Fabric** on chair (Sailcloth #346432), **fabric** for piping (Sailcloth #346430), all from Waverly. **Pillow** fabric (green #300262), **seat cushion** (Pony Print #100279), both from UltraSuede. **Blue vase**, green bowl, **Objects**, **Bottom right: Wicker** sheets, Ralph Lauren Home Collection.

ADDRESSES: Conso, 295 Fifth Ave., New York, NY 10016. Joe Biando, Harold Rudin Decorators, 653 11th Ave., New York, NY 10039. Lace Country, 21 W. 38th St., New York, NY 10018. Lillian Vernon, 510 S. Fulton Ave., Mt. Vernon, NY 10550. Margaret Ahern, Stylish Home Decorators, 10 Wilson Common, Yaphank, NY 11980. **Objects**, 1049 Madison Ave., New York, NY 10012. **Palais Royal**, 1725 Broadway St., Charlottesville, VA 22901. **Pearce Woolen Mills**, div. of Woolrich, Woolrich, PA 17779. **Quaker Lace**, 1040 Sixth Ave., New York, NY 10018. **Ralph Lauren Home Collection**, 1185 Sixth Ave., New York, NY 10036. **UltraSuede HP**, a div. of Springs Industries, 104 W. 40th St., New York, NY 10018. Waverly, 1-800-423-5881.

Winning Recipes

(Page 125) **Flatware**, Oneida, Oneida, NY 13421. **Ribbons**, Vaban Ribbons, 225 Fifth Ave., Suite 1121, New York, NY 10010. ■

BUYER'S GUIDE

On Our Cover

Green wicker chair, Portico, 67 Wooster St., New York, NY 10012. **Corduroy fabric** for rabbit, Cone (available at local fabric stores). **Silk flowers** (available through designers), United States Flower Company, 131 W. 38th St., New York, NY 10001.

Celebrations

(Page 34) **Passover dinner table**, Pierre Deux Antiques. **Goblet**, Samuel Saidian & Sons. **Matzoh plate**, Thaxton & Co. **Dessert photo: Table**, Pierre Deux Antiques. **Cake plate and teapot**, Thaxton & Co. **Antique fabric**, Samuel Saidian & Sons.

ADDRESSES: Pierre Deux Antiques, 369 Bleecker St., New York, NY 10014. Samuel Saidian & Sons, 1050 Second Ave., Gallery 45, New York, NY 10022. Thaxton & Co., 780 Madison Ave., New York, NY 10028.

Spring Fever

(Page 65) **Fabric** for tablecloth (Country Fancy in Wedgewood), Waverly, 1-800-423-5881.

Rites of Spring

(Pages 66-67) **Green wicker love seat**, Portico. **Silk flowers** on basket, United

States Flower Company (available through designers). **Cool melt glue gun** (used on basket), Stanley-Parker. **Candy eggs**, E. J. Brach Corp. **Colored wooden eggs**, Unfinished Business.

(Pages 68-69) **Wooden chargers**, small **baskets**, **napkin rings**, Unfinished Business. **Flatware**, pink **glasses**, Pottery Barn. **Green glasses**, bowls, Portico. **Napkins**, Glentex. **Rug**, ABC Carpet & Home Store. **Table**, chairs, Evergreen Antiques. **Candy**, E. J. Brach Corp. **Dessert photo: Table**, Evergreen Antiques. **Vase**, glass, Pottery Barn.

ADDRESSES: ABC Carpet & Home Store, 888 Broadway, New York, NY 10003. E. J. Brach Corporation, 4656 West Kinzie St., Chicago, IL 60644. Evergreen Antiques, 120 Spring St., New York, NY 10012. Glentex, 417 Fifth Ave., New York, NY 10016. Portico, 67 Wooster St., New York, NY 10012. Pottery Barn, 700 Broadway, New York, NY 10003. Unfinished Business, P.O. Box 246, Wingate, NC 28174. United States Flower Company, 131 W. 38th St., New York, NY 10001. Stanley-Parker, 149 Washington St., Worcester, MA 01610.

Fashion Fads and Follies

(Page 73) **Dress**, Cynthia Rowley, 212-465-9020. **Purse**, W. Loh & Associates, 415-863-3398. **Jewelry**, Sharent, 212-629-3161. **Hosiery**, Givenchy, 212-764-4630. **Shoes**, Unisa, 212-935-1033.

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April 25, 1991

Marvin Legator, Ph.D
Dept. of Preventive Medicine
& Community Health
U.T.M.B.
24 KEILLER-F19
Galveston, Texas 77550

fax

Re: Newman v. AT&T

Dear Dr. Legator:

I have an interesting case in which we have been asked to come in and take over for trial. Trial is set for June 24, 1991 in Denton County, Denton, Texas.

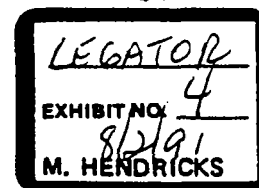
Here is the case in a nutshell:

AT&T bought a 2 acre tract of land from my clients. The tract of land is located at the top of a hill, in the middle of the property that my clients own. The rest of the property, aside from the tract of land sold, is used by the Newmans, (my client), for their residence and their farm. AT&T bought the property and situated a Microwave Relay Tower on it. At the time of the purchase, AT&T promised to maintain the vegetated growth on this easement by mowing the property. Contrary to their explicit promise, AT&T used and continued to use a herbicide. The continued use of the herbicide has caused many repercussions, not the least of which is that at least 65 trees have died or are dying on my clients property.

AT&T admits spraying the property with the herbicide in 1972, 1973, 1974, 1975, 1980, and in 1982. AT&T hired Kem-Kil to do some of the treatments. A Kem-Kil employee testified that he thought they used a product containing Bromacil, also known as Hyvar-X, which is manufactured by DuPont. During this time period, AT&T also had their own employees apply some type of herbicide to control the growth on the easement. Unfortunately,

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(or perhaps conveniently?) AT&T can not locate its records which show the exact chemicals used.

The family came down with symptoms that seem to correspond with the spraying. The mother was terribly fatigued to the point where, for example, she was having difficulty working and began sleeping during her lunch hour.

There are three daughters in the family. They are Toni D/O/B 8/26/59. Trisha D/O/B/ 8/25/67. Kippie D/O/B 11/29/71. The daughter's symptoms appear worse then their mother's. Toni was advised by her doctors to have an abortion 24 weeks into her pregnancy. Trisha gave birth to a baby girl 34 weeks into her pregnancy on 2/15/88. The baby girl was born hydrocephalic. Kippie gave birth to a baby on 8/04/90.

Trisha has been hospitalized several times since 1982, for numerous physical problems. She was hospitalized on 11/13/82 in an ICU suffering from extreme weakness, respiratory difficulty, very high levels of acetone, nausea, uncontrollable blood sugar from very high to hypoglycemic levels. During this stay at Flow Memorial, Trisha was extremely ill and in critical condition. Trisha was hospitalized on 4/26/83 for insulin allergy with irritation breaking out over her injection sites. She was hospitalized again on 5/27/83 for mononucleosis, fatigue, weakness, sinus infection, fluctuating levels of blood sugar and acetone. Trisha has suffered from extreme fatigue, weakness, respiratory problems, flu-type symptoms, numerous yeast infections, inability to keep insulin levels controlled, very high levels of acetone, muscle spasms, poor coordination, nervousness, edema, emesis, numerous sinus infections and poor kidney functions. Her problems were so extensive that she became homebound and tried to finish high school from home. [Note that prior to this she had not suffered from allergies and had not been sick much in her life.]

Trisha delivered a baby on 2/15/88, 34 weeks into her pregnancy. The baby girl was born hydrocephalic. Surgery was done on the child on June 03, 1988. It has not yet been determined to what extent the child will be hampered in its development as a result of these problems. However, one apparent problem is that this child appears to be very sensitive, or what is often described as "allergic" to everything.

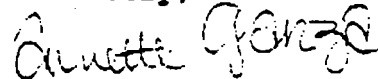
The other daughter, Toni was also pregnant. She

results to Dr. Robert J. Carpenter for a second evaluation. Dr. Carpenter recommended to Toni and her husband that it would be best to abort the baby. If not aborted the baby would be born severely deformed and would not have a chance of living. Issues concerning growth retardation were evident from the ultrasound. Toni had the abortion 24 weeks into the pregnancy on 5/05/88.

The horses on the property had been mated several times and they were attempting to foal them with no luck following the herbicide use. Then on January 27, 1987, one of the mares had a colt. The colt died, and was diagnosed also as being hydrocephalic. There were also fourteen cats on the property before the spraying in 1982. After the spraying all the cats disappeared. Last summer, in 1990, my client took in a stray cat. The cat became pregnant and had a stillborn and deformed litter.

As you can see, it is evident that we do have a very interesting case and we could use your professional expertise to help us. If you are interested in working on this case or have any further questions, please contact me. If this is not an area which you are interested, I would appreciate your referring me to any other expert.

Sincerely,



Annette Garza
Legal Assistant

cc: Tracey Conwell

:gll
2AG/N03002.L4

CHRONOLOGY
Newman/AT&T

- 7-20-60 Maude R. Newman and husband, C.E. Newman, sold to AT&T a 2.0 acre tract of land on a hill adjacent to their farm.
- -65 Maude stored hay in the barn located between AT&T's property and Floyd & Jean Halberts property. Hay was ruined by a run off drainage from AT&T's property. AT&T promised to build a ditch and not to spray any chemicals again. Marty Wright of AT&T was notified.
- 2-23-72 AT&T contracted with Kem-Kil to spray 16,000 sq. feet for vegetation control. [Note: AT&T only owns approximately 9,600 sq. ft.]
- -72 Maude noticed a purple substance had drained onto her property from AT&T's property.
- 3-25-74 AT&T contracted with Kem-Kil for vegetation control on 6,400 sq. ft.
- 2-20-75 AT&T & Kem-Kil contracted to spray 6,400 sq. ft. for vegetation control.
- 3-31-75 AT&T entered into a contract with Kem-Kil for vegetation control on 9,600 sq. ft.
- 4-26-75 AT&T contracted with Kem-Kil for vegetation control of 9,600 sq. ft.
- 3-17-77 AT&T sprayed with their "in house" employees. Chemicals sprayed are not known.
- -77 Several trees dying as well as the garden and peach tree owned by Floyd and Jean Halbert. Paths of dead grass leading from AT&T's property to the dead trees. Limbs of the dead trees sent to Texas A&M University Agricultural Dept. for Herbicide Testing.
- 4/77 AT&T & Kem-Kil enter into a contract for vegetation control. Denton is not included.
- 5-16-77 Texas A&M concluded that tree had died of herbicide poisoning.

6-6-77 AT&T made a settlement with Floyd and Jean Halbert in the amount of \$300. AT&T agreed it would not spray again.

3-28-78 AT&T & Kem-Kil enter into a contract for vegetation control. Denton is not included.

6-5-78 AT&T made settlement with Maude Newman in the amount of \$3,000. AT&T promised would not spray again.

3-30-79 AT&T contracted with Kem-Kil to spray 3,850 sq. ft. for the control of vegetation.

5-31-80 AT&T contracted with Kem-Kil to spray for the control of vegetation.

12-4-80 Kippie was hospitalized at Flow Memorial Hospital, for extreme vomiting, fatigue, and abdominal pain. Upper GI series was performed. Results showed abdominal pain probably due to gastroesophageal reflux; esophagitis probably due to above; and possible hypoglycemic state.

2-18-81 AT&T contracted with Kem-Kil to spray 9,600 sq. ft. for the control of vegetation.

82-12-84 Unable to allow animals to graze on pastures.

1-19-82 AT&T contracted with Kem-Kil to spray 9,600 sq. ft. for the control of vegetation.

3- -82 AT&T contracted with Kem-Kil to spray 9,600 sq. ft. for the control of vegetation.

Spring
1982 Noticed dying trees.

9-22-82 Wesley Patton Halbert's dog taken for examination. Vet said dog suffering from atoxia, astigmatism, nystagmus, and general lack of coordination; suggested severe damage to central nervous system.

9-24-82 Dog was euthanized.

10-5-82 TRAC report findings of Bromacil in Floyd & Jean's residence water, the stock pond and in the 820 ft. deep well.

11-13-82 Trisha hospitalized at Flow Memorial, ICU, for feeling bad; couldn't hold anything down; she had high levels of acetone, respiratory problems,

discharge diagnoses were: Diabetic ketoacidosis, candida vaginitis, acute sinusitis, hypoglycemia.

- 1-83 Wesley Patton Halbert suffered poor muscle coordination, extreme fatigue, headaches, nausea, and mononucleosis.
- 2-7-83 Dr. Grumaro Garza performed several blood and urine tests on Wesley Patton Halbert.
- 3- -83 Trisha 10th grade; took Stanford Test of Academic results showed she regressed back to the 8th grade level.
- 4-26-83 Trisha admitted to Medical City Dallas Hospital suffering from recurrent problems with infections, cramps, ketonemia, ketonuria, and fatigue problems.
- 5-27-83 Trisha hospitalized at Flow Memorial Hospital, suffering from acute severe mononucleosis, fatigue, weakness, severe tonsillitis, sinus infections, fluctuating levels of blood sugar and acetone.
- 1-9-84 Trisha and Kippie put on homebound school.
- 3-27-84 Results of Stanford test showed Kippie scored lower than previous year.
- 3-28-84 Trisha diagnosed as chemically sensitive.
- 3/84-1/85 Floyd, Jean, Trisha, Kippie, Wesley Halbert put on massive doses of vitamins.
- 4-2-84 Test performed on Trisha showed to have 11 different toxicants in her blood and 6 different toxicants present on the chlorinated pesticide screening test.
- 4-9-84 Kippie diagnosed as having mononucleosis.
- 5-7-84 Test performed on Kippie showed 12 different toxicants in her blood and 5 different toxicants present on the chlorinated pesticide screening test.
- 6-12-84 Kippie diagnosed as chemically sensitive.
- 8-1-84 Dr. Croissant removed warts on Wesley's penis shaft.
- 9-5-84 Wesley had to have his appendix removed. Dr. remarked appendix is unusually large.

- 10-3-84 Dr. Croissant removed 5 warts on Wesley's hands and penis.
- 4-1-85 Mare due to have colts in the summer of 1985. They never had colts although they were rebred every year until January 1987.
- 4-12-85 Dr. Croissant removed 7 warts scattered over Wesley's fingers and palms of hands. Dr. stated to parents that "Wesley's immune system had not fully developed, unable to fight wart virus."
- 5-14-85 Kippie Halbert attempts suicide. Diagnosed as suffering from atypical depression, PMS, allergies, food and chemical sensitivities. Severe depression due to hormone imbalance.
- 6-85 Liberty Christian conducted test on Trisha for next year. Results showed Trisha to be on 7th grade level.
- 1-27-87 Mare aborts colt. Vet diagnoses colt with hydrocephalus. Argyle Veterinarian Clinic.
- 2-20-87 Trisha takes insulin this am without Benadryl but goes to work in barn for about an 1 to 1 1/2 hours. Comes in and goes back to sleep. Mother wakes her up. Trisha can't speak, has slurred speech. Looks like she had a stroke. Appears to have been like a severe allergic reaction.
- 4-1-87 Kippie had her appendix removed. Dr. remarked "appendix unusually large."
- 12-30-87 Trisha has genetic screening. All genes normal.
- 2-1-88 Trisha has sonogram.
- 2-12-88 Trisha has sonogram, baby still appears hydrocephalic.
- 2-15-88 Trisha delivers baby by cesarean section, at 34 weeks into pregnancy. Baby born hydrocephalic.
- 4-8-88 Toni Ann Halbert Moon finds out she is pregnant.
- 5-6-88 Tony aborts baby 24 weeks into pregnancy because of abnormalities, with clinical history of renal agenesis demonstrated by sonography.
- 6-5-88 Trisha's baby, Megan, has surgery for hydrocephalus.

3/90 Megan's collar bone not connected.

5/90 Maude R. Newman, chemically imbalance, started seeing Dr. William Cudd.

8-4-90 Kippie delivers baby girl, Randi Ashlynn Cissna.

2AG/N03002.C7

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RECEIVED JUN 13 1991

M-C-T, INC.

Toxicology Consultants
Mutagens - Carcinogens - Teratogens
General Toxicology
I.D. #74 212 4899

70 Colony Park Circle Galveston, Texas 77551
Telecopier - (409) 744-6369

N03.002

M. Legator, President

MS. TRACEY CONWELL
CADELL & CONWELL
ATTORNEYS AT LAW
THE PARK IN HOUSTON CENTER
1331 LAMARR, SUITE 1070
HOUSTON, TEXAS 77010-3027

June 11, 1991

RE: NO. 82-4966-A; MAUDE NEWMAN ET AL V AT&T

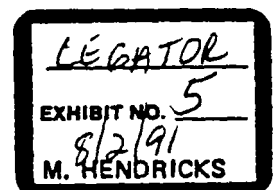
Dear Ms. Conwell:

The following is an invoice for services rendered in the above referenced matter:

RESEARCH AND CONSULTATION 1 1/2 DAYS (\$3,000/DAY) \$4,500.00

Yours truly

M. Legator
M. LEGATOR



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No. 82-4966-A

1991 JUL 15 AM 9:48

MAUDE R. NEWMAN, FLOYD W. HALBERT, JEAN A. HALBERT, TONI ANN HALBERT MOON, WESLEY PATTON HALBERT and FLOYD W. HALBERT and JEAN A. HALBERT as next friend of TRISHA KAY HALBERT and KIPPIE LYNN HALBERT, minors

VS.

AMERICAN TELEPHONE &
TELEGRAPH COMPANY, ET AL.

தமிழ்

IN THE DISTRICT COURT
DISTRICT OF COLUMBIA

OF DENTON COUNTY, TEXAS

16TH JUDICIAL DISTRICT

PLAINTIFFS' FIFTH AMENDED ORIGINAL PETITION

TO THE HONORABLE JUDGE OF SAID COURT:

COME NOW, MAUDE R. NEWMAN, FLOYD W. HALBERT, JEAN A. HALBERT, TONI ANN HALBERT MOON, WESLEY PATTON HALBERT, TRISHA KAY HALBERT, KIPPIE LYNN HALBERT, as next friend of KIPPIE LYNN HALBERT, and TRISHA KAY HALBERT as next friend of MEGAN MICHELLE RICHARDS, a minor (hereinafter referred to as Plaintiffs) complaining of AMERICAN TELEPHONE & TELEGRAPH COMPANY (hereinafter referred to as Defendant AT&T), KEM-KIL, INC. (hereinafter referred to as Defendant Kem-Kil), E. I. Du PONT De NEMOURS AND COMPANY (hereinafter referred to as Defendant Du Pont) and MIDLAND INDUSTRIAL WEED CONTROL, INC. formerly known as INDUSTRIAL WEED CONTROL, INC. (hereinafter referred to as Midland Industrial Weed Control) and would respectfully show unto the Court as follows:

C.E. Newman, Defendant AT&T constructed or caused to be constructed upon said tract of land a microwave relay tower and building in connection therewith.

V.

CHEMICAL USE BY AT&T

5.1 Plaintiffs would further show that after the purchase of the AT&T Tract, Defendant AT&T contracted with various companies for the purpose of controlling the growth of any vegetation upon said tract of land by the application of herbicides and/or pesticides and/or various mixtures of chemicals. During certain years in the period 1960 until present date, Defendant AT&T also had their own employees, known as "in-house" spraying, apply herbicides and/or pesticides and/or various mixtures of chemicals for the purpose of controlling the growth of any vegetation upon said tract of land. Defendant AT&T has been unable to locate all of its records to provide Plaintiffs with the exact types of herbicides and/or pesticides and/or various mixtures of chemicals it has used in controlling the growth of vegetation since it purchased the property in 1960.

VI.

KEM-KIL TREATMENTS

6.1 Plaintiffs would show that Defendant AT&T contracted with Defendant Kem-Kil in 1972, 1973, 1974, 1975, 1980, and 1982 to furnish labor, equipment and material for chemical vegetation control on the AT&T Tract.

Defendant Kem-Kil admits it sprayed said property with a herbicide manufactured and sold by Defendant Du Pont under the brand name of Hyvar-X.

VII.

M.I.W.C. TREATMENT

7.1 Plaintiffs would show that Defendant AT&T contracted with Defendant Midland Industrial Weed Control, formerly known as Industrial Weed Control, Inc., in 1981 for the chemical treatment to prevent vegetation growth on the AT&T Tract. It is Plaintiffs' understanding that said property was sprayed with a herbicide and/or pesticide, but the exact mixture of chemicals used is not known to Plaintiffs at this time.

VIII.

AT&T IN-HOUSE TREATMENT

8.1 Plaintiffs would show that in 1976, 1977, and 1978 Defendant AT&T did not contract with a particular company to apply the chemical treatment to prevent vegetation growth on said tract of land, but instead ordered its own employees to spray with a herbicide and/or pesticide. It is Plaintiffs' understanding that such herbicide and/or pesticide was purchased locally but the exact mixture of chemicals used and the amounts used is not known to Plaintiffs at this time due to the fact Defendant AT&T has been unable to locate its records and provide Plaintiffs with this information.

IX.

AT&T CANNOT IDENTIFY CHEMICALS USED

9.1 Plaintiffs would further show that Defendant AT&T has also been unable to locate its records reflecting the exact herbicide, and/or pesticide and/or various mixtures of chemicals used for the purpose of controlling the growth of vegetation upon said tract of land during the years 1960 through 1971.

X.

1965 PROBLEMS

10.1 In 1965 Plaintiff Maude R. Newman had stored hay in a barn located between the tract of land owned by Defendant AT&T and the house owned by Plaintiffs Floyd W. and Jean A. Halbert which is situated on the property owned by Plaintiff Maude R. Newman. Defendant AT&T had sprayed the AT&T Tract with a herbicide and/or pesticide and/or a mixture of chemicals unknown to Plaintiff. Following said spraying, it rained causing a water drainage problem off of the Defendant AT&T's property onto Plaintiffs' property. The run-off from said tract of land ran into the barn owned by Plaintiff Maude R. Newman and ruined the hay she had stored there. Plaintiff Maude R. Newman notified Defendant AT&T of said incident. At said time Defendant AT&T paid Plaintiff Maude R. Newman for the ruined hay and promised to dig a ditch to prevent water from draining down onto Plaintiffs' property in the future, which Defendant AT&T has failed to do. When Defendant AT&T inspected the ruined hay and promised to

dig a ditch to prevent water from draining down onto Plaintiffs' property, Plaintiff Maude R. Newman reminded Defendant AT&T of their agreement to control the growth of vegetation on the AT&T Tract by mowing and that there was to be no use of chemicals of any type on said tract of land or along the road or the cattle guards, which Defendant AT&T acknowledged and promised to comply with. A short time after the RUN-OFF described herein, four large oak trees located in the vicinity of said barn died.

XI.

1972 PROBLEMS AND PROMISES

11.1 In approximately 1972, Plaintiff Maude R. Newman noticed that a purple substance had drained onto her property from the AT&T Tract. Plaintiff Maude R. Newman notified Defendant AT&T by and through its maintenance supervisor, Marty Wright, who advised Plaintiff Maude R. Newman that Defendant AT&T had sprayed said area with a herbicide, pesticide and/or a mixture of chemicals to control the growth of the vegetation. Plaintiff Maude R. Newman advised Marty Wright that her young grandchildren frequently played in her yard and had been in the puddles of the purple substance and that she felt strongly that such use of any chemicals which affected her property was not safe for the health of her grandchildren or any farm animals and/or pets and would adversely affect any vegetation grown on her land. Again she requested that Defendant AT&T refrain from the use of any herbicide, pesticide and/or a mixture of

chemicals to control the growth of vegetation and to abide by their previous agreement to mow said tract of land. Defendant AT&T's maintenance supervisor, Marty Wright, advised Plaintiff Maude R. Newman that Defendant AT&T would not spray or use a herbicide, pesticide and/or a mixture of chemicals to control the growth of vegetation again.

XII.

1972 VEGETATION DIES AGAIN

12.1 In approximately 1977 Plaintiffs began noticing that several of their trees were dying as well as the garden and peach trees owned by Plaintiffs Floyd W. Halbert and Jean A. Halbert and that there would be paths of dead grass from the Defendant AT&T's property leading to the trees that had died. At that time Plaintiffs notified Defendant AT&T of the incidents mentioned above and inquired if Defendant AT&T had been using herbicides, pesticides and/or any mixture of chemicals for the control of the growth of vegetation on Plaintiffs' property. Plaintiff Jean A. Halbert and Defendant AT&T inspected Plaintiffs' property regarding the paths of dead grass, the garden, peach trees and other large trees that were dying.

XIII.

13.1 To confirm Plaintiffs' belief that Defendant AT&T had again been spraying chemicals on the AT&T Tract, the roadway leading to the tower, and cattle guards, Plaintiff Floyd W. Halbert sent samples of the dead tree limbs to

Texas A&M University and U.S. Department of Agricultural Cooperating to be tested for herbicide poisoning. Said report dated May 16, 1977, reflected the diagnosis of "herbicide damage," a copy of said report is attached hereto and made a part hereof as Exhibit "A".

13.2 Plaintiff Jean A. Halbert advised Defendant AT&T of the results of said report. Defendant AT&T made a settlement with Plaintiffs Floyd W. Halbert and Jean Ann Halbert in the amount of \$300.00 on or about June 6, 1977, a copy of a document regarding said settlement is attached hereto and made a part hereof as Exhibit "B". Said Exhibit "B" states in part the following, to-wit:

"...Payment of damages caused by spraying poison around tower yard and entrance to the Denton, TX. Site..."

"...Runoff from poisoned area onto garden and peach trees caused loss of same and produce therefrom for the season..."

Since such time no fruit was produced and the three peach trees died. Further Plaintiffs Floyd W. Halbert and Jean Ann Halbert planted a garden in approximately 1981 and nothing would grow.

13.3 Defendant AT&T made a settlement with Plaintiff Maude R. Newman in the amount of \$3,000.00 on or about June 5, 1978, a copy of said document regarding said settlement is attached hereto and made a part hereof as Exhibit "C". Said Exhibit "C" states in part the following, to-wit:

"...Payment for damages caused by spraying poison around tower yard and entrance at the Denton, Texas Site..."

"...Runoff and overspray from poisoned area onto trees and shrubs caused loss of 2-20" oak trees, 1-12" oak trees, 1-hackberry, 1-bird of paradise tree, 1-15 year old yucca plant and minor damage to several other trees..."

13.4 Plaintiffs Maude R. Newman and Jean A. Halbert discussed with Defendant AT&T that the chemical spraying was dangerous and a hazard to the safety and welfare of humans and animals. Again Defendant AT&T agreed to control the growth of vegetation on the AT&T Tract and along the roadway and cattle guards by mowing and would not use herbicides, pesticides and/or any mixture of chemicals of any type.

XIV.

INDUCEMENT AND RELIANCE

14.1 Plaintiffs would show that they believed and relied on the representations, assurances and promises made by Defendant AT&T that the chemical spraying would cease and that it nor anyone employed by said Defendant would use herbicides, pesticides and/or any mixtures chemicals of any type to control the growth of vegetation the AT&T Tract or along the roadway or cattle guards. Such representations were material to, and induced Plaintiffs to accept the payment for, settlement of their claims for loss of the vegetation. Absent this agreement, Plaintiffs would not have agreed to the settlement. Plaintiffs relied on these representations further in that they believed they were not at risk. Had they known AT&T would ignore its promises and wilfully continue to use chemicals on

the Denton tower site and surrounding area, then Plaintiffs would have taken further action to stop AT&T. More importantly, Plaintiffs would have had the opportunity to protect themselves from continued exposure to unwanted chemical exposure.

XV.

1982 EVIDENCE OF POISONING AGAIN

15.1 Plaintiffs would further show that in the spring of 1982 they noticed several trees dying and paths of grass leading up to said trees were dead or grey colored. Plaintiffs immediately suspected herbicide poisoning. Upon inspection of their property, Plaintiffs counted approximately 65 trees that had been damaged to some extent or completely dead. In addition, Plaintiffs noticed that the fish they had stocked in their tank were dying.

15.2 In the summer of 1982, Plaintiffs noticed that Plaintiff Wesley Patton Halbert's dog was unable to walk without staggering and seemed extremely lethargic. Plaintiffs Floyd W. Halbert and Jean A. Halbert took the dog for examination on September 22, 1982, and were advised by David C. Coleman, DVM, that the dog was suffering from ataxia, astigmas, nystagmus, and a general lack of coordination suggesting severe damage to the central nervous system. It was his diagnosis that the dog suffered from toxic encephalitis consequential to the exposure to herbicides in the past and his recommendation that he should be euthanized, which was done on September 24, 1982. A copy of Dr. David C.

Coleman's report is attached hereto and made a part hereof for all purposes as Exhibit "D".

XVI.

1982 WATER SAMPLES TESTED

16.1 In October, 1982, approximately six months from the most recent spraying of poison by Defendant Kem-Kil on the AT&T Tract, samples of water from their well which is 820 feet deep, stock pond and residence of Plaintiffs Floyd W. Halbert and Jean A. Halbert were tested by TRAC Laboratories, Inc. The analysis report stated that the results of the tests made on such samples showed the presence of Bromacil, a copy of said analysis report dated October 5, 1982, is attached hereto and made a part hereof as Exhibit "E". The report also showed high peaks of another substance that the lab suggested the Halberts test. However, the Halberts could not afford additional testing to identify the substance. Plaintiffs Floyd W. Halbert and Jean A. Halbert were advised that their well water was not safe to drink, thereby forcing them to purchase distilled water for drinking or install an activated carbon water filter.

XVII.

DU PONT'S PRODUCT

17.1 The herbicide Hyvar X which is manufactured by Defendant E. I. Du Pont de Nemours & Company consists of the active ingredient of 80% Bromacil (5-bromo-3-sec-butyl-6-methyluracil) and inert ingredients of 20%. Bromacil is a broad spectrum herbicide and was developed as a substitute for 2,4,5-T (2,4,5-Trichloro-phenoxyacetic acid). Said 2,4,5-T was widely used in Texas to control the growth of vegetation on easements and right-of-ways in the 1940's 1950's, 1960's and 1970's, but was banned by the Environmental Protection Agency. Further, as per Defendant Du Pont's label instructions, Bromacil was to be mixed using the chemical 2,4-D. In studies investigating the residual nature of Bromacil after application, residues were still detected in the surface soil two years after application. Peaks in residues generally followed periods of increased rainfall by about two weeks. Defendant Kem-Kil sprayed chemicals on the AT&T Tract, roadway and cattle guards which is located on Plaintiffs' property at least once a year during the years 1972, 1973, 1974, 1975, 1980 and 1982. Plaintiffs believe that Kem-Kil mixed Bromacil, 2,4-D and diesel and applied that mixture of chemicals to the AT&T Tract, the roadway and cattle guards during the years set out above.

XVIII.

ACTIVE INGREDIENT, INERTS AND CONTAMINANTS

18.1 From various studies, published articles and reports, the Plaintiffs have ascertained that an important principle for evaluation of the safety of commercial products is that one must be concerned with not only the major active component, but with the so-called "inerts," and with minor contaminants that may be present as a result of their formation during the manufacture or as the result of degradative reactions occurring in the environment. The Plaintiffs also believe that in mixing chemicals there is a danger of synergism, that is, that the toxicity is increased by combining the chemicals.

XIX.

TOXIC CHEMICALS

19.1 Herbicides as a family are neurotoxic, and chronic toxicity is difficult to detect and to evaluate.

19.2 Neurotoxic chemicals attack the central nervous system. Such chemicals may also attack the heart and liver and other organs. In addition, exposure to toxins on a chronic basis may alter the immune system resulting in immune system damage. The immune system, once damaged, may have increased or hypersensitive reactions to chemicals. In addition, the body's normal ability to fight infections and diseases may be diminished. Toxic chemicals are rapidly distributed to all tissues, especially the brain, liver, kidneys,

XXIII.

WESLEY PATTON HALBERT

23.1 Plaintiffs would show the Court that in approximately January, 1983, Plaintiff Wesley Patton Halbert suffered poor muscle coordination, extreme fatigue, headaches, nausea, and mononucleosis symptoms. He continued to suffer these symptoms for several weeks. On February 7, 1983, Dr. Gumaro Garza performed several different blood and urine tests. As a result of such services, Plaintiff Wesley Patton Halbert incurred the following reasonable and necessary medical expenses, to-wit:

Gumaro Garza, M.D.	<u>\$ 182.50</u>
TOTAL	\$ 182.50

23.2 Plaintiff Wesley Patton Halbert would further show the Court that in 1984 and 1985 he was treated for the removal of numerous warts on his body by Dr. R. S. Croissant. Dr. R. S. Croissant stated to Plaintiffs Jean A. Halbert and Wesley Patton Halbert that Plaintiff Wesley Patton Halbert's immune system had not fully developed and was therefore unable to fight the virus that was causing the warts to grow. Plaintiff Wesley Patton Halbert incurred the following reasonable and necessary expenses for such medical services, to-wit:

8/1/84	R. S. Croissant, M.D.	\$ 40.00
10/3/84	R. S. Croissant, M.D.	60.00
4/10/85	R. S. Croissant, M.D.	<u>80.00</u>
TOTAL		\$ 180.00

23.3 Plaintiff Wesley Patton Halbert would further show the Court that he continued to suffer extreme fatigue, lethargy and irritable bowel syndrome. Plaintiff Wesley Patton Halbert incurred the following reasonable and necessary medical expenses as a result of the treatment and tests for his illnesses, to-wit:

7/18/85	WJR and Associates, Inc.	\$ 100.60
7/18/85	Southwestern Clinical Laboratories	255.00
7/22/85	WJR and Associates, Inc.	70.00
7/23/85	WJR and Associates, Inc.	16.00
7/24/85	WJR and Associates, Inc.	48.00
7/27/85	WJR and Associates, Inc.	28.00
7/29/85	WJR and Associates, Inc.	59.50
7/30/85	WJR and Associates, Inc.	44.00
7/31/85	WJR and Associates, Inc.	26.00
8/1/85	WJR and Associates, Inc.	16.00
8/2/85	WJR and Associates, Inc.	20.00
8/6/85	WJR and Associates, Inc.	18.00
8/7/85	WJR and Associates, Inc.	<u>235.70</u>
TOTAL		\$ 936.80

23.4 That as a result of Defendants' negligence, conscious indifference and intent in continuously exposing Plaintiff Wesley Patton Halbert to pesticides, herbicides and/or a mixture of chemicals, he has incurred medical bills which exceed \$1,300, all of which were both reasonably required and necessitated by the exposure of pesticides, herbicides and/or a mixtures of chemicals to him. In all reasonable probability, Wesley Patton Halbert will continue to require medical care and attention and reasonable provisions should be made for such future medical attention and services.

23.5 In September, 1984, Plaintiff Wesley Patton Halbert had to have his appendix removed. After the surgery, the surgeon commented to Plaintiffs Floyd W. Halbert and Jean A. Halbert that Wesley's appendix was unusually large, a copy of the hospital records is attached hereto marked Exhibit "P" and made a part hereof.

23.6 That as a result of Defendants' negligence, conscious indifference and intent in continuously exposing Plaintiff Wesley Patton Halbert to pesticides, herbicides and/or a mixture of chemicals, Wesley Patton Halbert has suffered great pain, discomfort, incapacities, disabilities, and mental anguish. He has been unable to lead a full and active life of a healthy teenager. In all reasonable probability he will continue to so suffer for the rest of his natural life, all to his damage.

23.7 That as a result of Defendants' negligence, conscious indifference and intent in continuously exposing Plaintiff Wesley Patton Halbert to pesticides, herbicides and/or a mixture of chemicals, Wesley Patton Halbert's parents, Plaintiffs Floyd W. Halbert and Jean A. Halbert, have suffered great emotional distress and mental anguish in worrying over the health, welfare and future of their son, Wesley Patton Halbert. There is no proper price for the anxiety and concern of a parent for the well-being of their child when that is threatened. Plaintiffs Floyd W. Halbert and Jean A. Halbert have expended much time, effort and money in attempts to care for their son, i.e., time missed from their jobs for

Wesley Patton Halbert's numerous doctors' appointments and the expense for the trips for said appointments.

23.8 For each and all of the damages, costs and expenses which Plaintiff Wesley Patton Halbert has sustained in the past, together with reasonable compensation for his pain, suffering, mental anguish, incapacity and future disabilities, Plaintiff Wesley Patton Halbert should be awarded fair, reasonable and adequate damages in the amount of \$750,000.00.

23.9 For each and all of the damages, costs and expenses which Plaintiffs Floyd W. Halbert and Jean A. Halbert have sustained in the past, together with reasonable compensation for their pain, suffering, mental anguish, and emotional distress, Plaintiffs Floyd W. Halbert and Jean A. Halbert should be awarded fair, reasonable and adequate damages in the amount of \$500,000.00.

XXIV.

TONI ANN HALBERT MOON

24.1 Plaintiff Toni Ann Halbert Moon would show the Court that she was pregnant with her first child in April 1988. Pursuant to her doctor's suggestion, labor was induced prematurely because of multiple deformities. The due date of her baby was supposed to be August 25, 1988. Plaintiff's baby girl was delivered prematurely on May 6, 1988, when a problem with the pregnancy was discovered by Plaintiff's doctor. The autopsy report stated that she had "multiple

congenital anomalies, with clinical history of renal agenesis demonstrated by sonography".

24.2 That as a result of Defendants' negligence, conscious indifference and intent in continuously exposing Plaintiff Toni Ann Halbert Moon to pesticides, herbicides and/or a mixture of chemicals, she has suffered, and will continue to suffer in all probability, great emotional distress and mental anguish. Plaintiff fears that any future pregnancy she has will be complicated because of her exposure to pesticides, herbicides and/or a mixture of chemicals and that any child born to her will suffer because of said exposure to pesticides, herbicides and/or a mixture of chemicals all due to Defendants' negligence, conscious indifference and reckless disregard.

24.3 For each and all of the damages, costs and expenses which Plaintiff Toni Ann Halbert Moon has sustained in the past, together with reasonable compensation for her past and future pain, suffering, mental anguish, incapacity and disabilities, Plaintiff Toni Ann Halbert Moon should be awarded fair, reasonable and adequate damages in the amount of \$1,000.000.00.

XXV.

25.1 Plaintiffs Floyd W. Halbert and Jean A. Halbert would further show the Court that as a result of Defendants' negligence, conscious indifference and reckless disregard in continuously exposing Plaintiffs to pesticides, herbicides and/or a mixture of chemicals that they have had to incur the expense in the sum

of \$916.87 for the installation of one PSSAC-20 Activated Carbon Water Filter, which was both reasonably required and necessitated by the exposure of pesticides, herbicides and/or a mixture of chemicals to their property. Plaintiffs Floyd W. Halbert and wife, Jean A. Halbert should be awarded damages in the amount of \$916.87.

XXVI.

26.1 Plaintiffs Maude R. Newman, Floyd W. Halbert and Jean A. Halbert would further show the Court that as a result of Defendants' negligence, conscious indifference and reckless disregard in continuously exposing Plaintiffs and Plaintiffs' property to pesticides, herbicides and/or a mixture of chemicals, they have been damaged in their property. They would be ethically and morally unable to sell the property to anyone--other than AT&T--after what has happened to them there. They have been further damaged in that they have been unable to grow fresh vegetables to eat. Not only have Plaintiffs been unsuccessful in their attempts to have a garden, they are afraid to eat products off their land and watered by their water. The Plaintiffs are unable to eat any fruit produced by their fruit trees because all fruit trees died after they were contaminated. They were unable to allow any animals to graze in their pasture from 1982 until December, 1984 for fear that said animals would become contaminated with said pesticides, herbicides and/or a mixture of chemicals. When Plaintiffs purchased three (3) miniature mares which grazed all over the Plaintiffs' property in 1985. Although

the mares were due to have colts in the summer of 1985, they did not. They never had colts even though they were rebred every year. Finally, in January 1987, one of the mares aborted her colt. Its head was visibly deformed and enlarged. Plaintiffs had a veterinarian at the Argyle Veterinarian Clinic check the colt and he diagnosed the colt. The colt had hydrocephalus.

26.2 Plaintiffs Floyd W. Halbert and Jean A. Halbert, in following the recommendations of various physicians and the experts who tested Plaintiffs soil and water, ate organic grown vegetables and used bottled water and/or chemical-free water carried from their neighbor's home to their home until their filter was installed. Said bottled water was used from approximately March 1984, until January 1985, with a minimum of five gallons per week. However, during this time Plaintiffs had to use the contaminated well water for bathing, cooking and cleaning. Said bottled water cost \$6.00 per five gallon bottle. Plaintiffs Maude R. Newman, Floyd W. Halbert, Jean A. Halbert, Trisha Kay Halbert, Kippie Lynn Halbert and Wesley Patton Halbert incurred additional expenses as a result of having to buy said bottled water and were greatly inconvenienced as a result of having to use said bottled water and/or the chemical-free water hauled from their neighbor's home.

26.3 From March 1984 until March 1985, Plaintiffs Floyd W. Halbert, Jean A. Halbert, Trisha Kay Halbert, Kippie Lynn Halbert and Wesley Patton Halbert in following the recommendations of various physicians have been taking

massive doses of vitamins in an effort to detoxify their systems of the chemical poisoning. Said vitamins cost approximately \$50.00 per month. From March 1985 until present, Plaintiffs spend approximately \$50.00 every three (3) months for vitamins.

26.4 Plaintiffs would further show the Court that they have suffered extreme emotional distress and mental anguish since learning that they had been continuously exposed to pesticides, herbicides and/or a mixture of chemicals due to Defendants' negligence. That all Plaintiffs have suffered from extreme fatigue, muscle spasms and nervousness. Also Plaintiffs Floyd W. Halbert and Wesley Patton Halbert suffered a loss of hair on their bodies.

26.5 Plaintiffs would further show that their property value has greatly diminished as a result of Defendants' negligence in continuously exposing said property to pesticides, herbicides and/or a mixture of chemicals.

26.7 For each and all of the damages, costs and expenses which Plaintiffs have sustained in the past, together with reasonable compensation for damages suffered in the future, Plaintiffs should be awarded fair, reasonable and adequate damages of at least \$5,000,000.00, together with punitive damages in an amount of not less than \$5,000,000.00.

XXVII.

27.1 For the information of the Court, Plaintiffs would show that from Pesticide Chemicals Official Compendium, Association of American Pesticide

Control Official, Inc., 1966, regarding Bromacil (ASA) under "Use Precautions" it states, "...Avoid contact with skin, eyes, and clothing. Keep away from children..." and under "Residue Tolerances" it states, "...None established..." and under "Application: Precautions", it states, "...Do NOT apply, or drain or flush equipment on or near desirable trees or other plants, or on areas where their roots may extend, or in locations where the chemical may be washed or moved into contact with their roots. Do NOT use on lawns, walks, driveways, tennis courts, or similar areas. Prevent drift of dry powder or spray to desirable plants. Do NOT contaminate domestic waters..." A copy of said reference is attached hereto and made a part hereof as Exhibit "N".

27.2 Children tend to be more susceptible to pesticide, herbicide and/or chemical poisoning since their undeveloped immune systems are less capable of defending the body against toxic substances.

XXVIII.

28.1 Defendants exhibited gross negligence and/or conscious disregard for the rights, welfare, property, health and safety of Plaintiffs in that:

- (a) AT&T consciously disregarded its promise to Plaintiffs not to use poisons on the AT&T Tract and easement.
- (b) AT&T did nothing to ensure that poisons were not used.
- (c) AT&T never supervised any work of the other Defendants.

- (d) Plaintiffs were never advised prior to or after Defendants sprayed the AT&T Tract.
- (e) Plaintiffs never received any precautions or advice from Defendants regarding the possible side effects and/or dangers from the use of said herbicides, pesticides and/or mixture of chemicals on the property hereinabove described.
- (f) Defendants actively concealed their use of poisons; have denied and actively concealed their promises not to use more chemicals.
- (g) Defendants have concealed or refused to find documentation showing what chemicals were used.

Exemplary or punitive damages should be assessed against AT&T.

XXIX.

29.1 Plaintiff Maude R. Newman would show the Court that she and her husband, C. E. Newman, relied on and believed Defendant AT&T's assurances in 1960 when they sold Defendant AT&T the hereinabove described property that it would maintain the growth of vegetation on the hereinabove described property by mowing it and that Defendant AT&T would landscape same.

29.2 Plaintiffs would further show the Court that they relied on and believed Defendant AT&T's assurances in 1965 when it acknowledged and again promised to comply with their original agreement that no pesticides, herbicides and/or a mixture of chemicals would be used to maintain the growth of vegetation on the hereinabove described property but that same would be maintained by mowing it.

29.3 Plaintiffs would show the Court that the Defendant AT&T took unfair advantage of Plaintiffs, all to Plaintiffs damage. Plaintiffs relied upon Defendant AT&T's acknowledgments and assurances that no pesticides, herbicides and/or a mixture of chemicals would be used to maintain the growth of vegetation on the hereinabove described property but that same would be maintained by mowing it.

XXX.

30.1 Plaintiffs deny that their claims are time-barred. Further, should Defendants show that the claims may be barred by applicable statute of limitations, Plaintiffs assert that all of their claims were filed timely under the discovery rule. That is to say, Plaintiffs filed their claims within the applicable time period following the date they knew or should have known they had a cause of action.

XXXI.

31.1 Plaintiffs incorporate the above-referenced facts and would further show this Court, as causes of action:

1. BREACH OF CONTRACT

Defendant AT&T promised that it would control the vegetation on the tract by mowing and that it would not use pesticides, herbicides and/or a mixture of chemicals. Defendant AT&T breached that promise by applying, and hiring others to apply multiple chemicals for weed and vegetation control. As a result of this breach, Plaintiffs have suffered, and will continue to suffer, damages as more specifically alleged herein and hereby incorporated by reference.

2. PROMISSORY ESTOPPEL

In the alternative, without waiving the foregoing, Defendant AT&T promised to Plaintiffs that it would control the vegetation on the tract by mowing and that it would not use pesticides, herbicides and/or a mixture of chemicals. It was foreseeable to Defendant AT&T that Plaintiffs would rely on these representations.

Plaintiffs in fact relied and believed Defendant AT&T's assurances. Plaintiffs continued to live on the property without taking precautions that would have been taken if they had known the land and water were being contaminated. As a result of these assurances and of Plaintiffs' reasonable reliance thereon, Plaintiffs have suffered and will continue to suffer damages as more specifically alleged herein and hereby incorporated by reference.

3. FRAUD

Further, and without waiving the foregoing, Plaintiffs would show that Defendant AT&T made representations to Plaintiffs, as more specifically set forth hereinabove, with the intent to induce Plaintiffs to sell the tract to Defendant. Such statements were made knowingly or with reckless disregard that they were false. In addition, when AT&T paid Plaintiffs for the poisoned plants named in the attached agreements (Exhibits B and C), they promised not to use more chemicals. Yet they used more chemicals anyway. This amounts to fraud, or fraud in the inducement. Absent such promises, Plaintiffs would not have accepted the monies for the plants.

Plaintiffs relied on such misrepresentations to the consequential injuries of Plaintiffs which injuries have been more specifically alleged herein and incorporated by reference.

4. NEGLIGENCE

All Defendants owed Plaintiffs a duty of ordinary care. All Defendants breached that duty in applying poisons in a manner which exposed the Plaintiffs and their property..

Defendants Kem-Kil and Midland Industrial Weed Control should be charged with a higher duty of care. They should have been professionals with professional standards of handling and applying these toxic poisons. They were

not. Their actions fell far below the standard of care of an ordinary professional herbicide applicator.

Defendant AT&T owed Plaintiffs a duty of ordinary care to select and supervise the applicators in applying poisons. Based on Defendant AT&T's representations and dealings with the Plaintiffs, Defendant AT&T should be held to a higher standard of care. Defendant knew or should have known that the Plaintiffs did not want toxic chemicals used at the AT&T Tract or easement because of the danger of exposure to Plaintiffs' property. Defendant AT&T knew or should have known that the chemicals often used for weed control may be extremely toxic. Yet AT&T did nothing. Their negligence exceeds ordinary negligence and rises to the level of gross negligence because AT&T's acts show a total lack of care or reckless disregard for the Plaintiffs' health, welfare and property.

5. NEGLIGENCE PER SE

Further and without waiving the foregoing, Defendant Kem-Kil violated federal and state laws, including 7 U.S.C. § 136j(a)(2), by the application of herbicides in a manner inconsistent with label directions.

Further, Defendant AT&T is accountable for the actions of persons it authorized to apply the toxic chemicals to the property. The application of such materials is inherently dangerous or ultrahazardous and thus liability for the

resulting harmful consequences cannot be avoided merely because it was delegated to a third party.

As a result of these violations, Plaintiffs have suffered, and will continue to suffer damages as have been more specifically set forth herein and which are hereby incorporated by reference.

6. INTENTIONAL AND/OR NEGLIGENT INFLICTION OF EMOTIONAL DISTRESS AND FEAR

Further, and without waiving the foregoing, Defendants acted intentionally or recklessly in applying and permitting toxic chemicals to be applied so that the Plaintiffs and their property would be affected. Such conduct, as described more specifically hereinabove, especially in light of AT&T's promises to mow and landscape followed later by repeated promises not to use chemicals despite continuous knowledge of the trespass of the poisons to Plaintiffs' property, was extreme and outrageous, causing Plaintiffs to suffer severe emotional distress. Defendants acts were, at minimum, negligent in inflicting severe emotional distress. Any reasonable persons in Plaintiffs' shoes would have suffered extreme emotional distress.

7. TRESPASS

Further, and without waiving the foregoing, Defendants negligently and/or intentionally permitted toxic substances to contaminate Plaintiffs' property notwithstanding the numerous complaints from Plaintiffs that Defendant AT&T

cease using toxic substances. As a result of this trespass onto Plaintiffs' property, Plaintiffs have suffered and will continue to suffer damages as more specifically alleged hereinabove and incorporated by reference. Defendants are jointly and severally liable for all of the damages which flow from the trespass regardless of whether such damages were foreseeable.

8. PRIVATE NUISANCE

Further, and without waiving the foregoing, Defendant AT&T created a private nuisance by controlling vegetation on the tract adjoining to Plaintiffs' with ultrahazardous and/or toxic substances, and in such a manner as to contaminate Plaintiffs' tract with the run-off from such toxic substances. Such nuisance proximately caused Plaintiffs' damages as more specifically alleged hereinabove.

9. ULTRAHAZARDOUS AND INHERENTLY DANGEROUS ACTIVITY

Further, and without waiving the foregoing, in applying the highly toxic chemicals whose use is restricted by law, Defendants AT&T, Kem-Kil and Midland Industrial Weed Control were engaged in ultrahazardous activity in that the use of toxic herbicides necessarily involved a risk of serious harm to Plaintiffs.

Defendants, in conducting the activity, knew or should have known that such activities inherently involved a risk of toxicity and trespass of toxic chemicals by air, land and water to adjoining property and residents. The injuries to Plaintiffs were a direct and proximate result of the activity for which Defendants are liable.

At all relevant times, Defendant AT&T, as the owner of the tract, knew or in the exercise of reasonable care should have known that the work to be performed for them by Defendant Kem-Kil and/or Midland Industrial Weed Control was likely to create a peculiar risk of bodily harm to others, including Plaintiffs, from exposure to highly toxic chemicals. AT&T is responsible for the acts of its agents. AT&T cannot delegate such ultrahazardous and inherently dangerous work to outside contractors and thereby avoid liability. In addition, Defendant AT&T failed to take any reasonable precautions against these risks. Such failure proximately caused the injuries to Plaintiffs described herein.

Further, the damages suffered by Plaintiffs include, in addition to those described above:

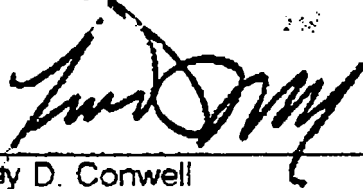
1. The costs of moving, temporarily living somewhere else while thoroughly testing the land and water and, if necessary, remediating the site, and then moving back to their property;
2. The costs of future medical monitoring, cognitive and psychological counseling; and
3. Anguish, fear, and emotional distress, including fear of cancer and other diseases, arising out of toxic exposure.

XXXII.

PRAYER

WHEREFORE, PREMISES CONSIDERED, each of these matters considered, Plaintiffs request that after trial and hearing of this matter that they be awarded fair, reasonable and just compensation, reimbursement and damages for the injuries and losses they sustained or could sustain as a result of the causes of action against Defendants as set forth herein. Plaintiffs further pray for prejudgment interest, post-judgment interest, costs of court, and for such other relief, general or special, legal or equitable, to which they may be justly entitled. Plaintiffs specifically pray that punitive damages be assessed against AT&T in an amount at least equal to actual damages.

Respectfully submitted,



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OF COUNSEL:
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Minor & Jester
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(817) 387-7585

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing instrument has been forwarded by certified mail, return receipt requested, this the 13th day of July 1991, to the following:

Mr. David McCracken
Locke Purnell Rain Harrell
2200 Ross Avenue, Suite 2200
Dallas, TX 75201-6776

ATTORNEY FOR
KEM-KIL

Mr. Neil Rambin
Strasburger & Price
901 Main Street, Suite 4100
Dallas, TX 75202

ATTORNEY FOR
AT&T

John L. Lancaster, III
Jackson & Walker
901 Main, Suite 6000
Dallas, TX 75202

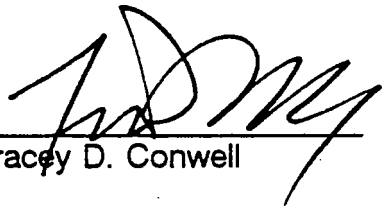
ATTORNEY FOR
Du Pont

J. T. Gandy, President
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Midland, TX 79702-3221

PRO SE

Mr. Ronnie Phillips
218 North Elm
Denton, TX 76201

GUARDIAN AD LITEM



Tracey D. Conwell

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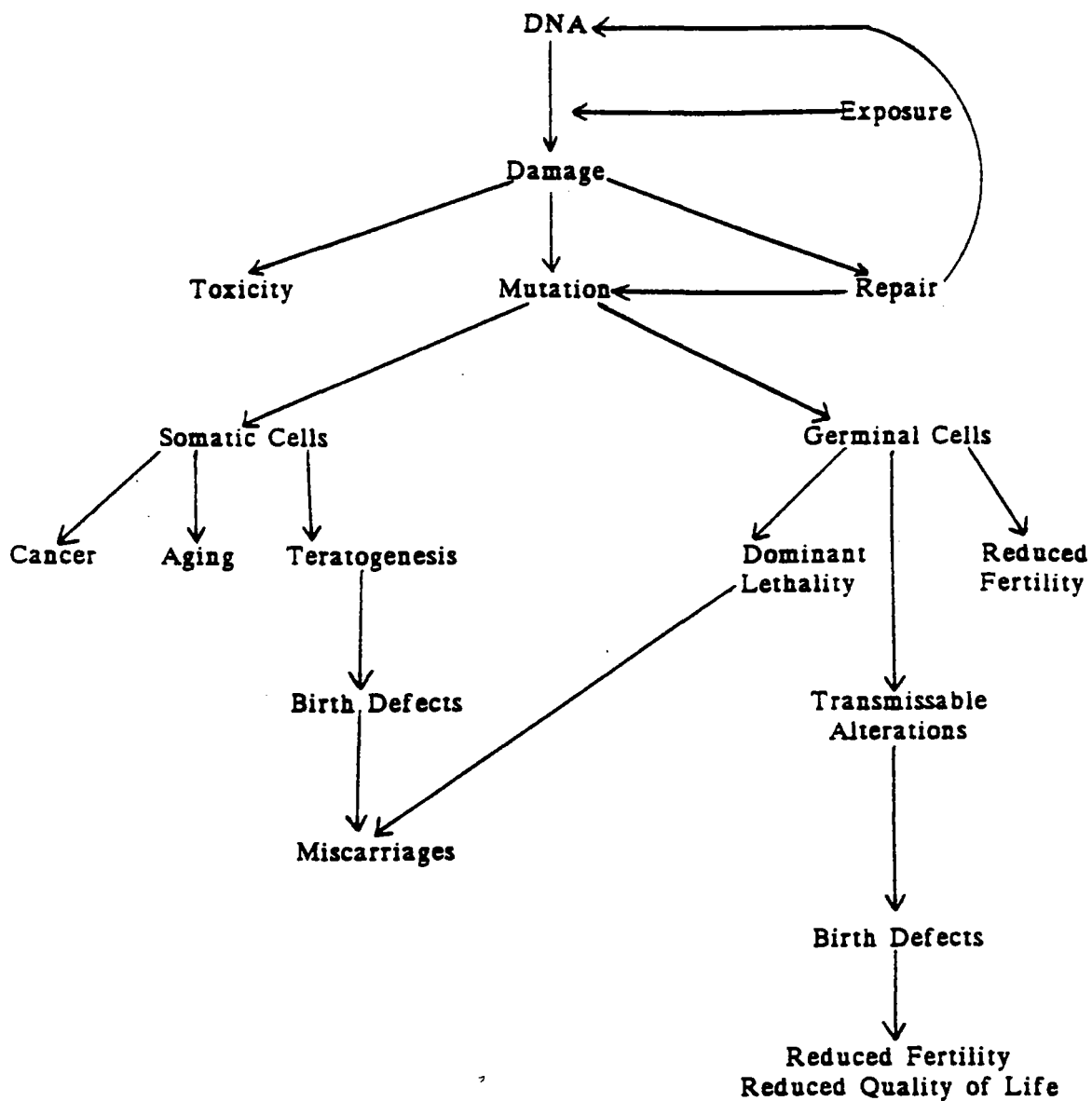
2605

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D. 2706

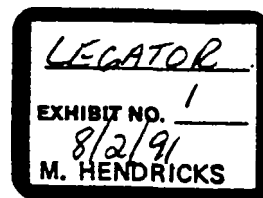
FIGURE 1:

POSSIBLE MANIFESTATIONS OF MUTATIONAL EVENTS IN HUMANS



2606

D. 2107



MEMO - 11/30/91 & LIST OF DOCUMENTS
ON 2,4-D & 2,4,5-T



2607

D.2708

MOYER FILE MEMORANDUM

TO: RICHARD SCHULER

FROM: JOHN BETTS

SUBJECT: 2,4-D AND 2,4,5-T CHEMICAL FORMULAS AND KEY
EPIDEMIOLOGICAL STUDIES

DATE: NOVEMBER 30, 1991

The following material was collected from a variety of sources as follows:

A. Chemistry formulation handbooks that explain exactly what is in these herbicides. (Mary Alexander's Personal Library).

B. U. S. Food and Drug Administration Report (Davis v. Dow Files).

C. Expert Witness File (Dr. Ozonoff) in Davis v. Dow files.

D. Dr. Teitelbaum's personal file on key epidemiological studies.

E. Dr. Frank Gardner's personal file on the most recent epidemiological studies to date.

LISTING OF DOCUMENTS

1. 2/23/79: Blair, A., et al., "Leukemia Among Nebraska Farmers: A Death Certificate Study", American Journal of Epidemiology, Vol. 110, No. 3. This showed a 183% increased risk for dying of leukemia in farmers born after 1900 and dying between 1957 and 1974 before the age of 66 years.

Comment: It should be an even higher risk if the study were done now, considering it takes 10 to 25 years after exposure for many of these leukemia cancers to manifest. The herbicides were just starting to get used in the time periods of this study and there was an immediate change in these types of cancers!

2.. 11/5/82: Reed, Donald, "2,4-D Herbicide", Food and Drug Administration, Bureau of Foods, Internal Report on Herbicides in Foods.

Comment: Shows that roughly 55-60% of 2,4-D is used on food or feed crops, while 40-45% is used on non-crop sites such as forestry, turf, and rangelands.

3.. Late 1980's: Sax, Irving N., "Chemical Makeups of 2,4-D; 2,4,5-T; and TCDD" (selected pages on these chemicals), Dangerous Properties of Industrial Materials, Sixth Edition.

4. Late 1980's: Verschueren, Karel, "Chemical Formulations and Toxic Properties of 2,4,5-T", Handbook of Environmental Data on Organic Chemicals, Second Edition.

5. 4/12/88: Zahm, S.H., et al., "A Case-Referent Study of Soft-Tissue Sarcoma and Hodgkin's Disease", Scand j. Work Environ Health, Vol 14, pp. 224-230. This found that the Soft-Tissue Sarcoma risk was higher among the farmers who themselves mixed or applied insecticides to animals in a Kansas study. This was associated with the chlorinated hydrocarbons in the insecticides. (Same as in the herbicides!). They talk about the reports from Sweden, Denmark, Italy and the United States that say persons exposed to the 2,4-D and 2,4,5-T herbicides have up to a 600% increased risk for soft-tissue sarcoma.

6. April 1989: Zahm, S.H., et al., "A Case-Control Study of Soft-Tissue Sarcoma", American Journal of Epidemiology, Vol. 130, No. 4, pp. 665-674. This looked at the same Kansas study and focused on non-agricultural workers, medical history, beverage consumption, and other factors on the incidence of soft-tissue sarcoma. Since the etiology of soft-tissue sarcoma is largely unknown, they wanted to see if any other factors were involved. The study found that users of the drug chloramphenicol produced a 540% elevated risk for this cancer. Other high risk groups were woodworkers and users of smokeless tobacco. **Note:** Maybe it is these same chemicals that are sprayed on the tobacco and on the trees in the forest or during processing at the mills.

7. Mar/Apr 1989: Alavanja, Michael C.R., et al, "Mortality Among Forest and Soil Conservationists", Archives of Environmental Health, Vol.44, No.2, pp.94-101. This report studies the USDA Forest Workers who died of cancer from 1970-1979. They found that non-Hodgkin's lymphoma (NHL) and colon cancer demonstrated a statistically significant linear trend with duration of employment as a forest or soil conservationist, which suggested an occupational etiology for both diseases. They found a 260% elevated NHL cancer risk and a 180% elevated colon cancer risk in the soli conservationists groups employed after 1960. Among the forest conservationists, the risk for both NHL and colon cancer appeared to be elevated before and after 1960.

Comment: This study talks a lot about all the various kinds of cancers found at different levels of forest workers.

8. September 1990: Zahm, S.H., et al, "A Case Control Study of Non-Hodgkin's Lymphoma and the Herbicide 2,4-D in Eastern Nebraska", Epidemiology, Vol 1, No. 5, pp. 349-356. This study showed a 310% increased risk of getting non-Hodgkin's lymphoma for farmers who mixed or applied 2,4-D more that 20 days per year. The risk increased above this with the degree of exposure, as indicated by application method and time spent in contaminated clothing.

Comment: This clearly shows that the cancer risk is a function of time and duration of exposure, especially when wearing contaminated clothing all day!

9. 10/19/91: Manz, A., et al., "Cancer Mortality among Workers in Chemical Plant Contaminated With Dioxin", The Lancet, Vol. 338, No. 87731, pp. 959-964. This study supports the hypothesis that TCDD is a human carcinogen. It says that the relationship of malignancy in animals to TCDD exposure has been observed, but that of human carcinogenicity with TCDD remains controversial. The debate stems primarily from the inconsistent findings in case-referent studies relating risk of soft-tissue sarcoma and non-Hodgkin's lymphoma to herbicide exposure. Several investigators have detected a positive association but others have not. Epidemiological associations between TCDD exposure and other cancers have also been reported. They studied 1583 German workers in a herbicide plant that was contaminated with TCDD and found an increase for all types of cancers of 124%. Public concern over the potential hazards from disposal of waste products contaminated with TCDD and other higher chlorinated dioxins led to plant closure in June of 1984.

10. 10/26/91: Saracci, R., et al., "Cancer Mortality in Workers Exposed to Chlorophenoxy Herbicides and Chlorophenols", The Lancet, Vol 338, No. 8774, pp. 1027-1032. They cite previous epidemiological studies that have revealed an increased risk of cancer, notably soft-tissue sarcomas and non-Hodgkin's lymphomas, in people occupationally exposed to chlorophenoxy herbicides, including those contaminated with TCDD. Here they did a historical cohort study of mortality in an international register of 18,910 production workers or sprayers from ten countries. The excess of soft-tissue sarcomas among sprayers is compatible with a causal role of chlorophenoxy herbicides. Four cases in four different countries all occurred after 10-19 years after the first exposure, a time shorter than that observed in Sweden or the USA. There was a 900% increase of Soft-tissue sarcoma noted among sprayers in particular, though not specifically for those probably contaminated with TCDD.