IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNITED STATES OF AMERICA,	)	
	)	
Plaintiff,	)	
	)	
vs.	)	No. 78 C 1004
	)	
OUTBOARD MARINE CORPORATION AND MONSANTO COMPANY,	)	
	)	
	)	
Defendants.	)	

May 28, 1981,

1:30 o'clock p.m.

The deposition of ROBERT E. KELLER resumed pursuant to noon recess at the offices of Kirkland & Ellis, 200 East Randolph Drive, Chicago, Illinois 60601, before Thea L. Urban.

PRESENT:

MR. JAMES T. HYNES,

MS. ROSEANN OLIVER,

MS. JOANNA NEW,

MR. BRUCE A FEATHERSTONE,

MR. ROBERT E. SHAPIRO.

- - -

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R O B E R T E. K E L L E R,

called as a witness herein, having been previously duly sworn, was examined and testified further as follows:

DIRECT EXAMINATION (Resumed)

BY MR. HYNES:

Q Doctor, you said earlier that once your department got on line with the new technology, the gas chromatograph and the mass spectrometer, you started doing various projects dealing with PCBs. You mentioned two, I believe: Biodegradation work and solubility.

Was it solubility in water, was that it?

A Correct.

Q These were considered to be non-routine type analytical-type work using that technology, is that correct?

A Yes.

Q Other than these two projects, were there any other non-routine type work you did using GC/MS dealing with PCBs between 1969 approximately when the technology was on line and 1973?

A Yes.

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Q Could you just briefly state what the other analyses were and this is on just PCBs.

A Yes.

MR. FEATHERSTONE: What is the relevancy to unknown tests? We are about to hear the testimony, perhaps if I let it go forward. Are there species that somehow are relevant to your case, Mr. Hynes?

MR. HYNES: Well, biodegradation is one. I am talking non-routine.

MR. FEATHERSTONE: I am not sure we know what non-routine means.

MR. HYNES: Special, I said similar in type to the biodegradation or the water solubility tests and that general analysis.

MR. FEATHERSTONE: All right. Go ahead, Doctor.

BY THE WITNESS:

A I think my answer was yes on that.

BY MR. HYNES:

Q What were these other types of projects?

A The support to the business group and Medical Department, our clients, on certain toxicology studies involving animals, measurement of PCB residues.

MR. FEATHERSTONE: In test animals?

THE WITNESS: Test animals.

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BY MR. HYNES:

Q Just briefly, your work on there was measuring the levels and types of PCBs within the test animals, is that correct?

A Correct.

Q You obviously didn't have anything to do with toxicology or any related field like that?

A Correct.

Q Any other types of work that you did of this nature?

MR. FEATHERSTONE: On PCBs.

BY THE WITNESS:

A No, I think those are the only ones.

BY MR. HYNES:

Q As to the work you did on biodegradation, was that more than one study?

A Yes.

Q How many studies, do you recall, that were involved?

A A sizeable number, and I can't give you an answer except to say more than five.

Q What was the specific subject matter or task as to each of these studies, as best you recall?

MR. FEATHERSTONE: Wait. May I have that question

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back?

MR. HYNES: Let me do it this way --

BY MR. HYNES:

Q You said there were many studies, more than five, you are not sure how many. Was there a distinct subject matter or area you were investigating in each of those studies?

MR. FEATHERSTONE: Could you respond to that?

THE WITNESS: Yes.

MR. FEATHERSTONE: All right.

BY THE WITNESS:

A Yes.

BY MR. HYNES:

Q And as best you can recall, what were the various subject matters of each of these studies?

A One principal series of projects were involving, looking at the Aroclor 1200 Series.

Q Looking at biodegradability of Aroclor 1200 Series, is that correct?

A Correct.

Q What other areas did you investigate other than the Aroclor 1200 Series?

MR. FEATHERSTONE: You mean products?

BY MR. HYNES:

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Q Products or subject matters of various studies.

MR. FEATHERSTONE: Why don't you tell us what you mean by subject. If the tests are on biodegradation, they would have to be on products or at least on chemicals. I don't know what else.

BY MR. HYNES:

Q Is that how it was broken down, you did biodegradation studies on different products or different chemicals?

A Yes.

Q One of the product groups was the Aroclor 1200 Series?

A Yes.

Q What were the other product groups you did biodegradation studies on?

A We worked on many product groups relative to --

MR. FEATHERSTONE: He is talking about PCBs, Doctor.

THE WITNESS: Okay.

BY MR. HYNES:

Q PCBs.

A I was going to conclude that of other organic products but this was the principal thrust on PCBs,

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was the 1200 Series.

Q So you did biodegradation studies on other products which did not contain PCBs?

A Correct.

Q To the best of your knowledge, the biodegradation work which you did do that related to PCBs was only the study on the 1200 Aroclor Series?

A Correct.

Q Who set up the protocol for the testing of the 1200 Series of Aroclors on biodegradation?

A That was set up in our analytical group.

Q Those are the people working for you?

A Yes.

Q Can you just briefly explain the purpose of the study, what you hoped to accomplish by it?

A It was directed toward developing information needed by the clients, the business groups and the Medical Department to better assess PCB products in terms of their usage and the presence in the environment.

MR. FEATHERSTONE: Better assess the state of the product, of the PCBs in the environment?

THE WITNESS: Yes.

BY MR. HYNES:

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Q When was it first determined that biodegradation --

MS. OLIVER: Could you read back that last answer?

(Record read.)

BY MR. HYNES:

Q When was it first determined that biodegradation studies should be done on the Aroclor 1200 Series?

A For our group, Applied Sciences?

Q Yes.

A This was in late 1960 -- 1969, possibly 1970.

Q By whom was that determination made that the testing should be done?

A By the business group and Medical Department.

Q Would the business group be the Functional Fluids?

A Yes.

Q Am I correct that they then requested your group to undertake studies?

A Right.

Q Was this direction given personally to you to undertake this testing?

A I can't reconstruct how this was communicated from the business group.

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Q Could you just briefly explain the work you did, the work your group did on the biodegradation studies on the Aroclors?

A The first task, you understand that this was a new technique for Applied Sciences. And the first task was to set this up as an operational technique and one of the first projects needed was to develop the technique which would be applicable to PCBs.

MR. FEATHERSTONE: You are talking about biodegradation technique?

THE WITNESS: Biodegradation technique for PCBs, the reason for that being biodegradation technique had been used within Monsanto Company approximately from the late '50s, possibly early '60s, in another division of the company at that time, the Inorganic Chemicals Division. The technique there was used for research groups dealing with surfactants, products for the soap industry, et cetera.

These were water soluble types of materials which could be used more readily in a semi-continuous activated study involving water soluble products.

Applied Sciences was to develop techniques, biodegradation techniques which would handle quite

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insoluble materials such as PCBs, so that work was concurrent with setting up the physical equipment, the hardware necessary to do this, and concurrent with this it was necessary for us to train out of our area, Applied Sciences, people with competency to carry out work of this type.

BY MR. HYNES:

Q So the first task was to --

A To become operational.

Q It was an accepted technique within the Organic Chemicals Division for testing biodegradation and that technique had to be modified so that it could work, be able to study biodegradation of insoluble chemicals like PCB?

MR. FEATHERSTONE: He didn't testify that a technique existed with the Organic --

MR. HYNES: I thought I said Inorganic.

MR. FEATHERSTONE: And the technique for water soluble compounds.

BY MR. HYNES:

Q The technique for water soluble compounds, it was your group's task to modify a technique so you could use it for insoluble chemicals such as PCB, is that correct?

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A Yes.

Q Once that task was accomplished, what was the next step in your study?

A To apply it to the PCB-types of products.

Q Did you take as part of your study each Aroclor compound and study each of them independently to determine the biodegradation qualities of each?

A Yes, I would like to add one comment as to what preceded your question of a study. That was a methodology beyond the biodegradation test. To be able to follow what happens with the biodegradation test, you have to be able to follow the fate of the chemicals under study and to do that required special methodology for the PCB-type materials.

And fortunately this was made possible, again, with the GC, gas chromatography, mass spectrometry techniques which were coming along nicely and were being put in place, so this made it possible and this is what we concentrated on secondly after the equipment was installed, to be able to monitor and assess what came out of the PCB studies. And then we moved into a study of the Aroclor 1200 Series.

Q Once the technology was operational and the methodology was operational, at that point, I think you

said then each Aroclor compound was separately analyzed to determine the biodegradation qualities of these?

A Of these, each Aroclor product?

Q Each Aroclor product.

A Which is a mixture of PCBs.

Q Am I correct that you did not analyze the Aroclor chemical but rather the end product which was sold as analyzed, each end product?

A No, that is not correct.

MR. FEATHERSTONE: Aroclors themselves are end products.

BY MR. HYNES:

Q The Aroclor will be a 1242 or 1248, that is what was analyzed?

A Correct.

Q And do you recall if each Aroclor Monsanto produced was in fact analyzed?

MR. FEATHERSTONE: He said Aroclor 1200 Series. Is that the limitation?

BY MR. HYNES:

Q 1200 Series, I'm sorry.

A Yes.

Q Do you know if any other Aroclors other than the 1200 Series were analyzed?

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A Yes.

Q Which were those, if you recall?

MR. FEATHERSTONE: Were these other than PCB Aroclors?

THE WITNESS: Yes.

BY MR. HYNES:

Q I am just talking about PCB Aroclors.

A No, if it is only PCBs, no.

MR. FEATHERSTONE: It is only PCBs. All the PCB Aroclors were tested for biodegradability, is that correct?

THE WITNESS: Correct, right.

BY MR. HYNES:

Q Did you also analyze, would PCT, poly-chlorinated terphenyl, be included in the 1200 Series of Aroclors?

A No.

Q Were any of those found that you can recall?

MR. FEATHERSTONE: Why is that a pertinent question, Mr. Hynes?

MR. HYNES: I think it is a pertinent question because the PCTs were also sold to Johnson Motors for a period of time as a substitute, as I understand it, for the PCBs and I think in a product case here if

there is any relationship between those two products in terms of analyses, end results and the like, I just want to know if there is any information that PCTs are related in this field of biodegradation to PCBs.

MR. FEATHERSTONE: PCTs are different compounds from PCBs.

MR. HYNES: They are similar compounds.

MR. FEATHERSTONE: But they are different compounds.

MR. HYNES: Fine, but similar.

MR. FEATHERSTONE: And the similarity that you have said in terms of relevancy is that we happened to sell PCT fluid to Johnson Motors and you have not complained of PCTs anywhere.

MR. HYNES: I think it is relevant as to the techniques utilized for determination of whether the PCBs and/or the PCTs are safe, are a problem in the environment.

MR. FEATHERSTONE: Are you complaining about PCTs?

MR. HYNES: No, but I think the work that is involved in PCTs might be relevant to see if indeed all the work that was done on PCTs was adequate in terms of warning and harm and the like.

MR. FEATHERSTONE: I don't see the relevance of

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how the --

MR. HYNES: I just want to find out at this point if the PCTs were analyzed and that biodegradation studies were done as with the 1200 Series of Aroclors with PCBs.

MR. FEATHERSTONE: Since I take the position the question is wholly irrelevant to your issue of the lawsuit, we are not going to answer this question.

MR. HYNES: You are not going to answer any question on PCTs?

MR. FEATHERSTONE: On the biodegradability of PCTs.

MR. HYNES: We can certify that.

MR. FEATHERSTONE: That was your question.

MR. HYNES: Fine.

BY MR. HYNES:

Q As to the analysis you did on biodegradability, the 1200 Series of Aroclors, and I will say PCBs, just briefly explain, did you use the same technique in analyzing each of the different Aroclors?

A Yes.

Q Other than the product itself under analysis, was there anything different in any of the work done on any of these products in terms of technique,

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methodology?

A No.

Q Could you explain just briefly then the series of steps that you went through to determine the biodegradability of each of these products and I don't mean 1242, but since you used the same technique, the series of steps you used to determine the biodegradability of the products.

A The test is a semi-continuous activated sludge test which simulated a secondary sewage disposal plant operation. It involved in the laboratory taking microorganisms from an actual sewage disposal plant, bringing them into the laboratory, putting them into our laboratory system, feeding these microorganisms with a nutrient-type growth to maintain their activity and then periodically charging the compound, in this case PCBs, in question to this system.

Then at predetermined intervals, such as 24 hours or 48 hours, withdrawing a sample from the system and analyzing it for residual PCB under study and comparing it to the amount charged.

The amount lost is used as a measure of biodegradability, normally reported as percent in a 24 or 48-hour period.

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MR. FEATHERSTONE: You say amount charged. You are referring to PCBs put into the test?

THE WITNESS: Right.

BY MR. HYNES:

Q Was there a standard nutrient used for these microbes?

A Yes.

Q Do you recall what it was?

A No, I don't recall.

Q This is a standard technique used for each of the different Aroclors, is that correct?

A Correct.

Q Am I correct in assuming that the types of microbes, the types of nutrients used, the intervals, samples were drawn and the like were all constant throughout each of the tests of the different Aroclors?

A Correct.

(Mr. Shapiro left the deposition room.)

BY MR. HYNES:

Q How long did this study or this series of studies take place once you had the methodology and technology in place until you came up with the final conclusions or your conclusions as to the biodegradability

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of the compounds?

A Normally from weeks to months' duration.

Q From weeks to months depending on which Aroclor you were studying at the time?

A Correct, correct.

Q Approximately how long did it take from beginning to end to analyze the whole 1200 Series?

A Approximately one year.

Q Do you recall what the lowest chlorinated Aroclor was, what the percentage of chlorine was?

A Yes.

Q Which was it?

A 1221.

Q What was the highest?

A 1260.

Q That is 21 percent chlorine, 60 percent chlorine?

A Yes.

Q What were the conclusions which you drew in terms of the biodegradability of the Aroclors?

A We found that the rate of biodegradation decreased as the chlorine numbers increased in the PCBs.

To put it in further perspective on a relative basis, Aroclor 1221 biodegraded faster than

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the next Aroclor up the line all the way to 1260.

Q In your study did you use any standard or set any benchmark where you determined that there was significant biodegradation at some point below this; it was significant above this; it was insignificant?

A What is significant?

Q That is what I mean. Did you determine yourself in this study that there was some point you would consider biodegradation significant or insignificant?

MR. FEATHERSTONE: Was that the function of your group, I guess is the preliminary question.

BY THE WITNESS:

A Let me answer the question this way:

From our group and our responsibilities, we had determined that the result was significant from the standpoint of our method accuracy, biodegradation technique accuracy. Once we felt that the answers were reliable with limits put on it as to accuracy, then these were turned over to our client, the business group or Medical Department for their judgment as to further assessment.

BY MR. HYNES:

Q Am I correct in assuming that your signifi-

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cance was the statistical significance of your findings in terms of accuracy?

A Correct.

Q But your group did not set any significance levels in terms of analyzing the data, saying below this point it is insignificant biodegradation?

A Correct.

Q Do you know if anyone in the business group or Medical Department ever made that determination that the biodegradation at some point was insignificant in any of these products?

MR. FEATHERSTONE: Made that precise finding that it was insignificant or that it was --

MR. HYNES: No, was there a determination made to his knowledge by either the Medical Department or business group that biodegradation up to a certain level of the product was insignificant.

BY THE WITNESS:

A I don't know how they used this information.

MR. HYNES: All right.

BY MR. HYNES:

Q Do you recall the ranges of biodegradation in the products 1221 and 1260?

MR. FEATHERSTONE: You mean the precise findings?

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BY MR. HYNES:

Q The percentages. You said 1221 was the highest percentage of degradation, 1260 was the lowest.

Do you recall what the range was in terms of percentage?

MR. FEATHERSTONE: He didn't say that. He said 1221 biodegraded more quickly than the next Aroclor.

MR. HYNES: He said it was expressed in a percentage of biodegradation.

MR. FEATHERSTONE: Over a period of time.

MR. HYNES: Yes.

MR. FEATHERSTONE: But your question does not take into account time, only the percentage.

BY MR. HYNES:

Q The biodegradation standard you used was biodegradation over a period of time, is that correct?

A Yes.

Q Using your standard then, your methodology, do you recall what the background was in terms of time, the measurements you used? Was it a standard interval that you used throughout the tests?

A Either 24 or 48-hour period.

Q So those were the only time standards that you used?

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A To my best recollection.

Q Do you recall what the range of the biodegradation at the 24-hour level was between the products?

A You are asking for absolute percent?

Q Best you recall, what the percent was of biodegradation.

MR. FEATHERSTONE: Could you do it?

BY THE WITNESS:

A 1221 which was the most degradable, in a typical 48-hour period, biodegraded --

BY MR. HYNES:

Q I said the 24-hour first.

A All right. I will say for the purpose of our continuing discussion, I think all these were done on a 48-hour basis percent and 48 hours, percent in 48 hours.

Q All right.

A And the 1221 biodegraded in the range of 50 to 60 percent in 48 hours. And this proceeded to decrease throughout Aroclor 1200 Series up to the 1260, which degraded at a slower rate in the order of few or more percent, 5 to 10 percent.

Q I think you stated when you were setting up

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the techniques and the methodology to measure the biodegradability that an important part of this was to be able to follow the fate of -- I am not sure if it was a chemical or the product, the compound. You needed to follow its fate and that was where the mass spectrometer came in.

I am kind of paraphrasing what you said. Could you explain what you mean by it was important to determine the fate of the product in terms of biodegradability?

MR. FEATHERSTONE: No, you have two ideas confused. From my notes one is the purpose of the project was to better assess the fate of PCBs in the environment. The second is they needed the GC/MS unit to monitor the biodegradation of PCB products.

MS. OLIVER: Beyond the biodegradation, you needed the mass spectrometer to be able to follow the fate of the chemical in your biodegradation study of the chemical.

BY THE WITNESS:

A That methodology is what is required to come up with a biodegradation figure.

BY MR. HYNES:

Q That is what I just don't understand.

Following the fate of the chemical, you mean follow the fate,here is the PCB molecule with certain percentage of chlorine and after it biodegrades for 48 hours the fate is the measurement of how much less chlorine is on the molecule, is that what you mean by the fate of the molecule?

A No. My interpretation if fate was brought out here --

MR. FEATHERSTONE: Well, your meaning was?

BY THE WITNESS:

A My meaning was that the business unit and the Medical Department were concerned about what happened to PCB products in the environment. They were directing their efforts to getting any and all information possible together to better assess what happens to these products and to make future judgments and appropriate actions relative to these products.

BY MR. HYNES:

Q In terms of determining the fate, in terms of the methodology you had established, and maybe I am just missing what the definition is that you are using of biodegradation. Let me do it this way:

What do you mean by biodegradation, what is your definition of that?

A It is the rate reported as percent at which the PCB disappears in a prescribed period of time, in this case 48 hours, in the presence of microorganisms such as those found in a secondary sewage disposal plant.

Q In terms of the measurement then, if you start out with a quantity of 100 units of whatever the unit of measurement, here of PCBs, at the end of 48 hours' measurement it biodegrades 20 percent, that means then there are 80 units of PCBs remaining?

A Correct.

Q That other 20 percent then is no longer considered to be a PCB, is that correct?

A That is correct.

Q And am I correct that it breaks down into its component parts, chlorine?

A Correct.

Q It breaks down to some extent into its component parts?

A Correct.

Q As to this breakdown into its component parts, was part of your test to measure what those parts were that it broke down into?

A We directed our efforts toward measuring

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residual starting material as opposed to measuring intermediate final degradation product from the biodegradation.

Q It was not part of your study to measure what happened to the percentage of PCBs broken down into component parts?

A Correct.

Q Did your group ever conduct a measurement of that type at any other time?

A It is possible the group that the biodegradation was in, Applied Sciences, carried out a study of this type and I was not aware of it. To my knowledge, this was not done.

Q On the biodegradation study, your function, your involvement in that was doing a study, coming up with the percent of biodegradation of these products. Is that where your responsibility stopped? Your results were then sent to the Medical group, Functional Fluids and they were responsible for taking any action they felt appropriate on the results?

A Correct.

Q Were you ever involved after your results were concluded, were you ever involved in any meetings or discussions or receive any correspondence from anyone

outside of the Analytical Department concerning any action taken as a result of your biodegradation studies?

A No.

Q Do you know of any action which was taken as a result of your study by Monsanto?

A No.

Q In setting up the technique and the methodology for conducting the biodegradation test, why was an activated -- you said it was semi-continuous activated sludge test. Why was the medium of sludge chosen for this methodology?

A It was the most ready source of microorganism of that type that would permit a biodegradation study that was available to us or to any who carried this out in terms of a test that had a chance of showing you what you wanted to show with materials biodegradable over a range and not water soluble.

Q To your knowledge, was there any environmental reason why activated sludge was chosen as the medium?

MR. FEATHERSTONE: Other than testing biodegradability of the products?

MR. HYNES: Right.

MR. FEATHERSTONE: Did you understand that question?

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THE WITNESS: Yes.

MR. FEATHERSTONE: You are doing better than I am.

MS. NEW: Me, too.

BY THE WITNESS:

A The reason it was chosen is it was expedient to come up with relative biodegradability figures in the presence of microorganisms.

BY MR. HYNES:

Q What I'm getting at is I assume that from what you are saying, activated sludge test, I think you said it simulates a sanitary treatment plant, whatever the medium that would be found in a sanitary disposal plant, sanitary treatment plant?

A Correct.

Q My question is was there any environmental concern that you know of or that was expressed to you that that medium should be chosen because of potential environmental problems of PCBs getting into sanitary treatment plants?

A No.

Q Your biodegradation study results, do you know if that was ever published in any type of a scientific journal or sent out to the scientific community as a whole at any point?

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A We made available what information we had to interested parties.

Q Basically someone who requested information like that, you would make it available to them?

A Yes, correct.

Q But it was not something published in Science Magazine or something of that nature?

A Correct.

Q You also mentioned the water solubility test which was conducted by your group. When was that study first proposed?

A Late 1969 or early 1970.

Q Approximately the same time period as the biodegradation study?

A Yes.

Q Were these two studies related in any way? Did you use the information from one to the other or were they independent studies?

A Related.

Q How were they related?

A Because we needed solubility information for PCBs which were very low in solubility to properly design the precision testing in terms of, for example, how much material could be charged and we had to be

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sure it would remain in a soluble solution.

This was a key reason for determining solubility at very low levels for our new GC/mass spectrometer because it was an important part of designing the biodegradation technology which we had to put in place.

Q Am I correct in assuming this water solubility study again meant this piece of information that you needed before you could do the biodegradation?

A Correct.

Q Would you please explain what the methodology you developed for this water solubility was?

A It involved sampling the reaction mass containing the microorganisms, the charged PCB and any other materials that might be present, selectively isolating residual charged PCB by appropriate extraction technique and proceeding with the gas chromatography/mass spectrometry separation, identification and measurement.

Q And the GC/MS would be the last step in that?

A Yes.

Q Of known quantity of solution, that would be able to measure how much remains in that solution?

A Correct.

Q Did you do anything else to the technique or the methodology that you can recall?

A No.

Q And similar to the biodegradation study, did you then utilize this methodology for each of the Aroclor compounds?

A Correct.

Q Again, 1221 was the lowest, 1260 was the highest, is that correct?

A Correct.

Q How do you measure that finding you do come up with on measuring water solubility? What is it, a percentage or is it the weight? How do you measure --

A Reported as?

Q How is it reported, thank you.

A Part per billion levels, reported as a concentration, reported as a concentration which dissolves in water at 25 degrees Centigrade or room temperature.

Q Am I correct then at the medium that would be 25 degrees Centigrade and the part per billion measurement would be how much of a known quantity of PCBs in that medium will dissolve at a part per billion level?

A Correct, how many part per billion of the PCB under test will dissolve and go into the aqueous phase.

Q Is there a time measurement involved in this also?

A The times that are needed to properly corroborate the emissible PCB with the water solution. My best recollection is this involved a few days' agitation, ending with allowing the phases to separate, subsequently going in and sampling the water phase and making the determination.

Q Would it be a different period of time for each of the Aroclor compounds or would that be a standard control?

A Appropriate intervals were selected with the thought some might be more emissible than others, but I cannot differentiate what the difference in time was for you.

Q Could you recall what the part per billion concentrations were for the Aroclors' range?

A Not specific for each one, but typical level would be 200 part per billion of the Aroclor 1200 Series.

Q Do you recall if there was noticeable

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difference in concentration between a lower chlorinated and a higher chlorinated, was that in the biodegradation work?

A Yes, on a relative basis, the lower chlorinated components, PCBs would be somewhat more soluble in this part per billion range than the higher chlorinated species.

Q The water solubility test results then were used as components for your test of the biodegradation of the PCBs, is that correct, or not a component?

A Was used to guide a design of appropriate biodegradation tests.

Q Do you know of any other use which was made of this water solubility test results?

A Nothing comes to my mind at the moment.

Q As the biodegradation studies, results and your involvement with it, in degrading one of the Aroclors, it degrades at a certain percent. Would you still be able to determine after that Aroclor degrades what Aroclor it is? Does it change its molecular weight in such a way that 1221 after degrading, I think you said around 50 percent, subsequent measurements, would that Aroclor still be able to be read as 1221 or would it now become 1242 or something like that?

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Does it lose its initial identification, I think is my question.

A Yes, because it is losing its characteristics of isomeric components.

Q Could that explain why Widmark and Jensen and the person in Scotland kept finding the higher chlorinated isomers because they really were, or a lot of them were a lower chlorinated, at some point biodegraded and now are being read as a higher component?

MR. FEATHERSTONE: Would you read that back?

(Question read.)

MR. FEATHERSTONE: Don't go any further.

A lower-chlorinated isomer does not biodegrade into a higher chlorinated isomer. Is that your question?

MR. HYNES: Let me try it again, so I can understand this.

BY MR. HYNES:

Q A lower chlorinated PCB, lower chlorinated Aroclor will, based on the results of your study, will biodegrade to some extent?

A True.

Q Subsequent to that percent of biodegradation, if someone took that remaining quantity of PCBs and

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measured it, would they then be able to determine that it is what its original composition was?

A No.

Q Then would it be read as a higher chlorinated hydrocarbon than it originally started out as?

MR. FEATHERSTONE: Why would that --

MR. HYNES: Stop. I know what I said wrong.

MR. FEATHERSTONE: Maybe.

BY MR. HYNES:

Q All I am trying to get to is Widmark and Jensen findings, the concern that was expressed there that they kept finding a higher chlorinated isomer, five or greater isomers.

Did the results of your studies here, at least to some extent, explain why there were the quantities of PCBs identified with the higher isomers?

A The answer to that is yes. It is a possible explanation.

MS. OLIVER: Could I just ask a question?

MR. HYNES: Yes.

MS. OLIVER: Once a lower chlorinated isomer or PCB is biodegraded to 50 percent or whatever, what is it then identified as?

MR. FEATHERSTONE: Isomer doesn't biodegrade to

50 percent, a product.

MS. OLIVER: The product PCB, Aroclor.

MR. FEATHERSTONE: But Mr. Hynes made the same mistake. You confuse isomer with the product.

MS. OLIVER: What is it identified as on the GC/mass spectrometer?

MR. FEATHERSTONE: Why don't you take 1221 as an example, if that is all right.

MS. OLIVER: Sure.

THE WITNESS: I think I can clarify this issue with two or three sentences' explanation.

MR. FEATHERSTONE: All right.

THE WITNESS: PCBs as an Aroclor product is a mixture, as you know.

MR. FEATHERSTONE: Mixture of isomers.

THE WITNESS: Mixture of isomers with varying levels of chlorination in the mixture. Biodegradation will, the bugs, the microorganisms chew up the lower chlorinated species faster. If you are feeding them a mixture, they then will reduce the level of the lower chlorinated isomers or species so that the residual PCB components remaining would tend to be the higher chlorinated isomers.

MR. FEATHERSTONE: Assuming there are higher

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chlorinated isomers in that original Aroclor.

THE WITNESS: True, 1221 does not have higher --

MR. FEATHERSTONE: What you have left is lower chlorinated. They just have not biodegraded yet.

THE WITNESS: Correct.

MS. OLIVER: If you identify the lower chlorinated isomers as being present after the product biodegrades as much as it is going to?

THE WITNESS: No.

MS. OLIVER: What is it then identified as on the GC/MS?

MR. FEATHERSTONE: I think after 48 hours using 1221, you have 40 to 50 percent PCBs left is what you have.

THE WITNESS: It will tend to be, it will be the higher chlorinated isomer species in that 1221 mixture.

MR. FEATHERSTONE: But they are still identified as PCB isomers, not identified as Aroclor 1221.

MS. OLIVER: That was my problem. Thank you.

MR. FEATHERSTONE: That was my problem with your question. You kept confusing product with isomers.

MR. HYNES: I think I have it as well as I'll ever have it.

MR. FEATHERSTONE: Let's go on to something else.

BY MR. HYNES:

Q You also stated that other types of work that your group did was support for the medical group and the business group with regard to doing analyses of animal tissues for PCB levels, is that correct?

A Yes, correct.

Q When was that?

A Approximately 1970.

Q Was that a direct request from either the Medical Department or the business group that you do conduct these tests?

A Yes.

Q Were you involved in any discussions with them concerning your capabilities to do it, your desire to do it?

A Involved with the analytical parts of the program, yes.

Q What was your involvement in that? What were the discussions concerning?

A To assure that the right methodology would be in place; to analyze tissues out of the studies for residual components used for the study.

Q These were in conjunction with toxicity testing being conducted, biodegradation tests, is that

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right?

A Correct.

Q Which toxicity tests were they?

A That was a province of the Medical Department and we did not participate in the selection, design those tests.

Q I didn't mean in the design and selection of toxicity tests. I mean do you know the subject matter of the test where your group analyzed the tissues?

A Could you clarify subject matter?

Q Long term chronic toxicity tests on rabbits or dogs or birds, the species that was studied?

A I was aware that there were animals, chickens, rats, dogs, et cetera, under study. I personally did not involve myself or become aware of what each of these studies were because it was in their hands.

MR. FEATHERSTONE: Mr. Hynes' question, Doctor, was whether your analytical group analyzed animal tissues or all the animals used in the tests or some or none, I guess.

MR. HYNES: No, I just wondered if he knew the subject matter of specific tests where your group analyzed the tissue.

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BY THE WITNESS:

A Yes, then you said by subject matter, you meant specific species which would be the rat, dog, chicken.

BY MR. HYNES:

Q Let me put it this way:

When your group received the different tissues from, I assume, the medical group, they were the ones who gave you the tissues to be analyzed?

A Through them we received them directly in some cases from Industrial Bio-Test Laboratories.

Q Did you set up a protocol as to the quantity of tissues which you needed to do the analysis?

A We participated in assuring the methodology used would have enough sensitivity for monitoring the level of PCBs or whatever might be studied.

Q In other words, you set up the method, the analytical method to follow and in setting that up, you decided you needed X quantity of tissues to have an accurate study done?

A Right.

Q Other than determining the levels of PCBs in the various tissues being analyzed, did your group have any other duties or responsibilities in that

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regard with those toxicity tests?

A No.

Q Had nothing to do with the interpretations at all other than just the levels of PCBs found in the tissue?

A Our responsibility was to make the determinations, report the levels found to the other groups.

Q Who did you report your findings back to?

A This was to the manager of the research unit for Functional Fluids and to the Medical Department.

Q You did not report them back to IBT and they in turn reported back to Functional Fluids?

A No, our clients in this case were Functional Fluids and the Medical Department.

Q Do you recall doing any other analysis of PCBs other than the three we have just gone through that were out of routine-type work your division would be doing?

MR. FEATHERSTONE: That has already been answered, Mr. Hynes.

BY MR. HYNES:

Q For your clients? Those are the only non-routine type tests?

A That's right.

Q Do you recall if your group or yourself ever did any analyses of Monsanto products containing PCBs where you were looking for dibenzyl furans?

A Yes.

Q Did you do any other analytical work for similar types of impurities in PCB products, and I will give you an example --

MR. FEATHERSTONE: Jim, why don't you relate the question specifically to impurities rather than similar types.

BY MR. HYNES:

Q Did you do any analysis of the impurities in the PCB-bearing products at Monsanto?

A Yes.

Q Were there specific impurities that you were looking for?

A Yes.

Q Which were they?

A Dibenzyl furans.

Q Any others?

A Yes.

Q Which?

A Dioxins.

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Q Any others?

A No.

Q Was that dioxins, plural?

A Plural.

Q Are there different types of dioxins?

MR. FEATHERSTONE: Is there a dioxin in this case, Mr. Hynes?

MR. HYNES: No, I want to find out what testing --

MR. FEATHERSTONE: You may want to find out a lot of things, but how are dioxins and dibenzyl furans relative to the lawsuit involving Waukegan Harbor?

MR. HYNES: Because the information from Europe from the University of Utrecht found they had found impurities such as dibenzyl furans in the PCB products in Europe. I want to find out if such impurities were found in the Monsanto products.

MR. FEATHERSTONE: How is that relevant?

MR. HYNES: Because they are very highly toxic poisons. If they are in the Monsanto products, that is a clear problem.

MR. FEATHERSTONE: Have you checked for dibenzyl furans in Waukegan Harbor?

MR. HYNES: That doesn't matter. I am asking what Monsanto did.

MR. FEATHERSTONE: We certainly did not search for dibenzyl furans.

MR. HYNES: But your product is the issue in the case here.

MR. FEATHERSTONE: No, PCBs.

MR. HYNES: Yes, PCBs from your product.

MR. FEATHERSTONE: PCBs are not dibenzyl furans.

MR. HYNES: But if impurities are found in the process of manufacturing PCBs in a company in Europe, which clearly if they are found here makes a PCB-bearing product more dangerous, much more toxic. If there are no impurities like this in the product, that's fine, but if that is part of the impurity in a product that is causing a problem, we certainly can get into that to see whether or not --

MR. FEATHERSTONE: The fact is your defense witness searched for dibenzyl furans in Waukegan Harbor and failed to find any.

MR. HYNES: And I am sure I can ask Dr. Keller who said he did do research to see if there were these impurities in the product and I expect he would answer what he looked for, what he found.

MR. FEATHERSTONE: I mean you don't have the specific research relative to what you claim to be

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relevant in the lawsuit; in other words, whether there are dibenzyl furans.

Your expert looked, your trial witness looked.

MR. HYNES: We did not manufacture the product. Monsanto did.

MR. FEATHERSTONE: What difference does it make?

MR. HYNES: What do you mean what difference does it make? If you have an impurity in a product and that impurity is a highly toxic poison or highly toxic substance, isn't Monsanto responsible for what is in their product?

MR. FEATHERSTONE: Your lawsuit involves PCBs at the bottom of Waukegan Harbor. It doesn't matter to take the point abstractly, what is over in California or in France. What is in Waukegan?

MR. HYNES: The manufacturing process of PCBs for the product in Waukegan Harbor, I would have to assume is the same manufacturing process for PCBs by Monsanto for any other company that purchases their products and I don't care if they are found here, there. I want to find out if Monsanto found these impurities in their product and the product in question.

MR. FEATHERSTONE: First of all, your expert

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didn't look.

MR. HYNES: What does my expert have to do with it, if it has anything to do with it?

MR. FEATHERSTONE: To take your point, the presence or absence of the impurity, assuming it is relevant to the lawsuit, is relevant only insofar as whether it is in Waukegan Harbor. Your guy looked for it and did not find it and told you that in a written report.

Secondly, why don't you ask some of your experts which impurities or their manufacture or intended manufacture are predictable. I mean, they will tell you that presumably because one lot has it doesn't mean the second lot has it or has it in the same quantity.

I have made my objection on relevancy. We will let him answer the question, but we will not go much further than that.

BY MR. HYNES:

Q I think my question was, Doctor, are there different types of dioxins?

A Yes.

Q Which are the types that you --

MR. FEATHERSTONE: You can ask him whether he

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found out.

BY MR. HYNES:

Q Did you say you checked for impurities, for dibenzyl impurities and you checked for dioxins and that was all you checked for, is that correct?

A In the -- would you repeat the question again, please?

Q All right.

I believe you said that your group checked for impurities in PCB products of Monsanto, is that correct?

A Correct.

Q And two of the impurities that you checked for were dibenzyl furans and dioxins, is that correct?

A Correct.

Q Do you recall looking for any other impurities other than these two?

A No.

Q Did you find any dibenzyl furans or dioxins in any of your products?

MR. FEATHERSTONE: You can answer.

BY THE WITNESS:

A No.

MR. HYNES: If you knew what the answer was, you

could have saved ten minutes.

MR. FEATHERSTONE: No, we could save a couple of hours if you would stick to the issues in the lawsuit, Mr. Hynes.

BY MR. HYNES:

Q After your group completed the water solubility tests or series of water solubility tests, am I correct that there was just one series of tests and that was used in the biodegradation studies?

A Right.

Q The series of tests which you did on the animal tissues, there were several analyses, several tests. When did they conclude the last analysis your group did, do you recall?

A Those tests extended over a period of time because some were long term tests, as I recollect; for example, two-year studies, so it was a period of several years.

Q Your involvement of the two to three-year period during some components of the test throughout --

A Yes.

Q Do you recall when the last test was conducted roughly?

A No, I don't.

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Q Do you recall or were you involved in any other non-routine test involving PCBs or PCB products at Monsanto subsequent to 1973?

MR. FEATHERSTONE: How is that relevant?

MR. HYNES: Well, PCBs stopped being produced in, I am guessing, 1975; between '73 and '75 when PCBs stopped.

MR. FEATHERSTONE: We stopped selling PCBs to Johnson Motors sometime late '70 or early '71. Why are we up to '75?

MR. HYNES: To see if he did any more research involving this to see what the problems were, the knowledge of Monsanto as to any problems in the environment as to PCBs.

MR. FEATHERSTONE: How is Monsanto's knowledge of that germane, a duty to warn, is that your count?

MR. HYNES: Right.

MR. FEATHERSTONE: It is?

MR. HYNES: Yes.

BY MR. HYNES:

Q Did you do any further questioning in the area other than these three categories of studies that you recall?

MR. FEATHERSTONE: You can answer that yes or no.

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BY THE WITNESS:

A The answer is no.

BY MR. HYNES:

Q Other than in a routine type of test that your group would get, your involvement with PCBs essentially stopped when these three tests were concluded, is that correct?

MR. FEATHERSTONE: Up to '75 which is your --

BY MR. HYNES:

Q Up to 1975.

A Correct.

Q I think you said earlier that your group did an analysis, I am not sure how many. Do you recall doing some analyses of samples sent to you from the business group from Johnson Motors in Waukegan?

A That's correct.

Q Do you recall how many samples your group analyzed from Johnson Motors?

A On the order of 5 to 10 samples.

Q Do you recall that they came in at distinctly different times or all of them came in at once and you did the five or so samples at one time?

A There were several intervals.

Q Where did you get these samples from, do you

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recall?

A Through our business group and the marketing function.

Q That again would be through the Functional Fluids group?

A Functional Fluids. When I say business group, I am talking about Functional Fluids.

MR. FEATHERSTONE: You are talking about PCBs?

THE WITNESS: When you are talking about PCBs, yes.

BY MR. HYNES:

Q You said just now marketing. Would that be the marketing group within the Functional Fluids?

A Correct.

Q Do you recall who the person was who delivered that sample or samples to you?

A This was Pogue, P-o-g-u-e.

Q Do you recall what was sampled? Was it water that was sampled to determine PCB content or was it sediment?

Was it oil out of a pipe, do you recall what it was?

A It was my recollection that these are effluent samples from Johnson Motors.

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Q Do you recall what the findings were in terms of PCB content?

A PCBs found ranged roughly from 10 to 100 to 200 part per million.

Q Did your group or did you yourself have any involvement with communicating these results directly to Johnson or go back through the business group which requested you do the analyses?

A Yes.

MR. FEATHERSTONE: It was a compound question, that is the problem.

Yes as to the latter part of that question?

THE WITNESS: Would you rephrase the question.

BY MR. HYNES:

Q You sent the results back to the business group that requested the analysis be done, is that correct?

A Correct.

Q Do you know what they did with the analysis results?

A No, I don't.

Q Would that request be considered a routine type of task for your group?

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A Yes.

Q Prior to your getting the equipment, the gas chromatograph/mass spectrometer, do you recall whether your group was ever requested to test a customer's effluent or a product for presence of PCBs?

A Not that I recall.

MR. FEATHERSTONE: When you say was the request from the business group with respect to Johnson Motors' sample a routine request, do you mean routine request at about that point in time?

BY THE WITNESS:

A I assume you were talking about that period of time we have been concentrating on, 1970.

BY MR. HYNES:

Q Right.

A Yes.

Q Were you ever involved within Monsanto with any meetings or discussions concerning labeling of PCB products?

A No.

Q Were you ever involved in or did you ever discuss the concept of sending out warning letters to customers who purchase PCB products?

A No.

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Q Were you ever involved in any meetings within Monsanto concerning a management plan in dealing with the PCB problem?

A Yes, from the analytical standpoint.

Q When was your first meeting as you recall with regard to management of PCBs within Monsanto?

A Approximately the same period of time.

MR. FEATHERSTONE: 1970?

THE WITNESS: 1970.

BY MR. HYNES:

Q What was your involvement in it?

A To assure proper analytical coverage needed for projects planned out of the Functional Fluids group and Medical Department.

Q In other words, in terms of decision-making suggestions, you were not involved unless it dealt with analytical techniques concerning presence, absence of PCBs and levels?

A Correct.

Q Were you ever involved with the Sales Department within Functional Fluids, the marketing group within Functional Fluids assisting them in anything dealing with PCBs other than the routine testing that you did?

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A No.

Q Were you ever involved in any work dealing with reclamation of PCB fluids?

A No.

Q Do you know as of today if the infrared spectrometer technique, the technique that is available today, is that capable of detecting PCBs?

MR. FEATHERSTONE: Objection, relevancy.

If you can answer that, go ahead.

THE WITNESS: Pardon?

MR. FEATHERSTONE: If you can answer it, go ahead and answer it.

Do you have the question in mind?

THE WITNESS: Could you restate the question?

MR. HYNES: Could you repeat it?

(Question read.)

BY THE WITNESS:

A Possibly detecting but not absolute identification.

BY MR. HYNES:

Q What do you mean by absolute identification?

A As to the exact chemical structure of the PCB.

Q The amount of chlorination, is that what you

mean by that?

MR. FEATHERSTONE: Position?

BY THE WITNESS:

A The position of the atoms in the chemical structure, the numbers, the types, their relative positions.

BY MR. HYNES:

Q Do you have an opinion as to when that technique was available or first available?

MR. FEATHERSTONE: You mean when today's technique was first available?

MR. HYNES: Yes.

MR. FEATHERSTONE: I object to the form of the question. Opinion as to when it was? Does he know when it was?

MR. HYNES: Fine.

MR. FEATHERSTONE: There is a difference.

BY MR. HYNES:

Q Do you know when it was first available?

A Today's technique is not that different from the technique existing years ago in the 1950s.

Q The ability to detect PCBs using today's technique which is, you say, similar to the one back in the '50s, when was there first a capacity to detect

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PCBs using infrared spectroscopy?

MR. FEATHERSTONE: In what kind of sample, environmental sample, in a known sample?

We have been through this this morning about the difference.

MR. HYNES: In an unknown sample.

BY THE WITNESS:

A The infrared doesn't have the capability of detecting, that is, identifying PCBs as chemical structures.

BY MR. HYNES:

Q Even today?

A Today.

Q If someone were tolook for PCBs, would they be able to detect it?

MS. OLIVER: Today?

MR. HYNES: Using the technology today.

MR. FEATHERSTONE: In a known or unknown sample?

MR. HYNES: No, I am saying if they were looking for it, if they don't know it was in the sample.

MR. FEATHERSTONE: Unknown sample.

BY MR. HYNES:

Q Is that what you mean by unknown sample, you are looking for it, you don't know what is in the

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sample. Is that what you meant by it?

A Yes.

Q All right.

A May I add to this for clarification?

The infrared then, back in the '50s, and today has capability for showing certain structures in chemical compounds.

It does not have the capability of putting these structures together and showing you what final chemical structure exists and if you move into complex mixtures, then it has no chance to demonstrate this.

MR. FEATHERSTONE: Complex mixtures such as PCBs?

THE WITNESS: PCBs.

BY MR. HYNES:

Q Do you know who Lou Stark is?

A Yes, I do.

Q Did Mr. Stark work for you at any point?

A No.

Q What was his position at Monsanto, if you recall?

A Group Leader in the Functional Fluids group.

Q That was not in your division?

A That was not in my area.

Q What was his function, do you recall?

MR. FEATHERSTONE: You have taken his deposition, Mr. Hynes.

MR. HYNES: You're right.

BY MR. HYNES:

Q Scott Tucker, did he work for you?

A Yes.

Q What was his position with you?

MR. FEATHERSTONE: Why don't you pick a year.

BY MR. HYNES:

Q 1970, did he work for you?

A Yes.

Q What was his position?

A He was group leader of the analytical group.

Q Was he involved in either the biodegradation study --

A Yes.

Q Was he involved in working on the water solubility study?

A Yes.

Q Was he involved in working on the tissue studies?

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A Yes.

Q Was it his group that he was a group leader, was it his group that was doing the work on these three studies?

A His group did a major part of the total effort, yes.

MR. HYNES: I don't have any more questions at this time.

MS. OLIVER: I just want to go through some of this material we went over.

MR. FEATHERSTONE: Let's take a short break.

(Brief recess had.)

CROSS EXAMINATION

BY MS. OLIVER:

Q Dr. Keller, my name is Roseann Oliver. I represent Outboard Marine Company in this litigation.

I have some questions and we are going to be jumping back around on some of the information you testified about earlier.

You earlier gave some examples of some articles that you wrote during your professional career with Monsanto. Have you prepared a list of your publications?

A I could develop a list.

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MR. FEATHERSTONE: The question is have you prepared one.

BY THE WITNESS:

A I have not prepared a list.

BY MS. OLIVER:

Q You talked earlier about starting at Monsanto as a research chemist in the Organic Chemicals Division. Was there a group within the division that you worked in?

A Yes.

Q What was the name of that group?

A It was Physical Chemistry group.

Q Were you in the Physical Chemistry group during your career?

A I started in the Physical Chemistry group as an analytical chemist first in the Organic Chemicals Division.

Q Actually during your period of time that you worked for the Smith, Klein Laboratory, the laboratory on the development of methods for analyzing pharmaceutical products, did you do any work on side effects of drugs or toxicological effects of drugs?

A No.

Q When you became a project leader in 1956 or

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thereabouts with Monsanto, was that in the Physical Chemistry section?

A Yes.

Q As group leader, you were in the Physical Chemistry Section?

A Yes. At that point we established the Analytical group. The Physical Chemistry group continued and it became a section at that point.

MR. FEATHERSTONE: Analytical group became a section or the Physical --

THE WITNESS: The Analytical group and the Physical Chemistry group together made up a section.

BY MS. OLIVER:

Q You were in charge of the Analytical group?

A Correct.

Q Were those groups within the Research and Development Section of the Organic Chemicals Division?

A It was a support unit within the Organic Division, Research and Development Department.

Q Before the seven years that you were head of the Analytical group, who did you report to?

A I reported to an assistant director of research.

Q And the assistant director of research was

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for the research group and in the Organic Chemicals Division?

A The assistant director was responsible for the section, made up of two groups: Physical Chemistry and Analytical Chemistry.

Q Who was that assistant director?

A Ralph Muench.

Q In about 1965 or so when you became the senior research group leader, that was still in the Applied Chemistry group?

A And Analytical Chemistry group.

MR. FEATHERSTONE: What is the amount of time, what is --

MS. OLIVER: Let me start over.

BY MS. OLIVER:

Q In about 1965 when you became senior research group leader, were you still in the Analytical group?

A Correct.

Q Did you report to --

A Correction to that. I was responsible for the Analytical group and I was both in it and responsible for it.

Q Did you still report to Dr. Muench as a direct supervisor?

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A There was a period there where I reported to another assistant director of research, resulting from reorganization of the Research and Development Department of the Organic Chemicals Division.

I am not sure just what year that occurred, what period that occurred, but it was about that period of time.

Q Who was that person?

A That would have been Harold Hubbard.

Q Would I be correct for the period 1968 to 1970 you and Dr. Richard were on parallel positions?

A Essentially, yes.

Q And your group did work for Dr. Richard's group as you were asked to do?

A He was our client, yes.

Q And the Medical group was also a client?

A Yes.

Q In the period before 1967 when you first learned about the reports of PCBs in the environment, could you tell me generally what types of projects were referred for work by the Medical Department?

A Prior to 1967?

Q Yes.

A Projects related to analytical studies,

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determinations of products of interest to our division, Organic Chemicals Division, which for some reason they needed out of their projects; whether it was toxicology or whatever, and I'm not sure. I cannot give you specifics beyond that.

Q Could you tell me generally what types of analytical work your group did for the Medical Department before 1967?

MR. FEATHERSTONE: Can you give us an example?

MS. OLIVER: That is what I am asking. Dr. Keller said he did support-type projects for the Medical Department as a client and I am just asking what types of projects were done.

MR. FEATHERSTONE: And he did analytical support-type projects.

MS. OLIVER: Yes.

MR. FEATHERSTONE: Can you remember anything specific?

THE WITNESS: Not specific enough that I would even want to use it as an example.

BY MS. OLIVER:

Q Would it be fair to say that most of the projects that came to you were from the business group rather than the Medical Department?

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A Correct.

Q When we talk about projects being referred to your group by the business group, we are talking about the Research and Development Section of the business group?

A Correct.

Q You mentioned that in 1971, you became manager of Applied Sciences group and you had responsibility for five different groups under you. The Organic Analytical group that you had responsibility for was the group that previously you had belonged to, is that correct?

A Yes, with comment that there was an internal reorganization within our own area of what we are referring to as Applied Sciences, so that we redistributed certain functions and prior to the five groups that you have referred to here known as Applied Sciences, we were divided into a spectroscopy group, analytical chemistry and environmental testing group, a physical chemistry group, instrument development group, applied math and computer sciences group.

Q So prior to 1971, the groups within Applied Sciences were the spectroscopy group, the analytical chemistry group --

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A Analytical chemistry and environmental testing.

Q The physical chemistry group?

A Right.

Q The instrument development group and applied math and computer sciences group?

A Correct.

Q Had those groups been in existence within Monsanto in St. Louis from the time you began working with Monsanto?

A The functions of those groups were in place. It was a matter of regrouping functions into the final five groups we called Applied Sciences.

Q When were those groups --

MR. FEATHERSTONE: Identifiable as such?

MS. OLIVER: Yes, prior to 1971.

BY THE WITNESS:

A Could you clarify those groups?

BY MR. OLIVER:

Q The spectroscopy group, et cetera, the groups that you mentioned.

A Those groups existed for approximately two to three years prior to the final formation of five groups known as Applied Sciences.

Q Before the two to three years before 1971,

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were there people within the analytical section who had responsibility for spectroscopy work?

A Yes.

Q Was there a person or persons within the analytical group who had that responsibility during the time you were with Monsanto from 1954?

A I had responsibility for that analytical group from the '50s to the point I became a section manager, and at that point I picked up responsibilities for the other groups, the physical chemistry, et cetera.

Q But my question is was there somebody within Monsanto who was responsible with respect to spectroscopy work?

A Yes.

Q To your knowledge, was there somebody with that responsibility from 1954 on?

A Well, the spectroscopy group didn't exist from 1954 on.

Q When did it come into existence?

A Approximately two to three years prior to my becoming a section manager.

Q When did the instrument development group come into existence?

A The function covered by that group and the

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group itself was established approximately 1957 or 1958.

Q And the function of the instrument development group was to develop instruments for use on Monsanto products?

A Correct, processes, custom instruments directed toward monitoring processes of the division, the Organic Chemicals Division, and custom instruments needed for research and development activities.

Q In about 1965, could you tell me who the group leader or head of that group was?

A The instrument development group?

Q Yes.

A Louis Fowler, F-o-w-l-e-r.

Q And the instrument development group is still in existence within Monsanto, is that correct, Dr. Keller?

A That is correct.

Q Who is --

A I will have to clarify. The Organic Chemicals Division had an instrument development group. The Inorganic Chemicals Division had a counterpart group. Upon formation of an operating company, these two groups were put together and made into one and continued

as part of Applied Sciences.

Q Who presently is head of the instrument development group?

A James Combs, C-o-m-b-s.

Q How long has he been head of the group?

A Approximately 20 years,with the first part of that being group leader of that group in the Inorganic Chemicals group.

Q Inorganic?

A Inorganic Chemicals Division. He shortly after combined the two groups with the Functional Industry Company, moved over as group leader of that group.

Q Is Mr. Fowler still with the company?

A He is deceased.

MR. FEATHERSTONE: Seance time.

MS. OLIVER: That's right.

MR. FEATHERSTONE: Federal rules provide for liberal discovery.

BY MS. OLIVER:

Q We have talked a lot today about the gas chromatograph/mass spectrometer and I think you testified that the gas chromatograph was available to be used since the early '60s.

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A Yes.

Q Your group had a gas chromatograph in the early '60s?

A Our group was instrumental in the United States of being the first in operation. Dr. Munch, the name I mentioned earlier, was the first to build a gas chromatograph in this country. Because of that, we have maintained a high expertise.

MR. FEATHERSTONE: The question was do we have one in the early '60s.

BY THE WITNESS:

A Yes.

BY MS. OLIVER:

Q Was a mass spectrometer available in the early '60s?

A To the Applied Sciences group?

Q Sure.

A No.

Q Do you know what use a mass spectrometer could be put to without the gas chromatograph being coupled with it?

A Yes.

Q What was its use?

A For study of organic structures of chemical

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compounds and certain simple mixtures; a technique used more extensively by the oil and petroleum products industry.

Q To your knowledge, when was the mass spectrometer available in the chemistry field?

MR. FEATHERSTONE: Which one, you mean in any form -- I mean it seems to get more sophisticated --

BY MS. OLIVER:

Q In any form.

A 1950s, possibly the 1940s.

Q The analytical group at Monsanto that you worked in did not have a mass spectrometer, is that correct?

A Did not have one.

Q For purposes of the work that was being done in the analytical group, it was not considered to be a helpful tool?

MR. FEATHERSTONE: Monsanto was not in the petroleum business.

MS. OLIVER: I am asking the question.

MR. FEATHERSTONE: He said it was used for the oil and petroleum products.

MR. HYNES: He said mainly used for that.

BY MS. OLIVER:

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Q It was not considered to be a helpful tool?

A It was not a common tool to analytical laboratories at that period of time.

Q Did it provide similar information that you would obtain from the gas chromatograph?

A No.

Q What are the differences in the information between a gas chromatograph and the mass spectrometer?

A The gas chromatograph separates chemical compounds into different fractions without identification.

A mass spectrometer will identify a chemical compound or in some cases simple mixtures as to chemical structure.

Q In the '60s or the '50s, was a mass spectrometer similar to an infrared spectrometer?

A No.

Q What is the difference between those two?

A Entirely different principles. The mass spectrometer takes a chemical compound, for instance, electron beams are impacted on this compound breaking it into parts. These parts are separated different ways, but for example, with a magnetic field, and it is these parts that are characteristic of the chemical

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structure.

Infrared, on the other hand, is dependent on putting a sample, the same compound in solution. The compound is not broken down or destroyed, but rather is left in solution and an infrared light of varying wave lengths will be put into the solution and the chemical structure by what they call vibration resonance of certain unique structures will absorb different wave lengths of that light.

The light that gets through is picked up on a record or chart and is a good indicator of the core of structures present, but it does not have the ability to put all the structures together and say here was the chemical compound in question, especially with mixtures and especially with unknown materials.

Q If I understand the principles correctly, it becomes more difficult to identify what you may have in a sample using the infrared spectrometer if the sample is a mixture of different compounds or chemicals, is that correct?

A Definitely.

Q For example, in Pydraul, which Pydraul A-200 to my understanding is a mixture of two different Aroclors, 1242 and 1248, would that complicate the

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identification of the detection of PCBs using an infrared spectrometer?

MR. FEATHERSTONE: Complicate over what?

MS. OLIVER: Complicate the ability or capacity to detect.

MR. FEATHERSTONE: You mean the fact that it is a product of two Aroclors?

MS. OLIVER: Yes, a mixture of two Aroclors.

BY THE WITNESS:

A The more components present, the more difficult it is to detect. In the example you gave, the infrared would, and I won't cover everything, but as an example, would be able to perhaps pick up that there is an aromatic 6-carbon ring. It might show a carbon chlorine chain, perhaps not much more than that, and from that point on, I can't tell you.

There would be considerable question about whether it was PCB, some other types of compounds containing those two structures I gave as examples.

MR. FEATHERSTONE: You don't know how it is put together?

THE WITNESS: That's right.

BY MS. OLIVER:

Q Would you be able to tell at least that much

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using a gas chromatograph?

A No.

Q So what you are saying is you would be able to tell less about the substance you are putting in or sampling?

A Correct.

Q Using the gas chromatograph?

A Yes.

Q Monsanto had a European office or offices in the '60s and the early '70s, is that correct?

A Yes.

Q Was there an analytical group in Europe that was comparable to your group in St. Louis?

A Yes.

Q In the '60s, did you work with that group in Europe on projects?

A We worked with projects occasionally.

Q I assume you would exchange information?

A When needed, yes.

Q Where was that group located?

A That was at our European plant in North Wales.

Q Do you know how long that group was in existence in Europe?

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A At least from the '50s.

Q You mentioned a group called the Monsanto Research Corporation which is a corporate research support arm. When was that formed?

A I don't know the answer to that; years ago.

Q During the time that you were in the Organic Chemicals Division, from 1965 to 1972 or '73, whenever the reorganization took place, who was the manager or head of that division?

MR. FEATHERSTONE: Of what division? Of Organic?

MS. OLIVER: Organic Chemicals.

MR. FEATHERSTONE: Over what period of time?

BY MS. OLIVER:

Q '65 to '73.

A The director of research and development.

MR. FEATHERSTONE: You want the head of the Organic Development or the Research Development?

MS. OLIVER: The Organic Development of the Chemicals Division.

MR. FEATHERSTONE: The whole division?

BY THE WITNESS:

A The name that I am quite sure was in place at that point as head of the division was Howard Minkler.

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BY MS. OLIVER:

Q Is he still with Monsanto?

A No, he is not.

Q Do you know when he left Monsanto?

A Approximately 1965.

MR. FEATHERSTONE: We have -- I am going to jump in.

The question was who was head of Organic Chemicals Division from '65 to '72. You named Howard Minkler and then you said he left in '65, but how can he be? Have you got his departure date wrong or the wrong fellow?

THE WITNESS: I am estimating the departure date and I am not clear in my own mind.

The period that Howard Minkler served, and my best recollection, he would have been here in place at that time, but I really cannot recall with certainty when he left.

MS. OLIVER: That's fair enough.

BY MS. OLIVER:

Q Do you recall any other person, the name of any other person who was in charge of Organic Chemicals Division beside Mr. Minkler?

MR. FEATHERSTONE: That information has been

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elicited at other depositions, Rose, and I suspect it is also in our interrogatory answers, so do the best you can but don't spend hours pausing.

BY MS. OLIVER:

Q If you don't recall, we are not going to sit here and wait for you to remember. If you do --

A I would not want to conjecture as this point.

Q You told us earlier that Monsanto obtained a gas chromatograph/mass spectrometer in late 1967 and it took several months to get it techniqued down and be able to use it.

How was the technique developed?

A Can you be a little more explicit on the how?

Q Sure. What did you do when it arrived to determine how it should be used or how it could be used?

A We embarked on a self-study program with members of our unit, Applied Sciences, to read, do anything possible on the part of the professionals involved to learn about it and get themselves up to speed.

Q Was there literature available?

A Yes.

Q That you read?

A Yes.

Q Do you recall the names of any articles or any publications or any literature that you read concerning the operation or use of the gas chromatograph/mass spectrometer?

A A key part of this was the manuals from the manufacturers which were provided, the instrument companies.

Q Were you able to buy one instrument that combined both of these units, or did you have to buy each one separately and then put them together yourself?

A We bought each separately and put them together.

Q Did you discuss or meet or communicate with any other chemists or scientists concerning what they might know about this instrument and how it could be used?

A As a matter of practice, we always do this. I cannot recall for you specifics of what we went into at that time.

Q You do not recall whether there were any other chemists or scientists in the United States in

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late 1967 that were aware of this technique and what Monsanto ought to do?

A Not that I am aware of. There were scientists recognized as experts in chromatography or mass spectrometry. We maintained constant competence in terms of state of the art with these two areas, but putting the two together was new enough simply because there were no instruments in this country, so that no one had the combined state of the art we could really go to.

Q Did you ever learn how the combination of these two instruments subsequently developed?

A Primarily as an opportunity through an instrument company to develop sales for a piece of equipment.

Q If you had been aware in 1965 that such piece of equipment were available, would you have recommended that Monsanto purchase it?

A It was our policy to be in the forefront on all skills in the analytical areas case.

Q You mentioned, I think, earlier this morning you believed it was the responsibility of all Monsanto scientists to keep abreast of developments, technological developments.

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Through the years, how have you done that?

A Constant reading of literature, but I must qualify that my role is more administrative/management function and I rely upon the professionals and the experts within the groups responsible for this to keep on top of it.

Q Would it be fair to say that in your position, you not only rely on them to keep abreast of new technology but you consider it their responsibility and their duty?

A Most definitely.

Q You also mentioned earlier that you and other people at Monsanto were concerned with the findings or reported findings of PCBs in the environment by Dr. Jensen and Dr. Widmark.

Why were you concerned?

A Because there had been no earlier indication that this existed. It was a complete surprise.

Q Was there anything about the chemical PCB that led you to be concerned?

A No more so than any of our other products that might be out in the environment.

Q When you purchased the gas chromatograph and

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the mass spectrometer, you mentioned you had to combine it, using an interface; it was a complicated step.

Why was it complicated?

A It required design of a system which would put two experimental instruments together which were operating on quite different experimental conditions, and secondly, the gas chromatograph has what is called carrier gas; for example, helium to move the components of interest through the chromatographic column and make the separations.

This carrier gas cannot be introduced directly into a mass spectrometer because of the amount of it relative to the material component being separated.

The big challenge was how to continuously introduce what comes out of the chromatograph into the spectrometer free of the carrier gas and that is the reason why it was necessary to come up with a suitable and so-called separator for removing of the carrier gas stream before introducing it. That part was a technical challenge.

Q Was the technical part of that done within Monsanto?

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A The technical part was done by several people: For example, Beeman who is a scientist involved with mass spectrometry and there was a Beeman separator. That is one of the earlier separators.

We acquired a separator of this general description which was then entering the marketplace at the time these GC/MS's were coming out and we had to physically ourselves put these three components together and make them work.

MR. FEATHERSTONE: Monsanto did not develop the separator?

THE WITNESS: We did not develop the separator.

BY MS. OLIVER:

Q But you developed the technology to put the units together. You did not go outside Monsanto to talk to other people or find out how other people put theirs together?

MR. FEATHERSTONE: You mean the hook-up, the instrument hook-up to the GC, the separator and the mass spectrometer?

MS. OLIVER: Right.

BY THE WITNESS:

A We had some communications with some others. Again, I don't recall the specifics of that, but it was

our main responsibility and challenge to do that and get the three together.

BY MS. OLIVER:

Q You purchased your units from a German manufacturer?

A Yes.

Q Do you recall the name?

A The instrument's name is MAT CH4-B mass spectrometer system, German instrument.

MR. FEATHERSTONE: That's because none were available in the United States?

THE WITNESS: Correct, for use with the gas chromatograph system.

BY MS. OLIVER:

Q When you went about finding a manufacturer to buy this unit from, what did you do to locate someone who could sell you a unit?

A It was our practice to know what U.S. companies could provide and in the way of instrumentation. We had a good reading on what mass spectrometers might be available. In our judgment the instrument we are talking about, the German instrument, was the instrument that should be used for gas chromatograph-mass spectrometer systems and through this, at about this point in

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time, an American company bought out the German company and the name of the American company is V-a-r-i-a-n, and I believe it is Varian Associates.

Q Did you buy your unit from Varian Associates?

A My best recollection is this was a change-over right at the point we were acquiring it and I think before we actually took delivery, Varian was the owner of that system, of that company.

Q Were there other units to look at and make a selection from?

A No.

Q Your Applied Sciences unit or Analytical Chemistry group worked on projects not only for Functional Fluids group, but other groups as well, is that correct?

A Correct.

Q Before 1967 you do not have a recollection of doing any projects on any of the Pydraul fluids for the Functional Fluids group?

A I think I responded to that earlier. It would only be through projects that would come in directly to our group and they would handle it and report out on it without my knowledge.

Q But to your knowledge, there would be none?

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A To my knowledge.

Q Prior to 1967, your Analytical Chemistry group had a gas chromatograph, is that correct?

A Correct.

Q You testified earlier that some of the plant manufacturing facilities had analytical laboratories.

Do you know whether gas chromatographs were in the manufacturing facilities?

A I know regarding some of the facilities, yes.

Q And the facilities that you have knowledge about, did they have gas chromatographs in their laboratories?

A At that period?

Q Prior to 1967.

A Yes.

Q Did your Analytical Chemistry group work on projects with the manufacturing facilities' laboratories.

A They could and did.

Q I think you testified that in about 1970, you did some analytical work on samples brought to you by the business group or the marketing group purportedly from Johnson Motors.

A Correct.

Q Was that the only analytical work with respect

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to Johnson Motors that you recall in the period prior to 1975?

A That is the only work that I have knowledge of.

Q Do you have any knowledge that that sampling was done as part of a program that Monsanto was trying to start on reclaiming Pydraul fluids?

A Yes, I am aware of it.

Q You are aware that Monsanto considered going into the business of reclamation of Pydraul?

A Yes.

Q And that was the reason, to your knowledge, why samples were being taken from Johnson Motors?

A To my knowledge.

Q If we can talk a couple of minutes about your trip to Europe in '69 when you visited a number of people -- when you visited Mr. Holden in Scotland and discussed with him his analytical work on pesticides, he told you he was finding PCBs interfering with his pesticide analyses, is that correct?

A Yes.

Q Did you discuss with him or did he tell you how long he had been doing that work?

MR. FEATHERSTONE: Pesticide work?

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MS. OLIVER: Yes.

BY THE WITNESS:

A He showed us results going back two or three years. How much he might have been involved prior to that, I don't know.

BY MS. OLIVER:

Q What results did he show you?

A Findings regarding levels of pesticides and where there would be apparent PCB interferences.

Q Had he identified the interferences as PCBs prior to 1969?

A To my best recollection, he had not identified. He was basing this on chromatographic findings.

Q Did you have the opportunity to look at his chromatographic findings?

A He showed us some chromatographic curves, yes.

Q Were you able to determine from those chromatographic curves the presence of PCBs?

A Not conclusively, no.

(Keller-OMC Deposition Exhibit No. 1 marked for identification, 5/28/81, TLU.)

BY MS. OLIVER:

Q Dr. Keller, I would like you to look at what

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we have marked as Keller Exhibit No. 1, which is a cover memorandum from you to a number of persons within Monsanto, referring to a summary of analytical findings, your European trip, May 1 to 21, 1970. Would you look at that a minute.

MR. FEATHERSTONE: Did you want him to read the entire document?

BY MS. OLIVER:

Q Can you identify this as being prepared by you, Dr. Keller?

A Yes.

Q Does this exhibit summarize your findings of your European trip which you discussed this morning?

MR. FEATHERSTONE: You discussed the 1969 trip?

THE WITNESS: Yes.

BY MS. OLIVER:

Q Is that the same trip you were talking about?

A No, it is not.

Q You made another trip?

A Yes, correct.

Q That was in May of 1970?

A Yes.

Q What was the purpose of that trip?

A A follow-up trip to visit certain ones later

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to determine progress made or changes relative to PCBs.

Q Did you talk to the same people in Europe that you had seen previously?

A Some of the same people. I would have to have an itinerary in front of me to be able to recall that.

Q Did Mr. Wheeler accompany you on the second trip?

A Mr. Wheeler accompanied me on one of the trips, either 1969 or 1970, and another Monsanto representative on the other trip.

Q Who was the other representative?

A A man by the name of Hardy.

Q What was Mr. Hardy's position with Monsanto?

A He was in the role of more of a special projects assignment person out of the London office.

Q If you would look at the second to the last page of this exhibit, the paragraph numbered 15, and just read that a minute.

A Yes.

Q It says:

"PCBs were found in fish in the waters of Scotland back to 1963 as shown by examination of

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old GC curves. No curves available for earlier years."

Do you recall how you learned that during your trip to Europe?

A This was through the visit with Holden.

Q This was your second visit with Mr. Holden?

A Yes.

Q Did he show you gas chromatograph curves dating back to 1963?

A Yes.

Q How is it determined that they showed PCBs?

A This is paraphrasing of what he said was there, okay?

Q Yes.

A And, again, it is the interferences to the chromatograms for pesticides.

Q Did he tell you how he made a determination that these were PCBs?

A I don't recall that he discussed that again. I think I commented that to my best recollection he used only chromatographic methods for this work.

Q Did you discuss with him whether his findings were accurate or not?

A Relative to?

Q Relative to his findings of PCBs.

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MR. FEATHERSTONE: You mean his claims. We have already established you cannot establish PCBs identification from a gas chromatograph alone.

MS. OLIVER: Apparently Mr. Holden thought he could.

MR. FEATHERSTONE: Is that a claim?

MS. OLIVER: Sure, call it a claim.

MR. FEATHERSTONE: Just like your complaints.

BY THE WITNESS:

A It was not my impression that Mr. Holden was claiming that he had identified conclusively PCBs. He was relating to findings of Widmark and Jensen who said we have identified certain interferences that look like this in chromatograms as PCBs.

This prompted him to go back, get his early chromatograms and say, I guess I see some of the same interferences; therefore, I've got PCBs.

MR. FEATHERSTONE: So he was looking back at 1959/1963 chromatograms. He was looking at them in the late '60s, is that right?

MS. OLIVER: I am going to object to the question, Mr. Featherstone. Mr. Featherstone can ask Dr. Keller questions at his opportunity.

MR. FEATHERSTONE: Answer my question, please.

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THE WITNESS: I had two questions come here. Could you repeat --

MR. FEATHERSTONE: Is this Holden analysis of 1963 GC curves an analysis he made in later analysis?

MS. OLIVER: Same objection.

MR. FEATHERSTONE: I will ask it later. Go ahead.

We can play games, go ahead.

MS. OLIVER: Okay.

BY MS. OLIVER:

Q Do you recall any further discussion with Mr. Holden about the gas chromatographs that you and he looked at on this trip in May 1970?

A No. We really didn't get into equipment or methodology specifics.

Q You mentioned earlier this morning that you met Mr. Richardson in 1969 and you discussed with him his analysis of materials for pesticides and interferences that he found, is that correct?

A Correct.

Q Do you know when he began his work on analyzing materials for pesticides and finding those interferences?

A The best I could do on that would be a few

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years earlier ahead of our visit.

Q And your visit to the University of Utrecht in 1969, you discussed with them their findings of PCBs in the Rhine and Netherlands, is that correct?

A Correct.

Q Do you know when they began their work which led to these findings?

A In their laboratories.

Q In their laboratories?

A Again, it was my impression it was a matter of a very few years ahead of our visit.

Q During that same trip in 1969, I think you testified that you had discussion with Dr. Widmark about their possible sources of PCBs that he was reporting and he thought that PCBs were coming from paint, from paint on ships?

A Yes.

Q Can you recall, Dr. Keller, Mr. Wheeler and you discussing any possible sources with Dr. Widmark?

MR. FEATHERSTONE: The question has been asked and answered.

BY THE WITNESS:

A No.

BY MS. OLIVER:

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Q You described for Mr. Hynes the non-routine projects which the Analytical group did regarding PCBs in the period 1969 to 1973.

What were the routine projects that were done by your group regarding PCBs during that period?

A This was in the category of where we had established suitable gas chromatography/mass spectrometry methods and felt confident enough to go ahead and start using those on certain materials such as water, effluent discharges, et cetera.

Q Do you know how it was determined where the samples were to be taken from for you to do your analytical work?

A No.

Q Do you know what group was responsible for making that determination?

A That would be through the business group.

Q You would just receive the samples, I take it?

A Correct.

Q With respect to the work you did for the Medical Department in measuring levels of PCBs in test animals, do you know if any outside groups did

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the same type of work as the Analytical group was doing?

A You are speaking of Monsanto projects?

Q Yes.

A Not to my knowledge.

Q So to your knowledge, the testing would be done by Industrial Bio-Test and the tissues of the animals would be sent to your group and you would analyze for the PCB level and return them to Bio-Test?

A No, no -- correction on the latter part of that. You are speaking of results when you say return to?

Q No.

MR. FEATHERSTONE: The question was what happens to the tissues. Did you return the tissues to Bio-Test? That is the way I understand her question.

BY THE WITNESS:

A To the best of my recollection, we did not return the tissue to Bio-Test.

BY MS. OLIVER:

Q Do you know what happened to the tissues when you had done your analyses?

A The group in Applied Sciences disposed of these tissues and I am not prepared to say how they did this except to say it was not considered to be a

problem because all the PCBs had been removed from the tissues.

Q In the biodegradation studies conducted on PCBs, was the methodology that you followed of using semi-continuous sludge and feeding an organism into it and periodically charging it with whatever you are going to measure for 48 or 24-hour period an accepted methodology?

A Yes.

Q For biodegradation studies?

A Yes.

Q What was the methodology available prior to 1969?

MR. FEATHERSTONE: We have already been through this. We are not going to answer it again now.

MS. OLIVER: I am not speaking in terms of PCBs. I am speaking of generally the methodology available for biodegradation studies.

MR. FEATHERSTONE: He has already testified to that.

MS. OLIVER: I am talking about the entire methodology --

MR. FEATHERSTONE: And he has already testified to that.

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MR. FEATHERSTONE: He has already testified to that.

MS. OLIVER: I am talking about the entire methodology --

MR. FEATHERSTONE: And he has already testified to that.

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MS. OLIVER: You are not going to let him answer that question?

MR. FEATHERSTONE: That's right.

MS. OLIVER: Certify the question.

BY MS. OLIVER:

Q Dr. Keller, would the rate of biodegradation that you would find vary depending on the type of substance, the material that you used? For example, if you used stream water instead of semi-continuous sludge, would you expect the rate of biodegradation to change?

A Yes.

Q In your water solubility tests that you conducted regarding PCBs, the methodology that you used was to inject the PCBs into water at 25 degrees Centigrade or room temperature?

A Correct.

Q Was there a standard methodology for a water solubility test?

A Yes.

Q Was that methodology available prior to 1969?

A For what types of materials?

Q For making a determination of water solubility of any chemical or compound?

A The methodology would have had to have been research. It was not available.

Q For PCBs?

A For PCBs at levels we are talking about, part per billion levels in water.

Q Am I correct that to your knowledge no bio-degradation studies or water solubility studies were undertaken or attempted within the Applied Sciences group of Monsanto prior to 1969 or 1970 for PCBs?

A Correct.

Q Dr. Keller, were you a member of an internal committee that was established to work on the PCB problem or the PCB claims thatarose in the late 1960s, early 1970?

A I was a member of a committee concerned, where my role concerned the analytical parts of certain projects, if that is what you may be referring to.

Can you be more specific as to the committee?

Q Well, for example, was there an informal, at least, committee within Monsanto to discuss and work on the various aspects of the PCB problem which had been reported?

A To my knowledge, that covers an awareness

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that there were representatives from the business unit, Medical Department and my operation to put together whatever was needed. I never viewed this as a committee, even informal.

Q Were there meetings within Monsanto that you attended concerning the various aspects of the PCB reported findings?

A We communicated orally and certainly there were meetings where that was done, yes.

Q Did you participate in any fish toxicity tests done at Monsanto regarding PCBs?

A No.

MS. OLIVER: Let me have a minute.

(Brief recess had.)

BY MS. OLIVER:

Q Dr. Keller, in 1970 when you were section manager of the Analytical and Physical Instrument Development Section, who did you report to?

A Dr. Tracy Patrick.

Q What position did he have with Monsanto?

A Associate Director of Research.

Q In 1971 when you became Manager of Applied Sciences, did you continue to report to Mr. Patrick?

A Yes.

Q You mentioned earlier a group called Environmental Test. When did that come into existence at Monsanto, to your knowledge?

A I believe we covered that in the earlier testimony as to the time frame for that analytical chemical and environmental --

Q Two or three years before you became manager of Applied Sciences?

A Yes.

Q There was no such group that did environmental testing before 1968 or so?

A This can be best clarified in that it was still the Analytical group but had been extended to include biodegradation and related activities.

Q I see.

Before 1968 or '69, did your Analytical group do analyses of effluent from Monsanto facilities for environmental purposes?

MR. FEATHERSTONE: I am sorry, the time frame of your question?

MS. OLIVER: Before 1968, '69.

BY THE WITNESS:

A As a general thing for any products?

BY MS. OLIVER:

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Q For any products.

MR. FEATHERSTONE: Wait a minute. What does any product have to do with this? Is your question directed to PCB analysis in the Monsanto plant before 1969?

MS. OLIVER: Dr. Keller said there was no, to his memory, PCB analysis before 1968, '69, so I am asking about environmental testing.

MR. FEATHERSTONE: For anything?

MS. OLIVER: For anything.

MR. FEATHERSTONE: How is that relevant to the lawsuit?

MS. OLIVER: Can he answer the question?

MR. FEATHERSTONE: Not unless you convince me it is relevant.

MS. OLIVER: I am not going to convince you it is relevant. If you want him to answer, let him answer. If you don't want him to answer, then direct him not to answer. Let us not talk about how relevant it is.

MR. FEATHERSTONE: Fine, he is not going to answer.

MS. OLIVER: Certify the question.

BY MS. OLIVER:

Q To your knowledge, Dr. Keller, before 1968,

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was there any group within Monsanto who did any type of analytical work with respect to environmental considerations for customers of Monsanto?

A Yes.

Q What group was that?

A Again, you are saying any type of analytical work?

Q Yes.

A As a customer support?

Q Yes.

A For any types of products?

Q Yes.

A Yes.

Q Are you aware of analytical work done by Monsanto for customers or of functional fluids with respect to environmental considerations prior to 1968?

MR. FEATHERSTONE: These are PCB functional fluids?

MS. OLIVER: Functional fluids.

MR. FEATHERSTONE: Limit your answer to PCB functional fluids.

BY THE WITNESS:

A On PCB functional fluids, no.

MS. OLIVER: I am not limiting the question to

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analytical work for PCBs because I think you have answered that before. I am talking about any environmental work regarding water pollution or environmental work regarding water pollution for Monsanto customers of functional fluids.

MR. FEATHERSTONE: And read that to be PCB functional fluids.

MS. OLIVER: PCB functional fluids, but not limited to analyses for PCBs.

MR. FEATHERSTONE: Fine.

BY THE WITNESS:

A The answer is no.

BY MS. OLIVER:

Q Doctor, would you look at Exhibit No. 1 that we have marked.

Was that prepared by you after your trip to Europe in 1970?

A Yes.

Q Was that prepared by you in the ordinary course of your business?

A Yes.

Q Was that prepared on or about the date of the memorandum?

A Yes.

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MS. OLIVER: I don't have anything else.

MR. HYNES: Do you want to go first? I have two or three questions.

MR. FEATHERSTONE: Go ahead.

DIRECT EXAMINATION (Resumed)

BY MR. HYNES:

Q Dr. Keller, in terms of the inability technically to detect PCBs in any substance in the environment that would be analyzed prior to, say, 1967, 1968, was it any concern to you or your group that there was an inability to detect PCBs in a substance, that you didn't have a technology to do it?

Was it ever a concern to you?

A There was never a need for it.

Q Was it a concern that there were other substances you would be unable to identify because of the lack of technology prior to 1967, '68 --

MR. FEATHERSTONE: Wait a minute. Could I have the question back?

MR. HYNES: Let me do it again.

BY MR. HYNES:

Q What I am getting at is were you unable to identify PCBs or any scientist was prior to this new technology, I think that is what we said. Was it a

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concern within your group that there was an amount of chemicals, an amount of compounds that you would not be able to identify because of the lack of technology?

MR. FEATHERSTONE: He just answered that with respect to PCBs.

MR. HYNES: I am talking about other compounds, other than PCBs.

BY MR. HYNES:

Q Was there a concern there with your inability to identify them?

MR. FEATHERSTONE: Unknown samples?

MR. HYNES: Yes.

BY THE WITNESS:

A We were always concerned as information was needed of that type.

BY MR. HYNES:

Q With members of your group or any other research groups within Monsanto, was it a part of their function to research and develop new technology other than for the internal control use like you said that one division was in the plant?

A Yes.

Q Was that group within the one you worked in?

A Could we clarify what group this is?

Q What I am talking about is the Applied Sciences group, make it the Research and Development group within the Organic Chemicals Division. I think that would have been the group that you would have worked in throughout your career at Monsanto, if I am correct.

A Correct.

Q Would any research within the Research and Development group of Monsanto, is there any entity or unit there set up on developing research, on developing analytical equipment?

A Other than Applied Sciences?

Q Were there any other divisions or groups within Monsanto who had that function?

A The one I testified earlier on the Physical Sciences Center.

Q Would they be the group that would assume that Monsanto developed this new technology about GC/MS, would that have been the group that would have developed it within Monsanto?

MR. FEATHERSTONE: Objection to the question.

MR. HYNES: If it had been developed within Monsanto, would he have developed it?

MR. FEATHERSTONE: You can go ahead and answer

the question.

BY THE WITNESS:

A It could have been developed by any of the groups we have discussed. Again, it would come back to a need basis.

BY MR. HYNES:

Q In other words, if someone within Monsanto, some group within Monsanto said we need to identify compound X, go develop some technology to do it, that is how it would come back, other than just pure research, come upon it in a laboratory and just working on it?

A Yes, right.

MR. FEATHERSTONE: I take it assuming Monsanto had the capabilities?

THE WITNESS: Yes, pure technology.

BY MR. HYNES:

Q You said with regard to the Widmark-Jensen article that you were surprised of their results because there had been no earlier indication that PCBs were in the environment, is that correct?

A Correct.

Q Was your surprise at the results, the ability of Widmark and Jensen to actually identify PCBs, or was

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it surprise there were PCBs within the environment?

A My first interest, and I wouldn't necessarily say it was surprise but interest, was their capability to make determinations of this type with the GC/mass spectrometer system.

Q I think you used the word surprise, but was your surprise the fact that there was technology out there but you didn't know about it before?

A Surprise may not be the right word.

Q Impressed?

A Impressed.

Q You earlier said that, paraphrasing, Monsanto took pride in having top technology available to it in their laboratories and research. Do you recall any discussions within Monsanto where you were present or heard about where somebody got called on the carpet because you didn't know about that technology that these Swedes had for at least a year or so before the article was published?

A No.

Q Prior to 1967, the technology being developed at the GC/MS, would a competent chemist in running analysis of a product, of some sample, using a gas chromatograph, would they be, am I correct, they would

find some unknown peaks, assuming PCBs were in this substance and they don't know PCBs were there, would they find some unknown peaks identifiable, is that correct?

A Correct.

Q Would that chemist be able to make an educated guess that these were PCBs given no other information?

A No.

Q If the chemist suspected PCBs were in the substance which was being analyzed, would they be able to guess that was PCBs but not really definitely be able to say that it was?

MR. FEATHERSTONE: I'm going to object to the form of the question.

MS. OLIVER: I'm going to object, too, calling for speculation.

MR. FEATHERSTONE: Yes.

BY THE WITNESS:

A That's what it would be, a guess.

BY MR. HYNES:

Q It would be a guess?

To your knowledge, did anybody guess like that prior to, did you ever see any published

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report or opinions at some of these symposiums that someone said these might be PCBs but we can't tell?

A Not prior to Widmark and Jensen.

MR. HYNES: I don't have anything further.

MS. OLIVER: Could I ask one?

MR. FEATHERSTONE: Yes.

CROSS EXAMINATION (Resumed)

BY MS. OLIVER:

Q In trying to identify these peaks on these gas chromatographs as PCBs, am I correct that the peaks depending on the mixture or the compound could move to different locations on your graph?

MR. FEATHERSTONE: Do you understand that?

THE WITNESS: I would like a little more clarification.

BY MS. OLIVER:

Q Now I am in trouble.

MR. HYNES: You mean just using the GC, not the mass spectrometer?

MS. OLIVER: Right.

BY MS. OLIVER:

Q Reading the gas chromatograph, my understanding is that it gives you some peaks that you could look at and whether you were able to identify what

those peaks are or not is a question, I guess, is that right?

A Correct.

Q Depending on the mixtures or the chemicals that you are analyzing, would, for example, the PCB peaks move into different ranges of the graph depending on the different mixtures or different isomers of PCBs that are in that compound you are analyzing?

A Yes.

Q That would further complicate the identification, is that right?

A Yes.

Q Would that problem exist in the IR spectrometer?

A Of the same general nature, but for different reasons.

Q But it would still cause a confusion in reading?

A Yes.

MS. OLIVER: I don't have anything else, thank you.

MR. FEATHERSTONE: I have two questions.

CROSS EXAMINATION

BY MR. FEATHERSTONE:

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Q Doctor, you testified that taking an unknown sample, unknown chemicals, an analytical chemist using a gas chromatograph alone could not determine the presence of PCBs in that sample, is that correct?

A Correct.

Q Why is that?

A Because it is not an absolute method for determining chemical structure.

Q My understanding of a gas chromatograph is that it prints out, if you will, a fingerprint or chromatograph off the components, is that correct?

A Correct.

Q From the peaks that counsel have referred to in their questions, can you tell from a particular peak on that chromatogram what the component is?

A No.

Q What does the peak tell you?

A The peak tells you that you have one or more components under that peak.

Q You say one or more components. I take it from that that a peak doesn't necessarily refer to one component.

A Correct.

Q Can you tell from just looking at the

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chromatogram itself or one peak on the chromatogram how many components a peak refers to?

A No.

Q So it could be two, three, four, five?

A Any number.

Q Since you cannot tell from a peak on that chromatogram what the component is, I take it the gas chromatograph does not completely separate all compounds in a sample.

A Correct.

Q Is it true that chlorinated hydrocarbons and other compounds that are not chlorinated hydrocarbons may be contained under the same peak?

A Very possible.

Q And that is why you cannot tell from a chromatographic peak or chromatogram itself why something is not a chlorinated hydrocarbon?

A Correct.

Q For that purpose, you used the mass spectrometer hooked up to it?

A Yes.

Q Doctor, you were examined to some extent or at some length about the infrared spectrometer, is that the proper instrument?

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A Correct.

Q You testified that a sample analyzed by use of that piece of equipment with a PCB sample would show perhaps an aromatic compound on a carbon hydrogen bond, is that correct?

A A carbon chlorine bond also, perhaps.

Q Why couldn't you tell from that readout, if you will, what the compound is?

A Because a mixture of materials where the chemical structures would use these examples you mentioned in different ways than the structures could not be identified as to components.

Q Is it fair to say then the readout you would get from the infrared spectrometer shows you the various components but doesn't, if you will, draw a picture as to how they are put together?

A Correct.

Q And you need that picture to be able to tell you what the structure is?

A Correct.

Q And therefore, what the chemical is?

A Correct.

Q Doctor, has Monsanto anytime in the '60s before it purchased the separator unit that was used

to join the gas chromatograph and the mass spectrometer internally developed such a separator unit?

A No.

Q Do you know of anybody of any expertise in Monsanto that could have developed such a unit?

A No.

Q Doctor, I want to show you what was marked as Exhibit 1 to your deposition and I want to direct your attention to what counsel for OMC showed you earlier, which is a paragraph numbered 15 which you have identified pertains to a conversation you had with, I guess it is Dr. Holden?

A Correct.

Q Did Dr. Holden tell you that in 1963 when he was doing his research and obtained a gas chromatograph printout in 1963 when he identified interference in those printouts, did he tell you that in 1963 he identified those interferences as PCBs?

A No.

Q When did he tell you that he thought those interferences were PCBs?

A After the Widmark-Jensen work.

Q So that he was, by going back to his old chromatographs, pulling them out and looking at them

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again?

A Correct.

Q Doctor, you stated that in the late 1960s, early 1970s, you made it a practice to generally follow the literature in your field.

Were you following at that time the literature published by analytical chemists reporting or claiming to report the presence of PCBs in the environment?

A Yes.

Q Were these reports published reports identifying the higher chlorinated isomers in the environment?

A Yes.

Q You testified earlier that you had this European trip, in fact, your trips in which you met with analytical chemists. Were the analytical chemists that you met with in 1970 also reporting finding the higher chlorinated isomers, that is, five chlorine atoms or more, than they had been in 1969?

A Yes.

Q Did you have discussions, Doctor, either formally or informally with other than analytical chemists during the European trips, and that would be analytical chemists outside of Monsanto?

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A Other than those on the European trip?

Q Yes.

A Yes, we always maintained communication with analytical chemists.

Q And did these analytical chemists in the late '60s, early 1970s, tell you what isomers or PCBs they were finding, if any?

A Yes.

Q Which were they?

A The high chlorinated PCBs, five chlorine and higher.

Q Doctor, when you say higher chlorinated isomers with the five chlorines and above, is that a particular Aroclor and higher, does that convert to a particular Aroclor?

A No.

Q Are there certain Aroclors that do not have five chlorine atoms among their isomers?

A Yes.

Q Which are those?

A The lower chlorinated products.

Q Such as 1242?

A Yes.

Q Doctor, you testified that in 1968 Monsanto

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was developing methodology for the use of a gas chromatograph/mass spectrometer unit that had been purchased.

Did different methodologies have to be developed for different types of samples?

A Yes.

Q Did you do a different methodology for a soil sample as opposed to a water sample, for instance?

A Each one was a separate project.

Q When you say each one, does that include an air sample?

A Yes.

Q Sludge?

A Yes.

Q Animal tissue sample?

A Yes.

MR. FEATHERSTONE: I have no further questions.

MR. HYNES: I have one, I think maybe two.

REDIRECT EXAMINATION

BY MR. HYNES:

Q With regard to your biodegradation studies which you did or the work you did on biodegradation, did you know of any groups or persons outside Monsanto which attempted to verify or duplicate your study?

A What period?

Q Any period subsequent to your study.

A I don't have personal knowledge of work of this type. I suspect work was done, but it is conjecture.

Q You suspect work was done but you have never seen the published results or discussed it with anyone who did it, yourself?

A Personally, I have not.

Q Do you know of anyone in Monsanto who has mentioned it to you?

A No.

MR. HYNES: Thank you.

RECROSS EXAMINATION

BY MS. OLIVER:

Q Dr. Keller, do you have any reason to believe that the results of your biodegradation studies in 1970 were inaccurate in any respect?

A No.

MS. OLIVER: I don't have any further questions.

REDIRECT EXAMINATION (Resumed)

BY MR. HYNES:

Q Doctor, you testified that your Analytical group did water solubility testing in 1969. Were

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the water solubility characteristics of PCBs and Aroclors at Monsanto known at Monsanto prior to the time of your study?

A Yes.

Q How was that known?

A Well, practice of any of our research chemists and scientists developing new products, processes, to know solubility properties of the products and materials, reactants.

Q And the tests that you did in 1969, were those to develop the low level solubility analysis that you needed to do with the biodegradation tests?

A Yes.

MR. HYNES: I have no further questions.

MS. OLIVER: No questions.

MR. HYNES: Thank you.

(Witness excused.)

FURTHER DEPONENT SAYETH NOT. . .

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IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNITED STATES OF AMERICA,	)	
	)	
Plaintiff,	)	
	)	
vs.	)	No. 78 C 1004
	)	
OUTBOARD MARINE CORPORATION AND MONSANTO COMPANY,	)	
	)	
	)	
Defendants.	)	

I hereby certify that I have read the foregoing transcript of my deposition given at the time and place aforesaid, consisting of Pages 1 to 225, inclusive, and I do again subscribe and make oath that the same is a true, correct and complete transcript of my deposition so given as aforesaid, as it now appears.

_____
Robert E. Keller

Subscribed and sworn to
before me this ____ day
of _____, A.D. 1981.

_____
Notary Public.

Thea L. Urban
Certified Shorthand Reporter
134 South La Salle Street
Chicago, Illinois 60603

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UNITED STATES OF AMERICA)
NORTHERN DISTRICT OF ILLINOIS)
EASTERN DIVISION) SS:
STATE OF ILLINOIS)
COUNTY OF COOK)

I, Thea L. Urban, a notary public in and for the County of Cook and State of Illinois, do hereby certify that ROBERT E. KELLER was by me first duly sworn to testify the whole truth and that the above deposition was recorded stenographically by me and was reduced to typewriting under my personal direction, and that the said deposition constitutes a true record of the testimony given by said witness.

I further certify that the reading and signing of said deposition was not waived by the witness and his counsel.

I further certify that I am not a relative or employee or attorney or counsel of any of the parties, or a relative or employee of such attorney or counsel, or financially interested directly or indirectly in this action.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my seal of office at Chicago, Illinois, this ____ day of June, A.D. 1981.

Notary Public, Cook County, Illinois.
My commission expires May 31, 1983.

Thea L. Urban
Certified Shorthand Reporter
134 South La Salle Street
Chicago, Illinois 60603

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