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IN THE UNITED STATES DISTRICT COURT

FOR THE WESTERN DISTRICT OF TENNESSEE

EASTERN DIVISION

WOODROW STERLING, et al,)

Plaintiffs,)

vs.) NO. 78-1100

VELSICOL CHEMICAL CORPORATION,)

Defendant.)

TRANSCRIPT OF THE EVIDENCE

VOLUME LVIII

SEPTEMBER 20, 1983

DEC 20 '87

I N D E X

E X H I B I T S

NUMBER	IDENTIFICATION	EVIDENCE
497	8747	8750
499	8756	8756
500	8758	8758
501	8762	8762
502	8763	8763
503	8764	8764
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505	8786	8790
506	8812	
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508	8861	

TUESDAY MORNING

SEPTEMBER 20, 1983

The trial of this case resumed on this date, Tuesday, September 20, 1983, at 9:40 o'clock a.m., when and where evidence was introduced and proceedings had as follows:

THE COURT: I have said good morning, everybody, so long, and it is in the record so many times, that I am just going to say good morning.

THE LAWYERS: Good morning.

THE COURT: All right, Mr. Gentry.

MR. GENTRY: Thank you, Your Honor. This morning we have a witness who was on briefly before the Court in January. He has been sworn. I will call him to the stand. Dr. Harbison.

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9-20-83

RAYMOND D. HARBISON,

having been previously sworn, was examined and testified further as follows:

DIRECT EXAMINATION
BY MR. GENTRY:

MR. GENTRY: If the Court pleases, we will voir dire Dr. Harbison on other areas of expertise other than that which he was qualified in January, which was toxicology.

THE COURT: All right, sir.

MR. GENTRY: He is also, we believe, an expert in other areas. I would proffer his previous CV to the Court.

Q. Dr. Harbison, it has been quite some time since you were on the stand before. Tell us your full name, if you will, please, and where you live?

A. My name is Raymond D. Harbison, and I live in Little Rock.

Q. We have previously established that one of your disciplines is toxicology. Tell us a little bit about that. Where are you as a toxicologist?

A. I am the Director of the Division of Inner-Disciplinary Toxicology at the University of Arkansas School for the Medical Sciences, and I am in the Inner-

Disciplinary Toxicology Program between the medical science campus and the National Center for Toxicology Research.

Q. What is the National Center for Toxicological Research?

A. The National Center is a Congressionally mandated facility, which was established approximately ten years ago, and the purpose of the National Center is to conduct mission oriented research in the area of toxicology to resolve or solve national problems that arise regarding chemicals, drugs and other substances.

Q. Tell me how that works as a practical matter? Tell me what questions you are asked, where are you asked, where the questions come from, who generates the questions?

A. The questions can be generated by Congress, by the National Institutes of Health, by the National Toxicology Program, and the questions that would be asked are is the substance a cancer-causing agent, or might it have a potential for causing birth defects, or might it be a mutagenic material or what the inherent toxicological properties of the material might be.

Q. Are the national laboratories to which you are referring and the laboratories of the University of

Arkansas School of Toxicology the same laboratories?

A. Well, they are physically separated, and, no, they are not the same laboratories. They are different.

Q. You wear two hats then?

A. That is correct.

Q. Let's talk in terms of the University School of Toxicology first. What kind of programs do you have at that particular school?

A. The toxicology program at the University serves several functions. One of our missions is education. We have a graduate training program in which we have about fifteen to twenty students who are seeking degrees in toxicology.

Q. Are those doctoral degrees or something less than that?

A. They would be a person seeking a doctoral degree.

We also serve the educational function of training physicians in the area of toxicology, and we also serve as a consulting function for the personnel of the medical center in cases where there might be suspicion of poisoning or unusual incidences in which there might be some need to have extra information or a resource to help treat these patients.

Q. This is at the University as opposed to the National Laboratory?

A. That is correct.

Q. Do you serve the EPA at the University?

A. Yes, I do.

Q. In what manner?

A. At the University I run a medical monitoring program for the United States Environmental Protection Agency, and I also provide a technical toxicological report service for the agency, for its contractors who are involved nationally in the investigation of hazardous waste sites, and the way it works is that we perform pre-employment examinations on the hazardous waste site workers. We also do an annual surveillance of hazardous waste site workers, and we provide toxicological information when it is needed for the investigation of the sites or for any problems that might arise regarding chemical contamination of personnel who are involved in waste site investigations.

Q. As head of the School of Toxicology at the University of Arkansas Medical School, do you or do you not teach med students?

A. Yes, I do teach medical students.

Q. What do you teach them?

A. I teach them the basic principles and concepts

of toxicology. I teach them about chemicals and the effects that chemicals can have and generally prepare them for the diagnosis, treatment and management of any chemicals which might induce some ailment.

Q. I want to digress one minute. You have already testified to this, but briefly give us your educational background?

A. I received a Doctorate in Toxicology at the University of Iowa in 1969. Prior to that, in 1965 I received a Bachelor of Science Degree in Pharmacy from Drake University. I subsequently was hired by Tulane Medical School, where I was on the faculty from 1969 until 1971, and in 1971 I went to Vanderbilt Medical Center, where I was in the Division of Clinical Pharmacology and Toxicology until approximately 1981, when I was recruited to the University of Arkansas for Medical Sciences.

Q. What is the discipline pharmacology?

A. Pharmacology is one of the basic sciences of medicine, and pharmacology is a study of the effects of drugs, the design and development of drugs and the testing of drugs for their efficacy in the treatment of diseases.

Q. Is your Ph.D. both in pharmacology and toxicology?

A. Yes, it is.

Q. Are you a registered pharmacist?

A. Yes, I am.

Q. Have you taught pharmacology before?

A. Yes. I have taught pharmacology for the past decade at Tulane Medical School as well as Vanderbilt.

Q. If one is a pharmacologist, does one need to know how the body metabolizes various drugs?

A. Yes. It's essential that one does that, because the length of action and the effects that drugs have on the body are generally dependent upon their metabolism.

Q. What is a teratologist?

A. A teratologist is one who studies the production of birth defects or studies of the causes of birth defects.

Q. What experience do you have in the field of teratology?

A. Well, the thesis that I prepared for my doctoral degree was in the area of teratology, and I described the geratogenics of the anticonvulsant Diphenylhydantoin, and generally described the effects that this drug had on the developing embryo and fetus. Since that time, I have been funded for approximately the past twelve years by the

National Instutite of Health to look at the effects of chemicals and environment pollutants on perinatal development, which is the development that occurs before birth and shortly thereafter.

Q. Just as a ballpark figure, how many funds have you received from the National Institute of Health?

A. A dollar amount?

Q. No, numbers.

A. Numbers of grants?

Q. Yes.

A. I would estimate somewhere around a dozen.

Q. What is the National Institute of Health?

A. The National Institute of Heatlh -- the National Institutes of Health -- there is more than one Institute of Health -- are those institutes which are part of the United States Public Health Service whose mission it is to describe and to research various diseases and causes of diseases and to report on those causes and develop cures for those diseases and treatments.

Q. Are you also an editor of a paper or magazine that deals with teratology?

A. Yes. We call it a journal rather than a magazine-- but, yes, I am.

Q. How often does it come out?
A. I believe it is published about every two to three months.
Q. And what is the name of that journal?
A. The name of the journal is Teratogenesis, Mutagenesis and Carcinogenesis.
Q. How long have you been editor of that journal?
A. I am not the specific editor, but I am on the editorial board -- for about the past three or four years.
Q. Is that a fairly widely distributed journal?
A. Yes, it is.
Q. Are you a writer?
A. Yes, I am.
Q. Tell me what you produce as far as writing is concerned?
A. Well, I have written approximately 85 to a hundred papers, chapters in books, during the past ten or twelve years. They have been all in the field of toxicology and pharmacology and some of those have been specifically in the subspecialty of teratology. That would be what I have done in the past ten or twelve years.
Q. You recently put into evidence your CV. It's an Exhibit. I think it is Exhibit 352. Are some

of your publications contained in that particular exhibit?

A. Yes, they are.

Q. I see a total of 69. Would that be approximately correct?

A. Well, those may have been the ones I put in some two years ago. However, it has changed since then.

Q. You have added to that number?

A. That's correct.

Q. Are you an advisor of any degree to anybody regarding toxicology, pharmacology and/or teratology?

A. Yes, I am.

Q. Tell me what type of advising you do?

A. I have been an advisor to the National Institutes of Health for approximately the last eight years, nine years, and most recently I have been appointed by the Assistant Surgeon General to advise the National Institute of Occupational Safety and Health on matters of workers' safety, and specifically we meet about four times a year, and when we meet, we review grants, proposals, contracts that have been submitted to the National Institute of Occupational Safety and Health for the study of the cancer-causing effects or the birth defects or mutagenic effects of chemicals that might

be found in the workplace. I have also been an advisor to the National Academy of Science on a variety of issues, and those would be the main classes.

Q. Are you engaged in any research either at the University laboratories or at the National Laboratories at the present time?

A. Yes, I am.

Q. Briefly describe those research projects, if you will, please.

A. I am involved in research and have research programs at both places. The research that is being conducted at the University of Arkansas for Medical Sciences is supported by the National Institutes of Health, and its main objective is to determine the effect of chemicals on the growth and development of the fetus, and it is also to determine the mechanisms whereby chemicals cause liver disease and diseases of other organs. The research that is being conducted at the National Center of Toxicological Research is focused again on those two areas, looking at the mechanisms whereby chemicals produce liver disease, alter liver function, and also the mechanism by which certain chemicals are able to affect reproduction.

Q. Have you written on the effects of chemicals

on the liver?

A. Yes, I have.

Q. How many papers have you published with regard to that particular area of toxicology?

A. I would have to estimate it. I think it is around ten to twelve, maybe even more.

Q. Are these projects ongoing?

A. Yes, they are.

Q. Do they involve animal studies?

A. Yes, they do.

Q Are you a hands-on person when it comes to animal studies?

A Yes, I participate daily in the animal experiments at both laboratories.

Q What is risk assessment?

A Risk assessment is the procedure of making a projection or forecasting the likelihood or the probability that some adverse effect may occur as a result of exposure to some substance.

Q Is that a tool of trade to the toxicologist?

A Yes, it is.

Q Is the pharmacologist involved in that particular tool as well?

A The pharmacologists have an important part in that because the basic underlying principles of risk assessment must rely upon certain aspects of the absorption, metabolism, the excretion of chemicals, so that conceptually, yes, risk assessment relies on pharmacology.

Q Have you done any risk assessment?

A Yes, I have.

Q For whom?

A I have conducted risk assessments for the United States Environmental Protection Agency, the United States Department of Justice, and for industry.

Q Are you teaching any group or organization regarding risk assessments at the present time?

A Yes, I am.

Q What organization would that be?

A I have a contract through the United States Environmental Protection Agency to provide basic risk assessment teaching to the eight southeastern states and also to the U.S. EPA in Region IV, which is in Atlanta, and what we are doing is providing a basic introductory course to state agencies, the Department of Health, the Water Quality Divisions, the Department of Pollution Control and Ecology. We have already conducted one such course here in Tennessee and it is designed to provide a foundation for these people and to introduce them to the principles and concepts of risk assessment so that they are better able to make public health decisions when water supplies or air supplies or ground are contaminated with chemicals.

Q Where are you going from here, sir?

A I am going to Atlanta, Georgia.

Q For what purpose?

A We are going to present the course to the EPA and to the State Department of Health for the State of Georgia.

Q Do you -- have you put together a textbook for risk assessment?

A Yes, I have.

Q Is that a textbook that will be used by members of the EPA in these upcoming classes?

A Yes, it will.

Q What is the -- what is a mutagen?

A A mutagen is a substance that is able to interact with the genetic material of a cell and cause a change in that genetic material to generally influence the future development of that cell. The cell can be one which is in the body or the cell could be an egg or a spermatozoa.

Q Have you published regarding mutagenicity of compounds and the like?

A Yes, I have.

Q How many publications?

A Again I would have to estimate maybe a half a dozen.

Q Now, that journal to which you referred is the journal of what?

A Teratogenesis, Mutagenesis and Carcinogenesis.

Q Have you published in the area of carcinogenesis?

A I have published in the area regarding tumor growth and the treatment of certain types of tumors,

solid tumors as well as leukemia. The answer would be yes.

Q Have you done risk assessments as far as carcinogens are concerned?

A Yes, I have.

Q We've discussed pharmacology. We've discussed teratology. You are a toxicologist, but I don't think we have really given a true definition as to what a toxicologist is. Would you give me one, please?

A I will try. A toxicologist is one who studies the adverse effects of chemicals and other substances on the living systems.

Q Historically when did this science come into fruition?

A The origin of the science of toxicology is in the discipline of pathology, although within the modern medical community within the United States toxicology has really evolved out of the basic discipline of pharmacology, and all of the original toxicology training programs were essentially part of the departments of pharmacology.

Q When was the first professional society of toxicology established?

A The first professional society was established

I believe in 1961, 1960 or '61

Q A fairly new discipline as it relates to the society itself?

A That is correct.

Q Have the principles and concepts of toxicology changed substantially or none at all over the last ten years?

A The principles and concepts have changed. They have evolved over the past ten years and most recently there have been significant changes in those principles and concepts.

Q Can you tell me what they are?

A Well, specifically in the area of cancer causation. In the past the design of experimental studies to determine whether or not chemicals cause cancer was simply a mission to use the highest tolerated dose that would produce tumors in animals to simply determine whether it would or would not produce tumors. It has become general knowledge that the mechanism by which chemicals produce tumors is critically important in making safety assessments and trying to develop public policy, and it has been determined that certain classes of compounds produce cancer only when they produce damage to the tissue and they produce it recurrently throughout the lifetime, and so that there has been the evolution of new

concepts regarding cancer causation and the factors that are important in that causation.

Q What professional societies do you belong to, sir?

A I belong to the Society of Toxicology, to the Teratology Society, to the American Association for the Advancement of Science, to the American Society for Pharmacology and Experimental Therapeutics.

Q What is an experimental therapeutic?

A Experimental therapeutics is the design, development and testing of new drugs for their efficacy or their ability to cure diseases.

Q Any other? National Academy of Science, did you name that?

A No. I am not a member of the National Academy of Science. I have served as an advisor, but I am not a member of the National Academy.

Q How about the New York Academy of Sciences?

A Yes, I am a member of the New York Academy of Sciences.

Q Have you received any awards in the area of toxicology since you have been in the discipline?

A Yes, I have.

Q What was that?

A In 1978 I received the achievment award from the

Society of Toxicology, which is that award given to a scientist under the age of thirty-six who last made a significant contribution to the science. It's given to only one person annually and it's not actually given annually, but some years there have been no awards given.

Q While you were in the state of Tennessee did you belong to any state boards that dealt with medicine or toxicology or pharmacology or the like?

A I didn't belong to any state boards, but I did have the occasion to be an advisor to the Medical Examiner's Board of the State of Tennessee.

Q In what capacity?

A I served the attorney's -- the Attorney General's office in advising the Medical Examiner's Board on the usual course of medical practice as it relates to the use of drugs, the pharmacological aspects of it, in reviewing licensure of in reviewing the revoking of licenses of practitioners in the State of Tennessee.

Q Do you have at the School of Pharmacology in Little Rock a procedure whereby medical doctors can call you and determine the toxicity of various compounds and chemicals?

A Yes, we do.

Q Tell me about that, sir, and tell me how it's

used.

A Well, we have a service which is used by the practitioners at the University Hospital in which we are available to them 24 hours a day, 7 days a week to provide consultation regarding the effects that might be expected or the diagnosis of chemical injury, and that service is also provided to the U.S. EPA contractors on a national basis, so that we essentially are available to all ten regions of the U.S. EPA throughout the United States.

MR. GENTRY: Your Honor, at this point of time I would represent to the Court, although the Court's memory is better than mine, that Dr. Harbison has previously been accepted by the Court as a toxicologist, an expert in toxicology. We would also present him to the Court now as an expert also in pharmacology, teratology, and risk assessment as it relates to chemicals and drugs.

THE COURT: Is there any objection?

MR. GILREATH: No, Your Honor.

THE COURT: All right, sir.

BY MR. GENTRY:

Q Dr. Harbison, let's go back to the research which you described for the Court just a few minutes

ago as relates to the liver. Can you give me a mundane description of what your people have been doing as it relates to the various programs you have been carrying out?

A Well, we have been trying to determine the ways in which chemicals affect the liver and specifically we have been interested in narcotics and analgesics, that is compounds that are able to affect pain, and we have been interested in the effects that these analgesics have on some of the enzymes that are produced in the liver, specifically the SGPT and SGOT.

Q Let me stop you right there. We've had a lot of discussion about liver function tests and I notice you refer to enzymes. Tell me the difference, if you will, please.

A Well, SGPT, serum glutamic pyruvic transaminase, and the SGOT, which is a similar enzyme, are enzymes that are produced or synthesized in the liver. They are normally released from the liver and various changes in the liver can alter the level of these enzymes that you would find in blood. And SGPT and an SGOT is not a liver function test. It is an enzyme or it is a set of enzymes that are found in the plasma or in the blood which are made by the liver and they can be altered or changed or elevated

depending on how the liver is acting at a particular moment in time.

Q Is this an animal study that you have been carrying on or a number of animal studies?

A We are carrying on animal studies and we have also conducted human studies.

Q As it relates to the liver enzymes?

A That is correct.

Q Tell me what you have done, if you will, please. I think this is pretty important.

A What we have done so far is we have found that drugs like analgesics, including the over-the-counter analgesic acetaminophen or Tylenol, are able to change these enzymes within the blood and can increase the levels of those enzymes within the blood, so that the administration of certain analgesics can cause a significant elevation in SGPT or SGOT levels.

Q Is that long lasting?

A It is not long lasting. It will generally be a trenchant effect. We have also found that other drug substances which are able to alter the metabolism of the liver, such things as the sedative hypnotics like phenobarbital, the anticonvulsants like diphenylhydantoin, are also able to increase these enzymes in the blood because they have a nonspecific

effect of increasing the synthesis of enzymes throughout the liver and as a result of that effect cause an outpouring of these into the bloodstream.

Q Is the increase of enzymes into the bloodstream by the introduction of these analgesics into the body, is that indicative of liver damage?

A No, it is not.

Q What is it indicative of?

A Well, it is indicative of a change within the liver whereby these compounds and others can cause an increase in the synthesis of these enzymes and thereby the increase in the production or the synthesis of the enzymes causes an increase of these in the bloodstream, so it's a simple physiological response.

Q. In these experiments or tests, what have you, do you have reason to look at liver slides?

A. Yes, I do.

Q. How often?

A. Oh, certainly on a weekly basis, probably every couple of days.

Q. And for what purpose?

A. For the purpose of determining whether or not there is a cell death that has occurred or what other changes might have occurred within the liver, which might have led to the elevation in the enzymes or the other effects that we may have seen.

Q. Now, you used a word that has puzzled me throughout this litigation. We are talking about the liver now, and you refer to cell death. Is it possible to have damage to the liver without having cell death?

A. Yes, it is.

Q. Let me ask you if you have, say, ten or eleven drinks one evening, would that create liver damage?

A. Yes, it would.

Q. Under ordinary circumstances with an ordinary human being, would it create cell death?

A. No, it would not likely create cell death or cause cell death.

Q. Explain to me the difference between damage and cell death, if you can?

A. Well, in damage there is a change in the cells of the liver, for example, in which these cells may become leaky, that is, they cause a discharge or a leaking of the enzymes into the bloodstream. The cell death is where the cell is actually destroyed, and it needs to be replaced, and the cells of the liver are quite easily replaced. So that in the case of cell death, there will not be any sort of survival or any rebounding of that particular cell. It's dead.

Q. Is the liver a sensitive organ or resilient organ?

A. The liver is a resilient organ.

Q. What is its purpose and function?

A. The purpose of the liver is to clean the blood of substances that are normally produced by the body, such as steroids, the breakdown products of blood; for example, bilirubin. It also has a function to synthesize or to produce other substances like clotting factors, steroids and other materials that it produces or alters by metabolizing them. So it has two functions, really. One is to cleanse the blood, to serve as an excretory organ, and the other is to synthesize materials that are essential for life.

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Q. What is necrosis?

A. Necrosis is cell death which can be seen on observation of the liver.

Q. In your experiments, to which you have been referring, do you sometimes see necrosis on your liver slides?

A Yes, we do.

Q. The liver damage, which you just described earlier, not the cell death, but the liver damage, can you see it on your slides?

A. Oftentimes you will not be able to see liver damage.

Q. It depends on the range of the damage?

A. That is correct.

Q. Are you familiar with the compounds carbon tetrachloride and chloroform?

A. Yes, I am.

Q. And in what manner?

A. Well, I have generally known about them for the past decade or more. While I was in pharmacy school, I had the occasion to prepare compounds that contained chloroform and dosages of medication for worms containing carbon tetrachloride. I have generally throughout my education experience been exposed to basic research that has been conducted on carbon

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tetrachloride and chloroform. I have done basic research on carbon tetrachloride and chloroform and have an active research program at this point on carbon tetrachloride and chloroform.

Q. Well, I would like to explore that, but first, let me ask you this: Have carbon tetrachloride and chloroform been used as analgesics in the past?

Q. As analgesics?

Q. Yes.

A. Actually, yes, they have. Carbon tetrachloride specifically -- carbon tetrachloride has been used as a topical treatment for burn injuries approximately twenty years ago.

Q. Have they been used as drugs in the past?

A. Yes, they have.

Q. In what manner?

A. Well, carbon tetrachloride has been used quite extensively in the treatment of worms. Carbon tetrachloride in the southeastern part of the United States was extensively used, and actually was in the textbooks of pharmacology when I was taking pharmacology. There are reports of the successful treatment of more than a hundred and twenty thousand patients with carbon tetrachloride. Chloroform has also been used as a drug. It has been used as an anesthetic. It has also

been used as a preservative, and it has been used as a carminative or a flavoring agent in the solution of other drugs and substances which don't taste very good.

Q. Before we get to your research program on carbon tetrachloride, tell me about that study with 20,000 people. What type of study was it?

A. The study of 20,000 people was a study in which the outcome of the treatment of patients who had tapeworms was conducted; that is the patients were followed, and it was an observation of the adverse effects that occurred as a result of the use of carbon tetrachloride or the lack of those effects.

Q. What type of doses were given to those people?

A. The general recommended dose was approximately five grams for an adult, given as a single dose, followed in approximately two weeks by another dose if the worms were not passed within that period of time.

Q. What dose would that be, the second dose?

A. The second dose would have been the same, approximately five grams for an adult person.

Q. Ten grams in two weeks?

A. That's correct.

Q. Tell me about your research program as it relates

to carbon tetrachloride?

A. The research program that we are conducting is one to describe the inter-action between carbon tetrachloride and chloroform in other chemicals, and we have defined the ability of carbon tetrachloride and chloroform to produce liver damage, and the ability of other chemicals to increase that ability to produce damage, and our general objective is to describe the synergistic activities, if you will, between carbon tetrachloride, chloroform and other chemicals.

Q. Let me refer you to Exhibit 18. Are you familiar with that exhibit?

A. Yes, I am.

Q. As a result of the experiments that you have been doing with carbon tetrachloride and chloroform, can you tell me and the court what the synergistic effects of all those chemicals there would be with carbon tetrachloride and chloroform?

A. I don't believe there would be any synergistic effects between those compounds listed on there with carbon tetrachloride and chloroform. Our research, as well as that of others, has really described twochemical classes that caused synergistic effects between carbon tetrachloride and chloroform, and those two chemical classes are alcohol or various alcohols,

and ketones, and those are really the only two classes that have been described which cause a synergistic effect between carbon tetrachloride and chloroform.

THE COURT: Ask him to describe what he means by synergistic effect.

MR. GENTRY: Certainly, Your Honor.

Q. Would you describe what you mean by that?

A. Yes. Synergism is the effect whereby when two chemicals are given or one is exposed to two chemicals, there is more than an additive effect. You don't simply add up the effects of one versus the other, but when the two are administered together, there is a greater than an additive effect.

THE COURT: The witnesses here have used the word potentiation. Would that be pretty much in the same class of what you are talking about -- maybe producing a more powerful effect possibly?

THE WITNESS: It's not a more powerful effect. The term potentiation has very specific meaning. Potentiation is a term that is used when you give one compound that has no effect itself. It has no intrinsic or inherent toxicological properties. But it greatly exaggerates the toxicity seen by another

compound. So rather than seeing the effect that you would expect at this particular dose level, if you give the two together now, you would see considerably more than you would have expected.

THE COURT: So there is a difference between the two concepts?

THE WITNESS: Yes, sir, there is.

Q. (By Mr. Gentry) Well, let's talk about potentiation as it relates to these compounds on Exhibit 18.

Can you give me an opinion if there is a potentiation between carbon tetrachloride and/or chloroform and the other compounds?

A. The same would apply; that the potentiation and the synergism that occurs is confined to two distinct chemical classes, and those are alcohols and those are ketones. There aren't any alcohols or ketones on that list.

Q. What is a metabolite?

A. A metabolite is a product that is produced from a chemical or a drug that would be ingested in man or that would be given to an animal. It is a changed material.

Q. Are metabolites important in your research as it relates to carbon tetrachloride and chloroform?

A. Yes, sir, they are critically important.

Q. Tell me why?

A. Because carbon tetrachloride and chloroform themselves do not produce liver injury. It is only the metabolites of carbon tetrachloride and chloroform that produce the injury. The carbon tetrachloride and chloroform themselves are rather stable molecules, and until you extract a chlorine from the molecule it does not become biologically important or reactive within the liver system or within other organs of the body.

Q. Are there some chemicals, compounds, or drugs that will produce more metabolites than others?

A. That will result in the production of more metabolites for themselves?

Q. Yes.

A. Yes, there are.

Q. Where do you classify carbon tetrachloride and chloroform?

A. Their metabolism is fairly simple, and they do not produce a lot of metabolites.

Q. Is that important to your study?

A. Yes, it is.

Q. Tell me why?

A. Well, because in trying to determine the

mechanism by which a drug or chemical produces an effect, it is important to know what the metabolites are, because in most all instances in which there is liver damage, the liver damage is produced by a metabolite. It is not produced by a parent compounded cell. In the case of carbon tetrachloride and chloroform, there are really very few metabolites produced; so it is a much easier task to identify what the causative agent is than, for example, in one in which you might have fifty metabolites or considerably more.

Q. Have you reached any conclusions as a result of your studies of carbon tetrachloride and chloroform in the laboratories?

A. Yes.

Q. Synergistically and the like?

A. Yes.

Q. What are the conclusions?

A. Well, the conclusions are that in order to increase the toxicity of carbon tetrachloride and chloroform as seen in the liver, that is to be able to produce the necrosis or cell death, it is essential that the compounds be given for a period of time which will allow synthesis of new enzymes to increase the ability of the liver to be able to convert the carbon tetrachloride and chloroform to the more toxic species

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and the more proximate cause of the injury.

Q. Can you say that in a little simpler terms?

A. Well, it's essential that the compound changed the metabolism of the liver in order to create a liver which is now different such that it handles carbon tetrachloride and chloroform in a different manner than it did before.

Q. Now, is that change damage or cell death?

A. The change that we see with the carbon tetrachloride and chloroform?

Q. Yes.

A. We are looking at both damage as well as cell death.

Q. Is there -- excuse me. Have you finished?

A. We look at both.

Q. Is there a threshold of the amount of carbon tetrachloride and chloroform that you give the animal over which there is cell death and under which there is damage?

A. Yes.

Q. You have read a number of parts of the transcript of this trial, have you not?

A. Yes, I have.

Q. And you have attended certain days of this trial as well, have you not?

A. Yes, I have.

Q. Are you familiar with Dr. Rodricks and his testimony?

A. Yes, I am familiar with his testimony, yes, I am.

Q. Are you familiar with his calculations?

A. Yes, I am.

Q. Are you familiar with the word or words that he used on Exhibit 237 --"cumulative exposure."

A. Yes, I am.

Q. What did he mean by that, Doctor?

A. Well, by cumulative exposure he added up the levels that the individuals would have been exposed to over a period of time and took that cumulative amount to be the amount that the individual would have been exposed to and thereby would have had in his system to produce the effects which he says would occur.

Q. Was Dr. Rodricks a pharmacologist?

A. I don't believe so. I think he testified that he was a chemist or a biochemist.

Q. As a pharmacologist, and we are talking specifically about carbon tetrachloride and chloroform, as a pharmacologist, does the cumulative exposure make sense as far as human beings are concerned?

A. No, sir, it does not.

Q. What happens to carbon tetrachloride and chloroform -- and/or chloroform when the human body either ingests it or inhales it?

A. Carbon tetrachloride and chloroform are readily excreted. Carbon tetrachloride and chloroform are blown off in the expired air. They are also rapidly converted to metabolites and rapidly excreted following that conversion. So they do not stay around for a long period of time.

Q. When you say rapidly excreted, are you talking in terms of hours, days or months?

A. I am talking in periods generally of days. It certainly would not be months, but it probably would be days.

end

Q When you ingest carbon tetrachloride and/or chloroform where does it go?

A When you ingest it most of it will go immediately to the liver. The vessels in the intestine, which are called the greater omental vessels, are those which collect the material from the intestine and will generally go directly to the liver, and chloroform and carbon tetrachloride are compounds which generally on the first pass through the liver will be sequestered by the liver, so they are very efficiently

taken up by the liver, so very little would get out into the rest of the system in circulation following the oral ingestion of those materials.

Q When you inhale carbon tetrachloride and chloroform what happens to them?

A When you inhale carbon tetrachloride and chloroform it would be likely that they would get into the systemic circulation much more efficiently, that is to the brain and to other organs of the body, before they get to the liver, because the blood would go to other organs first.

Q In light of the characteristics of carbon tetrachloride as those characteristics relate to the metabolizing by the body of the compounds, is daily dosage more important than cumulative exposure?

A Yes, it is.

Q At the risk of being repetitious, explain to me again why.

A Well, the daily dosage is important because that is the dosage which will determine whether or not the level of chemical reaches a level that is able to produce some response in the body, and unless it's able to reach that level on a daily basis it will not produce any effect.

Q I'm going to slip sideways on the direction

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of this examination if you will allow me, sir, and ask you if there's a book called Clinical Toxicology of Commercial Products?

A Yes, there is.

Q What's the purpose of that book?

A The purpose of that book is to identify the constituents that are contained within commercial products for the purpose of treatment and diagnosis of persons who might have unintentionally or intentionally ingested those products. You will find that text in most poison control centers and in most emergency rooms, because it is a quick reference to allow one to determine the makeup of some material that someone may have ingested.

Q Is it substantial in size?

A Yes, sir; it's probably four to five inches thick. It's quite a large textbook.

Q At my request did you extract from that book some information on carbon tetrachloride as it relates to commercial products?

A Yes, I did.

Q I know it's rather lengthy, but tell us about some of the products, some of the commercial products in which we find carbon tetrachloride presently and then give us an estimation of how many products there

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are with a not unsubstantial amount of carbon tetrachloride contained therein.

A Well, carbon tetrachloride is contained in probably, I would estimate from the list, maybe thirty to fifty products. It is contained in paint removers, it's contained in a variety of carburetor cleaners, it is most extensively used as a pesticide and as a fumigant, and --

Q What's a fumigant?

A A fumigant is a material that is used as a pesticide, but because it is volatile you are able to put the material within an enclosed space and have it get to essentially all parts of that space because of its volatility and thereby kill off the pest that you don't want in there.

Q Do you use that with grains?

A With grains?

Q Yes.

A Yes, sir.

Q I notice one of the first brand names is Acritet 34-66 fumigant.

A Yes.

Q By whom is that made?

A It's made by Stauffer Chemical Company.

Q There's also a reference to refrigerants. Is

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carbon tetrachloride contained in refrigerants?

A Yes, it has also been used as a refrigerant.

Q How many different companies, approximately, how many different manufacturers, use carbon tetrachloride presently in the manufacture of their various products?

A Well, I've not closely counted them. I would say there are probably at least a dozen.

Q In that book to which we have previously referred, Clinical Toxicology of Commercial Products, is there a section under carbon tetrachloride dealing with minimum acute toxicity concentrations?

A Yes.

Q What does that mean?

A I'm sorry, let me make sure I understand. Did you say is it in the book or is it in this paper?

Q Is it in that?

A On this paper?

Q Yes.

A Yes, it's on the paper.

Q Is that not contained in the book?

A No, it is not contained in the book.

Q Where do you get the minimum acute toxicity concentrations?

A The minimum acute toxicity concentrations are

those concentrations which are derived from a set of publications that the United States Environmental Protection Agency published some years ago and they are called Multimedia Environmental Goals, and what it allows one to do is to calculate a concentration to which one could be exposad for short periods of time, and that's what the minimum acute toxicity concentration is.

Q What is the minimum acute toxicity concentration for carbon tetrachloride in air?

A It's ten parts per million.

Q In water?

A It's nine hundred seventy-five parts per million.

Q Parts per what?

A Per million.

Q Now, I see something, land. Would that be in the dirt or earth or what have you?

A That would be soil contaminated or containing carbon tetrachloride.

Q And how many -- what's the minimum acute toxicity concentration for that?

A That's one thousand nine hundred parts per million.

Q Where is that information contained that you

just gave me as far as the EPA is concerned?

A It is derived from the Multimedia Environmental Goals, which is a methodology that the EPA proposed for determining concentrations to which people could be exposed for short periods of time as well as long periods of time.

Q Has the EPA derived a mathematical formula which translates into permissible concentrations of carbon tetrachloride over a 24-hour a day 7-day a week environmental circumstance?

A Yes, it has.

Q Can you tell me what that is for air?

A The estimated permissible concentration for air, and that is the concentration to which one can be exposed for 24 hours a day 7 days a week, is point zero two parts per million.

Q That would be twenty parts per billion?

A That's correct.

Q All right. What about water?

A For water it's two point three one parts per million.

Q And that's 24 hours a day 7 days a week?

A That is correct.

Q For a lifetime?

A That is correct.

Q And that was parts per million?
A Parts per million.
Q All right. Land?
A Land is four point six two parts per million.
Q Doctor, are carbon tetrachloride and chloroform suspected carcinogens?
A Yes, they are.
Q Tell me how and why they are suspected as carcinogens.
A Both carbon tetrachloride and chloroform are suspected carcinogens because in some animal studies it has been found that both of these agents are able to produce tumors, and specifically tumors of the liver.
Q Under what circumstances?
A Under circumstances of high concentrations over a prolonged period of time and under circumstances in which there is necrosis, cell death, that occurs over a substantial period of the lifetime of the organism, the animal.
Q Is chloroform a teratogen?
A Chloroform is teratogenic in mice or it has been found to be teratogenic in mice. It is not a human teratogen.
Q Is carbon tetrachloride a teratogen?

A Carbon tetrachloride is -- there is considerably less evidence even for carbon tetrachloride. It is not a human teratogen.

Q Are chloroform and carbon tetrachloride mutagens?

A No, they are not.

Q Is that important?

A Yes, it's extremely important.

Q Tell me why?

A Well, if carbon tetrachloride and chloroform were mutagenic substances, what that means is that they have the ability to bind to the genetic material, the DNA, and it means that they can cause cancer and that exposure over a period of time resulting in that genetic damage could in fact lead to tumors, but neither carbon tetrachloride or chloroform have been found to be mutagenic, which means essentially that they do not bind to the genetic material and they do not cause cancer by causing a change in the genetic material.

Q Were you in the courtroom yesterday when Dr. Sullivan talked in terms of binding?

A Yes, I was.

Q He described a physical property of these compounds that I think made it difficult for them to

bind. Are you familiar with that?

A Yes, I am.

Q Tell us about it again, if you will, please.

A Well, carbon tetrachloride and chloroform, because they contain only a single carbon atom, cannot form intermediates which are able to bind to macromolecules or various molecules within the cell, and more importantly they are not able to bind to DNA to cause some sort of damage or error within that material, so they do not have the chemical makeup to be able to be biotransformed or converted to metabolites which are able to bind.

Q Is this important as it relates to the manner in which people view carbon tetrachloride and chloroform when they are talking in terms of carcinogenicity?

A Yes, it's very important.

Q Tell me why.

A Well, again because neither of those two compounds are able to bind to DNA. That means that they will not be able to initiate the process of cancer or cause the process of cancer or that process which leads to cancer, and unlike other substances which are it means that these compounds cannot be those which bind and cause cancer themselves. They must have some other event, either through the process of

killing the cells or using massive doses to kill cells that will ultimately lead to the cancer process.

Q There are technical names for the type of toxins these are as opposed to the type of toxins that might bind with a cell, are there not, sir?

A Yes, sir.

Q We have heard them a number of times, haven't we?

A Yes, we have.

Q Just for the purpose of the record let's voice them again and then forget about them, because I think what you have described is adequate for our purposes.

A Okay. Those chemicals which are able to bind to DNA and initiate the process of cancer are called genotoxic chemicals. Those chemicals which are not able to bind to DNA but can under certain circumstances cause cancer because they consistently cause cell death at high levels or massive exposure levels, those compounds are called epigenetic carcinogens.

Q And what is carbon tetrachloride and chloroform?

A Carbon tetrachloride and chloroform are epigenetic carcinogens.

Q Doctor, I'd like for you to, if you have it in front of you, turn to Exhibits 232, 233, 234, 235 and

the supplements put into the record by Dr. Rodricks as a result of summary calculations. Do you recognize those?

A Yes, I do.

Q First, for the purpose of your testimony, tell us what those calculations are, about -- toward whom they are directed, and whether or not there are any footnotes on any of those.

A Okay. Exhibit 232 is the estimated chemical doses of selected chlorinated hydrocarbons to S. Sterling, 1969 through 1978, and it is an estimated cumulative dose of carbon tetrachloride, chloroform, chlorobenzene and tetrachloroethylene, and also an estimated average daily dose of those same materials from drinking water and from inhalation exposure.

Q What's 233?

A 233 is essentially the same thing, only this is for D. Johnson and it's 1976 through 1978.

Q And 234?

A 234 is for the Maness child, and this is April '76 through March '78.

Q Now, the next group of papers you have would be Exhibit 237, and what is the difference in those papers and the ones that you have just described?

A The next one I have is 235.

Q All right. Then you have one that's 237, the footnotes. It's not so marked.

A It's not so marked 237, yes, but it has the footnotes which are the --

MR. GENTRY: I'm sorry, Your Honor, I'm transposing numbers, which I'm wont to do. It's 327.

THE COURT: All right.

BY MR. GENTRY:

Q Those are the ones with the footnotes that are essentially the same as the previous exhibits except they have footnotes, is that correct, sir?

A That is correct.

Q Did you have reason to review those recently?

A Yes, I have.

Q For what purpose?

A For deriving the assumptions that Dr. Rodricks used in the calculations of his estimated doses.

Q Turning to 327, which is the one with the footnotes, let's look at the daily dosage of carbon tetrachloride and chloroform for Mr. Steve Sterling, both as a result of inhalation and ingestion. Do you see that, sir?

A Yes, I do.

Q What is the daily dose for chloroform shown in

Dr. Rodricks' figure?

A The daily dose for chloroform would be point zero two two milligrams per kilogram.

Q Which extrapolates out to what, parts per billion?

A Well, it would be parts per billion, but that would not be the proper way of using parts per billion.

Q Because of the milligram per kilogram?

A That's correct.

Q Is there any as far as ingestion is concerned for chloroform?

A You mean inhalation?

Q I mean inhalation.

A No, there is nothing for inhalation.

Q Now, what is the average daily dose for ingestion, Steve Sterling, shown by Dr. Rodricks in Exhibit 327 of Carbon tetrachloride?

A For carbon tetrachloride it is point two three milligrams per kilogram.

Q And inhalation?

A Inhalation is point eleven milligrams per kilogram.

Q Now, there's an interesting footnote with regard to the exposures here. Read those footnotes, if you will, please.

A The first footnote, number 1, is body weight

assumed to be sixty kilograms. Footnote number 2 is calculations are based on drinking water consumption through November 1977 and inhalation exposure through March 1978. Footnote number 3 is assumed two liters per day of well water consumed. Average ex -- I'm sorry. Number 4, the footnote number 4, is average exposure for highest year in milligrams per kilogram per day.

Q All right. Now, just a second. The average daily exposure to which you have just referred is the highest year?

A That's what it says.

Q That figure does not take into consideration any other years that were lower than the highest year?

A No, it does not.

Q Is that footnote the same for Daniel Johnson and for Jimmy Maness?

A Yes, it is. The only difference is that on Maness it's footnote number 3 rather than footnote number 4, but it's essentially the same wording.

Q Still referring to 327, what did Dr. Rodricks assume in that table as it relates to these daily doses?

A He assumed that there would be a consumption

of two liters of water a day and he assumed some other things about the amount of time spent within the bathroom in showering, and so forth, for the inhalation exposure.

Q Did he also accumulate those daily doses over a full year?

A Yes, he did. He accumulated them for a full year period of time and then he added the two of them together, that is the ingestion and inhalation.

Q As a pharmacologist do you perceive to be proper and correct?

A No, sir, that is not correct. That is incorrect. It ignores all of the basic underlying principles and concepts of pharmacology and toxicology.

Q How is that, sir?

A Well, it doesn't account for the metabolism of carbon tetrachloride, it doesn't account for the excretion of carbon tetrachloride, it doesn't account for the exhalation of these two compounds or in this case carbon tetrachloride in the expired air, it totally eliminates the considerations for the excretion of these materials from the human body, which are generally pretty efficient.

Q These average daily doses, and I'm going to

refer to doses as both inhalation and ingestion, for Steve Starling, I think the point -- the total there is point three four?

A It would be point three four milligrams per kilogram.

Q Both by inhalation and ingestion?

A That is correct.

Q In the highest year, 1977?

A That is correct.

Q Can you relate that type of dosage, daily dosage, to any of your animal studies or any of the animal studies with which you are familiar as they deal with carbon tetrachloride?

A Well, that dose would never produce liver damage let alone cell death in any of the animal studies that I have ever conducted or in any of the literature that I'm familiar with. One needs to get up to 60 milligrams per kilogram per day or thereabouts in order to produce those kinds of liver damage, either the cell damage or the production of the SGPT or SGOT.

Q We discussed how pervasive carbon tetrachloride was in our civilization. Have you seen a National Institute of Health document that tells us really how much the ordinary human being is exposed to carbon

tetrachloride and/or chloroform?

A Yes, I have.

Q What is that document called?

A It's called Chloroform, Carbon Tetrachloride, and Other Halomethanes in Environmental Assessment, and it's published by the National Academy of Sciences.

Q When was it published, do you know?

A 1978.

Q Does that document indicate what the National Academy of Science perceives to be the exposure of the ordinary human being in the United States to carbon tetrachloride and chloroform?

A Well, it does several calculations and comes up with a number of values, but I recall one being around 900 milligrams per year, I believe it was, for carbon tetrachloride. It will take me a minute to find it if you want the exact number.

I'm sorry, that was for chloroform. For an adult man it's 629 milligrams per year and for chloroform it's 984 milligrams per year.

Q Tell me what type of exposure they are talking about. Is that just for one year or is that for more than one year? What are they saying in that document?

A That's per year. That's the exposure to those materials per year.

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Q. By whom?

A. I am sorry. I don't understand.

Q. Who is being exposed to that amount?

MR. GILREATH: Excuse me. Could you quote the page number?

THE WITNESS: The page number is 180.

Q. Is it a specific person, or is it a group of people, or is it the whole United States?

A. This would be the whole United States; not referring to any specific person, but it would be the whole United States.

Q. Is that purportedly from the various compounds that you described to me that are being produced for the general public's use?

A. Yes; and also through the chlorination process of water in which you create chloroform. So it would be as a result of food contamination, water contamination and air.

Q. Did Dr. Rodricks make any assumptions, let's say, with regard to Steve Sterling concerning his total exposure of 280 milligrams per kilogram for the year 1977 as shown in Exhibit 327? Do you know if he made any assumptions concerning what risks Mr. Sterling might have from consuming that?

A. Yes.
Q. What did he say about that?
A. Well, his estimation was that there was a ten percent increase in risk for Mr. Sterling for that particular level of exposure.
Q. Did he confine it to the level that was in that year alone?
A. Yes. He confined it to the total cumulative dose for that year, which was 280 milligrams per kilogram.

MR. GENTRY: Would you mark this?

(The document above referred to was marked Exhibit 497, for identification.)

Q. (By Mr. Gentry) Doctor, did you take that assumption --

MR. GILREATH: Excuse me. Ms. Breaux, what is the number?

THE CLERK: 497.

Q. (By Mr. Gentry) Did you take that assumption and look at other documents and another exhibit and do some calculations as it related to that assumption?
A. Yes, I did.
Q. Tell me what you did?
A. Okay. What I did is I took the underlying assumptions for Dr. Rodricks' model, in which he

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estimated a ten percent risk for Steve Sterling. I subsequently took the doses, the cumulative doses that were estimated for D. Johnson and J. Maness and calculated the risk based upon a 10 percent risk for Steve Sterling, which would have been 8 percent and 7 percent for the latter two. Then I went to the OSHA permissible exposure level for carbon tetrachloride, which is 10 parts per million, and using the same assumptions of the volume of air taken in by Steve Sterling that Dr. Rodricks used, I calculated the amounts of carbon tetrachloride that will be taken in by an average worker in a one-year period of time. I used that cumulative dose, that is the amount he would have taken in for a period of one year, used the same risk estimate, that is the same procedure, and calculated the risk estimate for the average worker.

Q. Did you also go to a document that dealt with Velsicol filter operators?

A. Yes, I did.

Q. Was that Mr. Netzel's exhibit?

A. Yes, it was, and I used again the same assumption.

Q. Now, these calculations do not give validity to the cumulative exposure, do they?

A. No, they certainly do not.

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Q. And actually, as far as you are concerned -- well, withdraw that.

What result did you find using the type of extrapolation that Dr. Rodricks used?

A. Well, if we were to use the assumptions that Dr. Rodricks used and use the unusual procedure for estimating risk which he used, I have calculated using those assumptions that there should be nearly a hundred percent cancer amongst the workers who are exposed to carbon tetrachloride at the OSHA standards within two years and that they should more than all of them have cancer by the end of three years, and using the Velsicol filter operators as another example, within one year, 62 percent of them should have cancer, and within two years, a hundred and twenty-four percent.

Q. Did you hear the epidemiological study that Dr. Shindell did with reference to the heptachlor workers?

A. Yes, I did.

Q. Is there any indication that these percentages are indeed correct?

A. To the contrary, there is no indication that there is an increased incidence.

MR. GENTRY: Your Honor, we would move that this be admitted as an exhibit

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to Dr. Harbison's testimony.

THE COURT: All right.

(Exhibit 497 received in evidence.)

Q. (By Mr. Gentry) Is this a proper way to do a risk assessment?

A. No, sir, it's not.

Q. How do you go about doing a risk assessment under these circumstances?

A. The way a risk assessment is conducted is to use the daily exposure levels and to estimate the risk for a given population of people that is based upon the daily exposure level one would estimate the risk of occurrence or the increased likelihood of occurrence of a cancer in a thousand, a hundred thousand or a million people, and expressing it as a percentage is a very unusual way of estimating the risk.

Q. Doctor, looking at the highest daily dose for Steve Sterling, Daniel Johnson and Jimmy Maness -- look at that if you would, please.

A. This is for carbon tetrachloride?

Q. The combination, if you will?

A. Of carbon tetrachloride and chloroform?

Q. Yes.

A. Okay.

Q. We are still referring to Exhibit 327, are we

not, sir?

A. Yes.

Q. Do you have an opinion as to whether any of those three have an increased risk in cancer as a result of the daily dose which is shown by the plaintiffs' own expert?

A. Yes, I have an opinion.

Q. What is that opinion, sir?

A. My opinion is that there is no increased risk of cancer at those doses.

Q. Is that an opinion based upon your expertise as a pharmacologist, toxicologist, an expert in cancer?

A. Yes, it is.

Q. Is that with a reasonable medical certainty?

A. Yes, it is with a reasonable medical certainty.

MR. GENTRY: That's all, Your Honor.

THE COURT: Can we take a short recess and come back at 11:30?

Will that be satisfactory with everybody?

MR. GILREATH: Yes, sir.

(Recess.)

THE COURT: Go ahead, Mr. Gilreath.

CROSS EXAMINATION
BY MR. GILREATH:

Q. Dr. Harbison, I was looking at your CV, Exhibit 352. Have you published any -- do you have any publications that deal specifically with the carcinogenesis of carbon tetrachloride and chloroform?

A. That deal specifically with the carcinogenicity testing of carbon tetrachloride and chloroform?

Q. Yes.

A. No, sir, I do not.

Q. Do you have any publications that deal specifically with the toxicology of carbon tetrachloride and chloroform, specifically?

A. Yes, I do.

Q. What is that? Is that on your CV?

A. Yes, it is.

Q. What number?

A. I am sorry. I don't have it before me.

MR. GENTRY: May I hand it to him?

MR. GILREATH: Yes.

(Document handed to the witness.)

THE WITNESS: There is Number 81 which says, "Role of biotransformation in the potentiation of halocarbon hepatotoxicity by 2,5-hexanedione." The two substances that

were used there were carbon tetrachloride and chloroform. Those were the halocarbons.

Then number 84, "Potentiation of chlorinated hydrocarbon toxicity by 2,5-hexanedione in primary cultures of adult rat hepatocytes."

The halocarbons are the chlorinated hydrocarbons in that case where chloroform and carbon tetrachloride.

Q. Excuse me. What is hexa --

A. Hexanedione?

Q. Yes.

A. Hexanedione is a ketone, which is the substance that we were looking at, that class of compounds, as to how they potentiate the effects of carbon tetrachloride and chloroform.

Q. What is a ketone?

A. A ketone is a chemical that has a double bonded "O" in it. Ketones can be used as solvents.

Q. Are they used in everyday things that people use?

A. I am not aware of their contents in household products. I believe they are primarily used for industrial purposes.

Q. Have you done any work in the potentiation of

carbon tetrachloride and chloroform with 1,3-butanedion?

A. Butanedion?

Q. Yes. B-u-t-a-n-e-d-i-o-n -- Is that the way you spell it?

A. I don't specifically recall. We looked at about ten compounds, and I am sorry, I do not recall that one.

Q. Do you know what I am talking about -- B-u-t-a-n-e-d-i-o-l?

A. Butanediol?

Q. Butanediol.

A. Have I done any?

Q. Do you know what that is?

A. Yes, sir.

Q. What is it?

A. It is a butane that has two double bonded oxygens in it. It's a diaketone.

Q. Diaketone. What is it used for?

A. I do not know.

Q. Is it not a fact that the FDA has approved this as a flavor solvent in foods?

A. I am not aware of that.

Q. Let me show you an article that was published in Toxicology and Applied Pharmacology and ask you if

you have ever seen that?

A. Yes. I am familiar with the work.

Q. Is that a recognized publication in the field of toxicology and pharmacology?

A. Yes, it is.

Q. Have you ever seen that particular article before?

A. I am familiar with the work of B. L. Hewitt. I know him quite well, yes.

Q. There he did a study, did he not, of the potentiation of carbon tetrachloride by the 1,3-butanediol -- how do you pronounce that, Doctor? Butadiol?

A. Butanediol.

Q. Is that what he did?

A. Yes, sir.

Q. And 1,3-butanediol is a substance that is used in what, food, food emulsifiers?

A. It says that butanediol is used as a flavor solvent and has an indirect food additive in packaging films, gaskets and adhesives.

Q. And he found in his study, did he not, that carbon tetrachloride is potentiated by 1,3-butanediol?

A. He says that it enhanced the hepatotoxic effects, that's correct.

MR. GILREATH: We would like to have

that filed as an exhibit, your Honor.

THE CLERK: 499.

THE COURT: All right, sir.

MR. GENTRY: Is that 498 or 499?

MR. GILREATH: 499.

(The document above-referred to was marked Exhibit 499, for identification.)

Q. (By Mr. Gilreath) This question says, "However, the most significant use of BD, as they call it, is as a synthetic source of dietary calories for supplementation of human and animal diets."

Then I assume if a person is ingesting carbon tetrachloride and also ingesting 1,3-butanediol, that that would potentiate carbon tetrachloride toxicity? Is that right, a fair statement?

A. Well, that paper concludes that based upon the administration of some dosage of carbon tetrachloride to the animals. I don't recall exactly what that was.

MR. GILREATH: Your Honor, I move that that be received in evidence.

THE COURT: All right.

(Exhibit 499 received in evidence.)

Q. (By Mr. Gilreath) I believe it says in the heading up there -- just read that into the record about the dosage?

A. Okay. "Pretreatment of rats with 1,3-butanediol (1.0, 5.0, or 10.0 percent in drinking water) for seven days enhanced the hepatotoxic, but not the nephrotoxic effects of a single dose of carbon tetrachloride (0.1 milliliter per kilogram, ip) in a dose-related manner."

Q. Enhanced the hepatotoxic, did it say?

A. The hepatotoxic.

Q. The hepatotoxic means liver?

A. Liver damage.

Q. And you say you know the author or the authors of that article?

A. Yes, I do.

Q. Which one?

A. William Hewitt.

Q. Who is he?

A. William Hewitt was a postdoctoral student with Gabriel Plaa, and I believe he is now working for a drug company. However, he used to be at the University of Missouri, and Gabriel Plaa was one of my mentors at the University of Iowa.

Q. Is Dr. Plaa also one of the authors of that article?

A. Yes, sir. Gabriel Plaa was the chairman of the Department of Pharmacology at the University of

Montreal, and I believe he is now a Vice Dean or Dean of the University.

Q. Is he the president of the professional association that toxicologists belong to?

A. Yes. He is the president of the Society of Toxicology, that is correct.

MR. GILREATH: Would you mark this as an exhibit, please?

(The document above referred to was marked Exhibit 500, for identification.)

Q. (By Mr. Gilreath) Dr. Harbison, I will show you what has been marked Exhibit 500, which is entitled "Short Communication -- Potentiation of Carbon Tetrachloride-Induced Hepatotoxicity by 1,3-Butanediol," and ask you if you recognize this as an authoritative work in the field?

A. Yes, I do.

Q. Does that deal with the same subject as the previous exhibit?

A. Yes, it does.

MR. GILREATH: We would like to have that introduced into evidence.

THE COURT: All right.

(Exhibit 500 received in evidence.)

Q. (By Mr. Gilreath) If 1,3-butanediol potentiates

carbon tetrachloride -- you were explaining earlier the difference between potentiate and synergistic or synergism?

Under potentiation your basic thesis or the basic premise I believe that you gave was that a substance might not have any capacity to do damage unless it potentiated, is that the way you put it?

A. No. The substance itself, like butanediol, does not have the ability or may not have the ability to produce the damage itself, and that it exaggerates the toxicity of the chlorinated hydrocarbon, or the reverse of that. So one has an action and the other one does not.

Q. And did I understand you to say that you have done studies on the synergistic effect between carbon tetrachloride and chloroform?

A. Yes, sir.

Q. How many studies?

A. Let me clarify. I have done studies with carbon tetrachloride and chloroform not looking at the two substances together, but looking at other substances which enhance the toxicity of either one of those materials.

Q. Oh, I see. You have not done studies, putting them together, just the two of them?

A. No, sir, I have not.
Q. And the substances which you have done were what -- with carbon tetrachloride? Let's take carbon tetrachloride.
A. The ketones.
Q. Ketones?
A. Yes, sir.
Q. Is 1,3-butanediol a ketone?
A. I think I have already said that yes it was, but it is a diol. It is actually a two oxygen, but it's an alcohol -- it's not a ketone. It has two hydroxyl substitutions on it.
Q. Has Dr. Hewitt done any work in the potentiation of chloroform or carbon tetrachloride by ketones?
A. I believe he has, yes.
(Document handed to Mr. Gentry)
Q. While he is looking at those, Dr. Harbison, when you did your study of the effect of ketone on carbon tetrachloride, did that cause any potentiation?
A. Yes, it did.
Q. How is that relevant to this case, this study?
A. Well, I think it's relevant in that, as I said before, the two classes of compounds that cause potentiation are alcohols, like butanediol, and like hexanedion,

which we studied, and to the best of my knowledge, those are the only two chemical classes that cause potentiation of the carbon tetrachloride and chloroform toxicity; not all compounds potentiate the toxicity of those two compounds.

Q. Have you done any other studies other than ketone yourself, as far as potentiation of carbon tetrachloride is concerned?

A. Yes, sir. We have also looked at some alcohol, some of the shorter chained alcohols. I don't recall specifically which ones. We have looked at about, I would estimate, ten different chemicals in reference to that, and I can find it here.

This is not an up-to-date curriculum vita.

We presented it at the Society of Toxicology meeting last year, which is essentially a study of the structure activity requirements of alcohols and ketones for the potentiation of chloroform and carbon tetrachloride hepatotoxicity.

I also have a thesis -- a student has completed a thesis on those studies as well, which has also been published.

Q. Other than alcohol and ketones, have you performed any other studies insofar as the synergistic effects on carbon tetrachloride and chloroform or the

potentiation?

A. The only other substances which we have looked at are the sedative hypnotic, and we have looked at -- I believe it was phenobarbitol.

Q. All right. Any other?

A. No, sir. That would be it.

MR. GILREATH: I will ask that this be marked Exhibit 501 for identification.

(The document referred to above was marked Exhibit 501, for identification.)

Q. (By Mr. Gilreath) Let me show you Exhibit 501, which is entitled -- it's an article from the Journal of Toxicology and Applied Pharmacology, and is entitled "Acute Alteration of Chloroform-Induced Hepato- and Nephrotoxicity by Mirex and Kepone."

I will ask you if that is an authoritative paper?

A. Yes, it is.

MR. GILREATH: I would offer that as the next exhibit in evidence, Your Honor.

THE COURT: All right, sir.

(Exhibit 501 received in evidence.)

THE WITNESS: If I could make one addition -- actually, we did look at Mirex and Kepone as well, which are included in the

thesis.

Q. (By Mr. Gilreath) You looked at the same thing that is in this article, Exhibit 501?

A. Yes.

Q. What is Mirex?

A. Mirex is a pesticide.

Q. What is its chemical content?

A. It's a chlorinated hydrocarbon.

MR. GILREATH: I will ask that this be marked Exhibit 502 for identification.

(The document above-referred to was marked Exhibit 502, for identification.)

Q. (by Mr. Gilreath) I will show you Exhibit 502, an article from the Toxicology and Applied Pharmacology Journal entitled, "Acute Alteration of Chloroform-Induced Hepato-and Nephrotoxicity by n-Hexane, Methyl n-Butyl Ketone, and 2,5-Hexanedione."

Is that an authoritative article?

A. Yes, it is.

MR. GILREATH: I will ask that Exhibit 502 be introduced in evidence.

THE COURT: All right, sir.

(Exhibit 502 received in evidence.)

MR. GILREATH: I will ask that this be marked Exhibit 503 for identification.

(The document above referred to was marked Exhibit 503, for identification.)

Q. (By Mr. Gilreath) I will show you exhibit 503, an article from Toxicology and Applied Pharmacology, entitled Role of Biotransformation in the Alterations of Chloroform Hepatotoxicity Produced by Kepone and Mirex."

I will ask you if that is an authoritative article?

A. Yes, it is.

MR. GILREATH: I will ask that that be introduced in evidence, Your Honor.

THE COURT: All right, sir.

(Exhibit 503 received in evidence.)

MR. GENTRY: Your Honor, I am not making any objection to these studies. I am just curious, in light of the fact that there is really no cross examination on any of these studies, as to the status of those studies in the record. Are they for the truth of the matter spoken therein? Are they for identification as authoritative articles? We would just like a clarification from the plaintiff, if the Court please.

THE COURT: All right, sir.

MR. GILREATH: Well, Your Honor, the purpose of the article is Dr. Harbison has indicated he has done his own studies in potentiation of carbon tetrachloride by certain compounds, and it looks like that he has done the same studies that these people have, and we are introducing these to show -- and I think he has already testified -- that carbon tetrachloride is potentiated by certain other chemical compounds, which include kepone and mirex and butanediol, which is a food additive. That's the purpose of these articles.

end

MR. GENTRY: Your Honor, that's fine, with the exception that the butanediol I don't believe is a food additive. It is an indirect food additive, which is substantially different from an active food additive. That's what I thought they were saying and I just wanted to clarify that.

THE COURT: All right, sir.

BY MR. GILREATH:

Q Now, did I understand you to say on direct examination, Dr. Harbison, that carbon tetrachloride and chloroform were not potentiated by chlorinated hydrocarbon?

A By those chlorinated hydrocarbons which are ketones they are. The chemical classes that potentiate the toxicity of chloroform and carbon tetrachloride are ketones and alcohols.

Q All right. Is butanediol an alcohol?

A Yes, sir, it is.

Q According to this article, Exhibit 499, it's used as a flavor solvent in food, as an indirect food additive in packaging films, it's used as a food preservative, and it's used as a food emulsifier. What do you mean by food emulsifier?

A I'm not sure what that means. I think alcohols

in general are used to create stable emulsions and by adding small amounts of alcohols you can change the emulsion qualities of various materials.

Q All right. In this article it says that "the in vitro binding" -- what does in vitro mean?

A It means outside of the organism.

Q -- "in vitro binding of carbon tetrachloride-derived radioactivity to microsomal protein was increased both aero"-- I can't --

A It's aerobically and anaerobically, I believe.

Q Right. --"but was greater under aerobic conditions. BD appeared to potentiate carbon tetrachloride liver injury, at least in part by producing an increase and/or alteration in mixed function activation of carbon tetrachloride to toxic metabolites."

Did you find that true in your studies?

A Yes, sir, we did. We found that it was necessary to have a change in the metabolic activity to have the potentiation occur for the carbon tetrachloride and chloroform.

Q "Thus, BD potentiation may arise through several interrelated pathways."

Is that true?

A Yes, I would agree with that.

Q You did not do any tests to determine the

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synergistic effect between carbon tetrachloride -- you already said in chloroform -- nor did you do any between, say, toluene and carbon tetrachloride or benzene?

A No, sir, I did not, because there would be no reason to suspect that occurred.

Q Now, you were a part -- when did you do your tests that you were talking about?

A The general ones of the chloroform and carbon tetrachloride?

Q Yes.

A Those studies began when I was at Vanderbilt. The student thesis probably developed over probably the past five years, so I would estimate somewhere around 1977, '78.

Q That was about the time or it was about that same time that you were a part of the task force in this case, is that right?

A That is correct.

Q And you were -- that task force had meetings with AWARE, I believe? Were you working for AWARE then or were you working for Velsicol?

A No, sir, I was a consultant to AWARE.

Q And at that time was it Velsicol's intention -- did you talk to them about them doing a health study?

A Did I talk to them personally?

Q Or did they talk to you or was it --

A No, sir, to the best of my recollection there was no such discussion.

Q There was never any discussion that you know about about Velsicol going to do a health study on the people at Hardeman -- at Toone?

A No, that discussion did occur, but it did not occur with me specifically.

Q All right. Who did it occur with?

A Well, it was discussed amongst the task force on several occasions and that's about all the recollection that I have of that particular matter.

Q Now, you have been speaking this morning about carbon tetrachloride and chloroform or at least Mr. Gentry has been talking in terms of most questions would be carbon tetrachloride and chloroform used interchangeably. Insofar as toxicity, are they in the same ball park or in the same --

A They are similar, yes, sir.

Q So insofar as harmful effects are concerned, they are similar insofar as toxicity?

A Yes, sir, they would be similar.

Q He also -- or you went through certain principles of the toxicology in your direct, and I'd like to go

over some of those principles of toxicology with you that I've kind of gone into. I'd like to show you what's been marked as Exhibit Number 498, entitled Principles of Toxicology. That is my own term -- my own terminology for this. Looking at Page 1, the first one is "Chlorinated hydrocarbons are manmade, and occur rarely, if ever, in nature." Is that true?

A That's probably not totally true. There is some evidence now that those compounds in fact probably do occur naturally and probably are created in the troposphere as the result of irradiation.

Q So you would disagree at least to that extent with that statement?

A Yes, sir.

Q "Extensive experience and research with these chemicals has led to an awareness that adverse health effects can result from exposure to low concentrations of these chemicals."

A Yes, sir.

Q That's true?

A Yes, it is.

Q "We have also discovered that some of these compounds also can cause cancer, birth defects and possibly mutations after exposure to low

concentrations."

A I would agree with that.

Q "In addition, these compounds are hepatotoxic (toxic to the liver) nephrotoxic (toxic to the kidneys) and neurotoxic (toxic to the central and peripheral nervous system)."

A I would agree with that.

Q On Page 2: "Cells that have been damaged in a nonspecific way invariably perform less well than normal cells, whereas cancer cells not only survive in competition with normal cells, but have a selective advantage over them."

Is that generally true?

A Yes, sir.

Q Number 3: "First, epidemiological methods are insensitive and may only detect extremely large increases in cancer risk. The lower limit of detection by these methods has been approximately a 30 percent increase in cancer."

Does that sound okay so far?

A Yes, sir.

Q "Even a 10 percent increase in cancer would be unacceptable, although it would be undetectable in a study of human populations."

Is that --

A I would agree with that.

Q "Second, clinical cancers only appear in humans exposed to carcinogens after substantial lag periods; typically on the order of 15 to 30 years."

A I would agree with that.

Q Number 4: "For the reasons stated, animal tests have become our principal source of information about which chemicals pose a cancer risk in humans. The animals most often used as models are rodents, usually rats and mice. These animals are good predictors of human cancer risk, although arguments can be made that they are in fact not as sensitive to carcinogens as humans."

A I would agree with that.

Q We do know that these rodents, then, are not as sensitive to carcinogens as humans?

A No. I think it says that an argument can be made. I don't think we can make general statements. We have to refer to specific compounds.

Q Okay. Number 5: "Animal test models are used for two purposes. The first is to identify chemicals which are capable of causing cancer, regardless of the dose. Properly designed animal studies use as their highest dose the maximally tolerated dose, defined as a dose which causes no

observable lethal or sublethal tissue damage and results in no more than 10 percent weight loss in the exposed versus unexposed groups. High doses are used in order to produce cancers at a rate high enough to be detected with animal populations of practicable size. If the substance is not a carcinogen, and most are not, it will not increase tumor risk at any dose. The only serious question presented in such modeling is whether a chemical can be a carcinogen at a high dose but not at a low dose, i.e., whether a 'safe' threshold exists. A great deal of independent biologic evidence suggests that there is no such safe threshold. The presumed mechanism of cellular transformation discussed above supports the same view and measurement of tumor risk at low dose levels is statistically inaccessible to practical determination. Second, these tests aid in estimating the extent of the increased risk of cancer at low doses, given high dose data. These estimates are made on the basis of mathematical extrapolations of the high doses which have been shown to cause cancer. None of the several competing models of low dose extrapolation in use assume a 'safe' threshold. Disagreements on the proper model to use do not involve whether the chemical can cause cancer at

low doses; such disagreements rather pertain to how much cancer it can cause."

Do you agree with that?

A Yes, sir, I do.

Q Number 7: "Animal tests are used to identify chemicals which are capable of causing birth defects. The animal tests are used in estimating the extent of the increased risk of birth defects. There is a better than 90 percent correlation between substances which give positive and negative responses in these animal tests. Evidence based upon the techniques described above has shown that the inorganic compounds, and the organic compounds including chlorinated hydrocarbons . . . are toxic and in many cases are carcinogens, teratogens and mutagens."

Do you agree with that?

A Yes, sir, I would.

Q Number 8: "Chloroform is an established animal carcinogen causing cancers in several strains of mice, in rats, and probably in dogs. These animal models have shown that the affected organs include the liver, kidney and thyroid. Several epidemiological studies on human populations exposed to chloroform in public drinking water have shown correlations between chloroform and population cancer rates. On the basis

of available animal and human data, exposure to chloroform in drinking water increases the risk of cancer, birth defects and abortions."

Do you agree with that?

A No, sir, I do not.

Q You do not?

Number 9: "Chlorinated hydrocarbons are known to cause -- are known to damage the liver, kidney, heart and nervous systems. Chlorinated hydrocarbons are suspected of causing cancer and birth defects. On the basis of animal -- of available animal and human data, exposure of chlorinated hydrocarbons in drinking water increases the risk of cancer, birth defects and organ toxicities."

Do you agree with that?

A I don't agree with it in terms of its generality. It would have to depend on which compounds we are talking about.

Q It would have to depend on what?

A It would be compounds specific, that is which ones we were referring to that might produce those changes.

Q Say chloroform?

A It would depend on the level to which the individual was exposed or the level of the water

contamination.

Q And you disagree with that as a general statement about chloroform?

A Well, I disagree with it in the sense that it does not relate to the level of exposure, and unless I know what the level of exposure is I can't agree with the statement.

Q Well, let's take the level of exposure on Exhibit Number 375, which is the average concentrations -- average annual concentrations in ppb on the Sterling and Johnson wells and the Mosier well. Assuming those levels of exposure, would you agree with that statement?

A No, sir, I would not.

Q We are talking about chloroform levels in the drinking water in 1978 of 950 and 970 ppb?

A That is correct.

Q Now, going back to number 8, let's take number 8 first. What is there about number 8 that you disagree with?

A Well, I think that there has been a change conceptually regarding the toxicity produced by chloroform and I would not agree, but again it's going to depend on the level at which the chloroform is in the water as to whether or not there might be

some possibility of producing any of those effects.

Q Haven't you in the past testified to that statement on Page 8?

A Yes, sir, I have.

Q And where was that?

A I believe that testimony was in New Jersey. I can't remember exactly. I believe it was Atlantic City, New Jersey.

Q And in making that statement have you changed your mind since then?

A Well, I agree that chloroform is an established animal carcinogen. I agree with the statement that it causes changes in mice and rats.

Q It causes cancer to several strains of mice and rats, is that right?

A That's correct. I do not agree with the statement about chloroform and its correlation with cancer rates in humans.

Q. When you made this statement in New Jersey, what was the level of chloroform in the drinking water that you were looking at there?

A. I can't recall.

Q. Do you recall whether it was lower or higher than the concentrations in the exhibit there on the board?

A. I am sorry. I can't recall.

MR. GILREATH: Would you mark this as an exhibit for identification?

(The document above referred to was marked Exhibit 504 for identification.)

MR. GENTRY: May I see it?

(Document handed to Mr. Gentry.)

Q. (By Mr. Gilreath) Do you recognize that exhibit?

A. Yes, I do.

Q. That is an affidavit which you filed in the case in New Jersey, is that correct?

A. That is correct.

Q. And on page 11 under "Chloroform --

A. Yes, sir.

Q. Starting down about the third of the way down on the righthand side of the page where it says, "Chloroform is an established animal carcinogen."

A. Yes, sir. I see that.

Q. Would you read that to the end of the paragraph for me?

A. Okay.

(Reading) "Chloroform is an established animal carcinogen causing cancers in several strains of mice, in rats, and probably in dogs. These animal models have shown that the affected organs include the liver, kidney and thyroid. Several epidemiological studies on human populations exposed to chloroform in public drinking water have shown correlations between chloroform and population cancer rates. On the basis of animal and human data, exposure to chloroform in drinking water increases the risk of cancer, birthdefects and abortions."

Q. Now, that's the same statement that is on page 8 of the previous exhibit, is that correct?

A. That's right.

Q. Now, you were looking at chloroform -- in this case you were testifying for the EPA, is that right?

A. For the United States Department of Justice.

Q. And in this case it involved a landfill in New Jersey?

A. That is correct.

Q. And in that landfill they had polluted the

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drinking water of some of the residents?

A. Well, actually it was polluting the drinking water of Atlantic City, New Jersey.

Q. And in this case you were using, you and the government, you as the witness, were using the water quality criteria by the EPA as your standard?

A. That is correct.

Q. And by the water quality criteria we mean what?

A. The water quality criteria are levels which the U. S. EPA has generated which identify health risks that might be associated with exposure to those for some period of time.

Q. All right. Now, over on page 14 of your affidavit is shown "EPA Well No. 1A." Doyou see that?

A. Yes, sir.

Q. And in that well is shown under "Chloroform" 68 ppb?

A. That is correct.

Q. And your statement was, "This level is approximately the 350 times greater than Water Quality Control standards." Is that true?

A. That is correct.

Q. And how many times greater would the 960--

950 -- 950, rather, 1978 in the Johnson and Starling well be -- how many times greater than the Water Quality Control Standard would that be?

A. The Water Quality criteria -- it would probably be several hundred.

Q. Well, 68 is 350 times?

A. Yes, sir.

Q. ppb?

A. Yes, sir.

Q. And that's several times that, even, isn't it?

A. Well, that's 970 parts per billion; so it's a larger concentration.

Q. Well, the concentration in your well number 1A on your affidavit was 68 parts per billion.

A. That's right.

Q. And you testified in this case that that was unsafe?

A. Well, I testified that the general composition of the water for regulatory purposes was not safe for continued consumption by the population of people who would have been exposed, which is not only these people, but the Atlantic City water intake, and it includes a variety of other materials.

Q. And on page 9 -- what is the exhibit number,

the Principles of Toxicology -- what is your Exhibit number on that?

A. That's Exhibit 498.

Q. 498?

A. Yes.

Q. On page 9 of Exhibit 498 is the statement that comes from page 12 of your affidavit, does it not?

A. Yes, sir.

Q. Now, on page 14 of your affidavit you show tetrachloroethylene at 9 ppb.

A. Yes, sir.

Q. In Well No. 1, which exceeds the Water Quality Control -- water quality criteria?

A. That's correct.

Q. And then on page 15 you show in Well No. 2 chloroform at 123 ppb -- that this level exceeds the water quality criteria by 647 times.

A. That's correct.

Q. What is the number of the exhibit for the affidavit?

A. That's 504.

MR. GILREATH: Your Honor, we would like to have Exhibit 504 introduced in evidence.

THE COURT: All right, sir.

(Exhibit 504 received in evidence.)

Q. (By Mr. Gilreath) Would you read into the record from page 11 under "Chloroform" down to where it ends with the word "System."

A. I am sorry. I don't find "System," here.

Q. Okay. We read the other. Let me show you.

A. I see. Do you want me to read the rest of the paragraph?

Q. Yes.

A. "Trichloromethane or chloroform is an industrial solvent and chemical intermediate used in the production of other chemicals. Chloroform is completely absorbed when ingested in drinking water and is then distributed throughout the body. The highest concentrations are found in the peripheral nerves. Rats exposed to chloroform have shown retarded development and reduced birth weights and in one study, an increased rate of malformation was found. Chloroform sensitizes the heart, increasing the possibility of fatal cardiac arrythmia (sudden death.) The lowest doses at which this condition might occur are not known. At high doses it is toxic to the liver, kidney and central nervous system."

Is that where you want me to stop?

A. Yes. We already read the rest of that in, I believe, did we not?

A. I think that's correct.

Q. So chloroform does attack the central nervous system?

A. Chloroform has the pharmacological properties of being able to alter the function of the nervous system. However, it does that only at high concentrations.

Q. Well, you just stated here that the lowest dosage at which this condition might occur are not known. Is that true?

A. I believe that I was referring there to the heart in the sensitization of the heart tissue and the production of cardiac arrythmias.

Q. Well, you didn't say anywhere in this statement that this only occurs in high dosage, did you?

A. No, sir, I did not.

Q. Would you read into the record Paragraph No. 38, on page 19.

A. Part of it is blurred out. Number 38?

Q. Yes.

A. (Reading) "I am concerned as a scientist about the many contaminants and their quantity which have been identified in the water surrounding

-- and then it is blanked out -- in my judgment as a toxicologist, individuals using private wells in the area of the landfill sites should not be exposed to these chemical contaminants in water used for drinking or other purposes, such as bathing. As is evident from my previous observations, the presence of most of these contaminants in public drinking water supplies in any significant quantities would present an extremely serious public health problem."

Q. Now, the short term effects of the chlorinated hydrocarbons are irritation of the eyes, irritation of the throat, skin eruptions, central nervous system effects, depression -- is that true?

A. Well, at certain levels of exposure to chlorinated hydrocarbon those things can occur, that is correct.

Q. Well, if those things occur in the presence of chlorinated hydrocarbons, then it would be natural to assume that the levels of exposure were -- that the levels were enough to cause it, would it not, assuming you had those conditions?

A. No, sir. Those conditions can be caused by other things as well.

Q. What are the long term effects of chlorinated hydrocarbons?

A. Well, the long term effects, again, depending on the dose, might be organ injury, damage to the liver.

Q. Injury to the respiratory system?

A. That is a possibility.

Q. Injury to the blood forming system?

A. Yes, sir.

Q. Injury to the nervous system?

A. Yes, sir.

Q. Now, that can occur as a result of low level exposure, can't it?

A. In general, those effects will be seen only with high exposure, and generally with chlorinated hydrocarbons that are much larger in molecular weight than chloroform and carbon tetrachloride.

Those things generally occur with the higher chain chlorinated hydrocarbons.

Q. Didn't you testify in the Price Pit case that these conditions can occur as a result of long term low level exposure?

A. I don't recall that testimony. I may have.

MR. GILREATH: I will ask that this be marked for identification.

(The document above-referred to was marked Exhibit 505, for identification.)

Q. (By Mr. Gilreath) Is that a copy of your testimony in that case, Exhibit 505?

A. Yes, it is.

Q. Would you look at page 23?

A. Yes.

Q. Look at line 13 --

"Q. Could you advise the court what such short term effects generally are in terms of these toxic chemicals?"

And then read your answer.

A. (Reading) "A. The short term effects would be various irritations such as irritation of the eyes, the throat, causing coughing, perhaps skin eruptions, things like chloracne or pimples as a result of exposure to various chlorinated hydrocarbons. General nuisance irritation problems as a result of exposure which lasts for a short term occur very soon after exposure."

Q. And the next question --

"Q. Are central nervous system effects also short term or acute effects?"

And then your answer.

A. (Reading) "A. Central nervous system effects such as depression, unconsciousness or affecting the central nervous system in one way or another to impair motor activity would be a short term effect."

Q. And the next question --

"Q. Now, in addition to the short term effects, Dr. Harbison, can you advise us what long term effects or chronic effects may occur?"

Would you read your answer?

end

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A "The long term effects or chronic effects are generally thought of as being either specific organ injuries, such as injury to the respiratory system or injury to the blood forming system or injury to the nervous system which occurs as a result of long term, low level exposure to various substances. Examples of that might be lead encephalopathy, an alteration of nervous system function as a result of long term, low level exposure to lead. The other chronic effects that are of concern and that are generally thought of are birth defects or the production of birth defects, which is known as a teratogen or teratogenicity. The production of mutations in genetic material of germinal cells which will affect future generations and the production of cancer which would be an effect on genetic material of somatic cells or all other, the egg or the spermatozoa."

MR. GILREATH: Your Honor, we'd like to move that Exhibit 502 --

THE CLERK: 505.

MR. GILREATH: -- 505 be admitted.

THE COURT: All right. This is the last document you had reference to?

MR. GILREATH: Yes.

THE COURT: All right, sir.

MR. GILREATH: Exhibit 505 is testimony in the United States District Court for the District of New Jersey.

(Whereupon, the above-mentioned document was marked Exhibit Number 505 to the testimony of the witness and same will be found among the exhibits hereto.)

BY MR. GILREATH:

Q Now, insofar as the water quality guide of the EPA is concerned for suspected carcinogens, which is -- chloroform is one and carbon tetrachloride under their criteria, is that right?

A That is correct.

Q Insofar as risk evaluation or risk determination is concerned, no level is safe, that's what they say, isn't that right?

A Well, the EPA says that there is no scientific basis for any model for making judgments about safety and, therefore, since there is no scientific basis for that as an interim action they will assume that there is no safe level.

Q And that's what you so testified in this Price's pit case, that was your testimony?

A You mean did I testify that the water quality

criteria were -- I'm not sure I understand your question.

Q Did you not testify that methods do not now exist to establish a threshold for a carcinogen and that there is no scientific basis for estimating the safe level, therefore there is no safe level for a carcinogen in drinking water?

A Well, sir, I only testified in reference to the compounds that were found in those wells, which include the longer chain chlorinated hydrocarbons like vinylchloride, which included the chlorinated benzenes, the naphthalenes. For those substances that is a different consideration. For carbon tetrachloride and chloroform that is not a consideration.

Q Is not chloroform and carbon tetrachloride a suspected carcinogen?

A Yes, sir, it is.

Q Then doesn't that quality control guide apply to those suspected carcinogens? Isn't that what it says?

A The water quality criteria, yes, sir, it does.

Q So if you applied that rule, then, then there would be no safe levels for carbon tetrachloride and chloroform under that rule?

A Under the rule of the water quality criteria,

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that's correct.

Q And that's the rule that you were advocating when you were testifying for EPA in that case?

A Well, I was advocating that rule based upon a regulatory process to prevent the utilization of water by the city of Atlantic City that contained these materials.

Q Well, you wouldn't apply a different rule to this Hardeman County situation, would you?

A Yes, sir. I think there's a very different rule. What we are talking about is causation and that differs significantly from regulatory standards.

MR. GILREATH: I think I'm about through, Your Honor.

BY MR. GILREATH:

Q Dr. Harbison, are you familiar with a study involving a human being who was cleaning his gun with carbon tetrachloride, he had a couple of drinks and caused a peripheral neuritis and there was a study done on this person? Do you recall that study?

A No, sir, I do not.

MR. GILREATH: That's all we have.

THE COURT: All right, sir.

MR. GENTRY: Your Honor, I will be about fifteen or twenty minutes on redirect.

THE COURT: All right. Do you want to come back at 1:45? Will that be all right?

MR. GILREATH: Can we finish that now? We have got a witness that needs to get on after lunch.

MR. GENTRY: I don't see how that is going to make a lot of difference if we are going to break for lunch immediately afterwards.

MR. GILREATH: All right.

THE COURT: All right.

(Recess.)

THE COURT: All right, Mr. Gentry.

MR. GENTRY: I'm waiting for Mr. Gilreath.

THE COURT: Oh, okay.

MR. GENTRY: May we proceed, Your Honor?

THE COURT: Yes, sir.

REDIRECT EXAMINATION
BY MR. GENTRY:

Q Dr. Harbison, I'd like to take Exhibit 498, which is entitled Principles of Toxicology written on top of the exhibit, and paraphrase the first one a little bit, if I may.

Carbon tetrachloride and chloroform are manmade and occur rarely, if ever, in nature.

Is that true or false?

A Well, it's partially true and partially not true.

Q Still talking in terms of carbon tetrachloride and chloroform as opposed to chlorinated hydrocarbons:

Extensive experience and research with these chemicals has led to an awareness that adverse health affects can result from exposures -- exposure to low concentrations of these chemicals, carbon tetrachloride and chloroform.

What would you say to that?

A I would say that's not true.

Q "We have also discovered that some of these compounds" -- and let's just say that we have also discovered that carbon tetrachloride and chloroform also can cause cancer, birth defects and possibly mutations after exposure to low concentrations.

A That is not true.

Q In addition, carbon tetrachloride and chloroform are hepatotoxic, nephrotoxic, and neurotoxic.

A That is partially true.

Q How many chlorinated hydrocarbons are there, sir?

A There are hundreds, thousands.

Q What's the difference between carbon tetrachloride and chloroform and chlordane?

A The number of carbons in the molecule, the amount of chlorine on the molecule, the basic structure of the molecule, its physical properties, both its physical and chemical properties.

Q The molecular weight?

A Molecular weight is considerably different.

Q Is the difference in molecular weight a critical difference?

A Yes.

Q Carbon tetrachloride and chloroform, are they high molecular weight or low molecular weight chlorinated hydrocarbons?

A They are low molecular weight.

Q Dr. Harbison, tell me about this United States versus Charles Price, et al. When did this occur?

A Well, I believe it was late 1979 or sometime in 1980. I can't recall the exact date.

Q And you were a witness for whom?

A I was a witness for the United States Department of Justice.

Q They were bringing an action under what?

A Under the Clean Water Act.

Q And they were basing their action against these people on what?

A Well, on the changing of the quality of the water that had been there and based upon the use of that water for public drinking.

Q Were they relying upon the water quality criteria as set up by the EPA?

A Yes, they were.

Q Do you discuss in your affidavit what the water quality criteria means?

A Yes, I do.

Q Where do you do that, sir?

35?

A I haven't found it yet.

Q On Page 12.

A Right, it's 35.

Q Read that to the Court, please.

A "Following the passage of legislation in the Congress, the United States Environmental Protection Agency promulgated standards designed to ensure that the American public is not exposed to dangerous levels of toxicant drinking water. These standards are expressed in terms of risk analysis. While U.S. EPA suggests that no exposure to carcinogens occur in drinking water, it has expressed its standards in terms of estimated risks from these contaminants. These estimates are based upon the scientific information to

which I have previously referred. The Water Quality Criteria are expressed in terms of one additional cancer per one million population as a function of a lifetime exposure to the particular carcinogen. The most recent publication of the standards appear in the Federal Register on November 28, 1980 and is attached as Exhibit B to this affidavit. The Water Quality Criteria are a useful guide to risk assessment from chemical exposure and will be referred to by me in my analysis of data in this case."

Q Now, there is an exhibit that is the Water Quality Criteria, is there not?

A That's correct.

Q Can you turn to Page 79323 of the Water Quality Criteria and read the first paragraph or the first couple of sentences designated "Risk Extrapolation".

A Okay, it's entitled "Risk Extrapolation."

"Because methods do not now exist to establish the presence of a threshold for carcinogenic effects, EPA's policy is that there is no scientific basis for estimating 'safe' levels for carcinogens."

Do you want me to proceed?

Q Yes, please.

A "The criteria for carcinogens, therefore, state that the recommended concentration for maximum

protection of human health is zero."

Q All right. Now, drop down to Health Guidelines in the next paragraph, and there's a phrase which commences "The estimation of health". Do you see that?

A Yes, I do.

Q Read that.

A "The estimation of health risks associated with human exposure to environmental pollutants requires predicting the effect of low doses for up to a lifetime in duration."

Q Are those scientific statements or policy statements?

A Those are policy statements.

Q Are those statements directed to genotoxic carcinogens?

A Yes, sir, they are.

Q And what did you tell me a genotoxic carcinogen was?

A A genotoxic carcinogen is one that is able to interact with the genetic material of the cell and cause a change in that cell to initiate cancer.

Q Would that be -- withdraw that question.

Do you have the transcript of the hearing in front of you, sir?

A Yes, I do.

Q Can you turn to Page 28 for me, please?

A Yes.

Q Do you see line 8 there? And I'll start with the question, if I may, and I will let you answer the questions. Will you do that with me?

A Yes.

Q "Now, we've described the tools which toxicologists use in identifying problems caused by chemicals. We've also talked about the results from a toxicological standpoint in terms of their short term and long term effects. By the way, in terms of long term effects, Dr. Harbison, can you give us a time frame? We talked about chronic or long term, but what is generally meant from a toxicological standpoint in terms of years?"

What's your response?

A I'm sorry, give me the page again.

Q Do you have the transcript? Not your affidavit, the transcript.

A Yes, I have the transcript.

Q It would be 26, as near as I can see.

A I'm sorry, I thought you said 28.

Q It looks like 28 and I believe it's 26.

A Okay. Line 18?

Q Yes.

A Okay. "For carcinogenicity or the production of cancer, it is generally thought of to be fifteen to thirty years. That is the time from exposure until the disease actually occurs. For mutagenicity it's thought to be at least one generation, which would be approximately twenty-two years. And for teratogenicity it could be anywhere from a few weeks to probably more like eight to nine months."

Q Now, before I read the next question, I'd like to ask you, are we referring to genotoxics there?

A Yes.

Q The next question is:

"In any event, Doctor, we have discussed the tools that toxicologists use, the effects that are generally observed through the use of those tools. I wonder if you could advise the Court when one is dealing with the human being or the human system what the entry points are that these chemicals may attack or actually get into the body to cause the type of effects which we have just described?"

A "Chemicals can get into the human system by one of three ways. They can be"-- It says observed, but I'm sure that should be absorbed -- "across the surface of the skin, which is known as percutaneous

absorption. They can be" -- again it says observed, but I think it should be absorbed -- "from the gastrointestinal tract view contaminants in food or drink, and they can also be absorbed through the respiratory tract if they are airborne either as a mist or vapor or somehow suspended in the air."

Q Now if you would turn over to Page 28, we are talking about mechanisms for the production of cancer and the attorney questions you:

"I wonder if you could advise the Court what those mechanisms are?"

A "Well, there are at least two. And one is a genetic mechanism, the genetic mechanism being the direct interaction of the chemical with DNA of various cells of the body. The other mechanism is an epigenetic mechanism and tumors or transformation of cells into cancerous cells occurs as a result of toxic recurrent tissue injury from exposure to an irritant or some chemical to produce various tissue damage."

Q The chemical that produces the genetic mechanism, is that a genotoxic chemical?

A Yes, it is.

Q And what kind of chemical would produce the epigenetic mechanism?

A That would be substances like carbon tetrachloride and chloroform.

Q Is that testimony consistent or inconsistent with the testimony you have given here today?

A That testimony is consistent.

Q Would you turn to Page 31, please, sir.

A Yes.

Q At the top of the page, I believe it's Mr. Walsh says:

"Dr. Harbison, you were talking about the routes in which chemicals can cause cancer in human beings. I wonder if with reference to 408 you could describe those various pathways?"

I'm assuming 408 was an exhibit.

A Yes, sir.

Q What is your answer there?

A "What we are talking about, two specific mechanisms whereby chemicals can introduce cancer as a result of interaction with the cells. The two pathways are one, a genotoxic pathway or genetic time mechanism whereby the chemical interacts with -- directly with DNA. There is an interaction which -- which occurs with DNA to alter the genetic mixture. So now the cell is transformed into a new cell line which is now uncontrolled and in growth. The other

mechanism, being enzymatic or a tissue injury pathway as a result of chronic recurrent tissue, might occur from trichloroethylene or other chlorinated hydrocarbon solvents which produce various organ injury such as injury to the liver. The chronic recurrent injury over a period of many years into the repair process by chance alone, there will be spontaneous mutations which will occur which will again transform cells into a new cell line which now become uncontrolled in their growth. So both of these result in transformation of cells to a new cell line." It's says lining, but I think it should be line. "The hazard with the genotoxic organic pathway is only a cell, a single cell, to transform the DNA."

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Q. Is that statement consistent or inconsistent with testimony you have given here today?

A. That statement is consistent with the testimony I have given here today.

Q. Turn if you will to page 50, at the bottom of the page, and Mr. Walsh queries you as follows:

"Q. With respect to chloroform, can you advise the Court as to its toxic properties?"

Would you give me your answer to that, please?

A. (Reading) "A. Chloroform is an -- it says UP -- I don't know what that means -- chloroform is an up as opposed to the ethane. It is a single carbon atom, and chloroform has been around for a long period of time. Chloroform is a very potential anesthetic. It has very potent properties to depress the central nervous system. It was actually used for an extensive period of time as an anesthetic agent. Most recently, and the reason it was discarded as an anesthetic compound is because it sensitizes the heart tissue to the compounds that are known as cathepolmines, c-a-t-h-e-p-o-l-m-i-n-e-s and the cadmium, c-a-d-m-i-u-m, are the materials that cause the heart to beat faster, and chloroform sensitizes the heart and those compounds and causes an arrythmia. It results in very sudden death as a result of the exposure to the vapors of

9-2

chloroform, is one of the reasons for abandoning it as an anesthetic."

Q. (Reading) "Q. Because it will fibrilate the heart?

A. (Reading) "A. Cause fibrilation and cause immediate death. It is also toxic to various organs. It produces --"

Q. (Interposing) I expect that is hepatotoxic.

A. (Continuing to read) "-- hepatotoxic"-- I think that sentence should be "It produces hepatotoxicity. It produces hepatotoxic injury to the liver resulting in destruction of liver cells; resulting in extensive liver damage. It also damages the kidneys and it is a recognized carcinogenic as well as being a teratogen."

Q. I will ask you this, sir, with regard to that statement: Would it take a large or small dose of chloroform to create extensive liver damage?

A. It would take a very large dose.

Q. On the order of how many parts per billion or million, sir?

A. It would take hundreds of thousands of parts per million.

Q. Would it take a large or small dose to damage the kidneys?

A. It would be the same. It would take a very

9-3

large dose.

Q. I will ask you to turn to page 60 of the transcript if you will, please. Mr. Walsh asked you the following question, bottom of the page:

"Q. Dealing with the actual water quality criterion as they affect human beings, does the water quality criterion itself indicate the water is safe to drink?"

Now, your answer.

A. (Reading) "A. No; the contrary. For those substances which are known carcinogens or suspect carcinogens there is a statement that no level is safe. But assuming a certain level of contamination the increased risk for cancer would be at a certain level, assuming consumption of the water at that level of contamination."

Q. (Reading) "Q. You actually deal with the concept of the water quality criterion at paragraph 35 of your affidavit, 175 in evidence, do you not, Dr. Harbison?"

A. (Reading) "A. That's correct."

Q. (Reading) "Q. I wonder if you could advise the Court and counsel what the risk factor is based upon and how U. S. EPA has come up with the so-called water quality criterion?"

9-4

A. (Reading) "A. The risk factor is based upon an extrapolation of animal data from a high dose to a low dose. Through that extrapolation process the risk factor is determined that based upon a certain level of exposure there will be a likelihood of one or more cancers occurring for certain numbers of population or for a certain number of people who would be exposed to that particular contaminant in the drinking water."

Q. Now, I am asking you this question exclusive of the record to which we are referring, and by the way, that record, for our transcript, is Exhibit 505.

Is that a lifetime exposure?

A. That is a lifetime exposure.

Q. Doctor, I have just one more area to query you about. If you will turn to page 78 of the cross examination. Mr. Gladden asked you this question:

"Q. You have testified at length about the types of chemicals and their results on the human cells. In fact, that some cause cancer mutations, et cetera. Do we get into a problem of how much dosage causes or has the kind of effects that you have testified to on the cells?"

And your answer?

A. (Reading) "Yes."

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Q. (Reading) "Q. What kind of dosages are we talking about?"

A. (Reading) "A. For which effect?"

Q. (Reading) "Q. Well, let's take the first one. For the cancerous things."

A. (Reading) "A. For the cancer effect depending on whether it is a genetic pathway or a genetic action or epigenetic pathway, probably as we have already pointed out, maybe only one molecule. That doesn't seem very probable, but certainly that is a workable hypothesis. For the recurrent tissue injury we would have to have enough exposure to provide or to produce some sort of organ injury. So, for example, trichloroethane or some of the smaller molecular weight chlorinated hydrocarbons, it would be a much larger dose."

Q. (Reading) "Q. Does the dosage also affect whether the results on the cells are acute or chronic in nature?"

A. (Reading) "A. It can, yes."

Q. (Reading) "Q. I notice that the water policy criteria talked about a lifetime situation. What does that mean?"

A. (Reading) "A. It means ingestion of that material for the lifetime of the individual."

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Q. (Reading) "Q. Well, I am a layman. I have a little trouble understanding that. Are we saying that if a person throughout his lifetime -- we take the normal life -- what, sixty years, seventy years, something like that?"

A. (Reading) "A. Yes."

Q. (Reading) "Q. Is that what is done to create this standard, ingest the chemical involved for a lifetime, then he is exposed to the risk of one in a million or whatever the test comes out to be?"

A. (Reading) "A. That is correct."

Q. Dr. Harbison, were there certain wells that were involved in this lawsuit?

A. Yes.

Q. Before we get to that, there was some reference to your putting into evidence in that transcript a flow chart or something that described the genotoxicity route as opposed to the other route, the recurrent injury route.

A. Yes.

Q. Do you remember what that looked like?

A. Yes, I do.

Q. Do you have one of those with you?

A. Yes, sir, I do.

Q. And what is it contained?

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A. That chart is contained in the book that we have put together for the U.S. EPA, entitled "Toxicological Evaluations, Risk Assessment and Safety Determinations for Chemical Exposures."

Q. Do you have more than one copy of that book?

A. No, sir. I only have the one.

Q. Would you turn to wherever that flow chart is located, if you will, phase?

A. That flow chart is located between page 55 and 56.

Q. Would you hand it to me so I may show it to opposing counsel first.

A. All right, sir.

MR. GENTRY: With the Court's permission, may I hand this particular chart to the court?

THE COURT: I see what it looks like. It looks awfully complicated. Maybe he can just describe what it is.

MR. GENTRY: All right, Your Honor.

Q. Tell me what that chart shows, if you will, please, Dr. Harbison?

A. Well, the chart shows that a substance is metabolized or changed from a parent compound to a metabolite, and that metabolite can result in tissue injury or produce cancer as a result of an epigenetic

pathway, or it can bind to DNA directly and cause cancer by genotoxic pathway, and it goes on to describe the various kinds of damage that would be produced as a result of that metabolic transformation.

Q. You referred to tissue damage as far as that chart is concerned. Is that the same thing as cell death?

A. Yes, it is.

Q. Does that chart describe the type of compounds that you think carbon tetrachloride and chloroform are?

A. Yes, it does.

Q. What does it say about those two compounds?

A. Well, it --

Q. (Interposing) I know it doesn't refer to those two compounds specifically. But what does it say about them?

A. That the epigenetic pathway is the pathway by which carbon tetrachloride and chloroform produce recurrent cell damage and cell death and can result over a prolonged period of time in the production of cancer.

Q. Is that chart in any way contrary to your testimony that you have given here today?

A. No, it is not.

MR. GENTRY: Would you make that entire

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volume an -- we seem to be putting in things by books, Your Honor -- so I would just standardize the procedure and ask the court to admit the book as Exhibit 506, with the understanding that that chart is contained between pages 55 and 56.

THE COURT: All right.

Q. (By Mr. Gentry) Would you make that an exhibit for identification?

(The document above-referred to was marked Exhibit 506, for identification.)

Q. (By Mr. Gentry) Just so I understand, I will ask you again -- what is that book?

A. This is the book that we have prepared which is entitled "Toxicological Evaluation: Risk Assessments and Safety Determinations for Chemical Exposures."

It was prepared for the United States Environmental Protection Agency for teaching this course to its people and the Department of Public Health persons in the southeast.

Q. Anywhere in that book do you advise the EPA to use a percentage as a risk assessment?

A. No, sir.

Q. Let me ask you to turn your attention for a moment to Exhibit 504, and let's just go to the first

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well on page 14 of 504.

A. Yes.

Q. I notice there are inorganic compoundsand organic compounds in that well?

A. That's correct.

Q. Of the organic compounds, am I correct most of them are chlorinated hydrocarbons, but not all?

A. That is correct.

Q. How many parts per billion of chlorinated hydrocarbon do you have in that first well?

A. Well, I roughly added it up, and it is about 140,000 parts per billion.

Q. Of all chlorinated hydrocarbons?

A. That is correct.

Q. Of which chloroform represents how many parts per billion?

A. 68 parts per billion.

Q. Now, you are not counting the inorganics in there, are you, sir?

A. No, I am not.

Q. What is the largest combination of chloroform and carbon tetrachloride in the worst year on Exhibit 375?

A. Well, it looks to be about 10,300, and I would say 40 or 50 -- 10,350 parts per billion.

Q. Of --

A. Of chlorinated hydrocarbons.

Q. When you look at the organic compounds in well No. 1, are there some or many heavy molecular weight chlorinated hydrocarbons, I should have said few or many.

A. There are -- compared to carbon tetrachloride and chloroform, there are many which have a higher molecular weight.

Q. Turn over to page 15, and let's look at the inorganics on well No. 2 just for a minute.

I notice they have arsenic, 31 parts per billion there. Is that a known human carcinogen?

A. Yes, sir. Arsenic is a known human regulated cancer-causing agent.

Q. Are there any other of those heavy metals that are known regulated human carcinogens?

A. I am not sure. Cadmium, maybe. I am not really for sure about that. I don't think it is on the list of known.

Q. What was the United States asking as it related to these wells, what was their position as it related to these wells?

A. My understanding of the position of the United States Department of Justice is that it was asking for

a new water supply to these people who had contaminated wells and was further asking for some relief to the possible intake of these materials into the Atlantic City water supply, and that relief was in the form of moving the water intake for the City of Atlantic City to some other place such that it would not take these materials into it.

Q. Were the people still ingesting the water from those wells at that time?

A. To the best of my knowledge I believe they were.

Q. Doctor, in light of the cross examination, I am going to ask you one question, one more question. What is the scientific reason for your testimony that there is no risk of cancer in these people who ingested the waters as we see them in Exhibit 375?

A. The scientific basis for my testimony considers the mechanism of action of carbon tetrachloride and chloroform; that is what we know, both about its metabolism and its interaction with cells and parts of cells. Both carbon tetrachloride and chloroform are not converted to metabolites which interact with DNA. They could not possible form substances which interact with DNA to lead to initiation of cancer, and, further, based upon our occupational experience with carbon tetrachloride, and chloroform, which has a

long history, there is no evidence that these two substance have resulted in an increased incidence of cancer, and, further, based upon our extensive experience with the use of these materials as therapeutic agent in the pharmacutical sciences, again there is a long continued history and safe use of these materials for the treatment of a variety of diseases. So it is based upon my knowledge of the mechanism of action of these materials and also based upon their past incidence of use.

MR. GENTRY: Thank you, Dr. Harbison, that is all.

RECROSS EXAMINATION
BY MR. GILREATH:

Q. Doctor, looking at Exhibit 13, is toluene a genetic or epigenetic carcinogen?

A. I don't believe that there is very much evidence regarding the carcinogenicity of toluene. I couldn't answer that question.

end

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Q How about benzene?

A Benzene. There is certainly evidence that benzene can be metabolized to a metabolite which could bind to DNA. It can be metabolized to an epoxide, it certainly has that potential.

Q And naphthalene?

A Naphthalene, my response would be similar to that for benzene. Certainly has the molecular configuration whereby it could be biotransformed to a compound that could bind.

Q All right. That would make them, then, under your definition, a genetic carcinogen as opposed to an epigenetic, is that right?

A Yes, sir. My opinion about that would be that those would be much more likely to be genotoxic agents.

Q All right. Now, if you take a genetic carcinogen such as those two, then you have the potential for what you call the one-hit mechanism, don't you?

A Well, I don't call it the one-hit mechanism. There certainly is a hypothesis that suggests that. A single chemical can interact with a single strand of DNA to cause transformation of a cell, and certainly naphthalene and benzene, based upon their molecular

configuration, could have that potential.

Q Look on Page 32 of your testimony at Line 7, the question:

"This sometimes" --

A I'm sorry, I haven't found it yet.

Q Okay. I'm sorry.

A Page 32?

Q Yes.

A Yes.

Q "This sometimes called the one-hit hypothesis? ANSWER: That is correct."

A Yes, sir.

Q Now, the one-hit hypothesis is outlined in your affidavit on Page 4, is it not, under Number 11?

A Yes, sir. It says in theory, that's correct.

Q That's what you are talking about there is the one-hit hypothesis. Would you read that, please?

A "In theory, it might take only a single molecule of chemical to produce a mutation in the DNA of a body cell. A single chemical molecule in a liter of water would have an extremely small possibility of causing such change, but when a chemical contaminant reaches the level of detectability it is present in a liter of water in a number of hundreds of

trillions or quadrillions of molecules, ten to the fourteen or ten to the fifteen molecules. What seems an insignificant exposure, tens of parts per billion, for example, is in reality an occasion for an enormous number of damaging encounters between a chemical carcinogen and its DNA target in body cells. It is in this way that very small exposures can lead to damage."

Q There you are talking about the concept of causing cancer without first causing injury?

A That is correct, that is the direct binding of the substance to the DNA.

Q May I see your green book there for a moment?

All right, looking at Exhibit 506, on the left is your epigenetic mechanism, is that right?

A Yes, sir.

Q All right. Now, in your epigenetic mechanism you assume that there is some repair and regeneration?

A Yes.

Q All right. Now -- and that there is no immunosuppression?

A That is correct.

Q Now, this thesis that you are advocating there, then -- and I'm reading from the book on carbon tetrachloride and other -- chloroform and carbon tetra --

the National Research Council book. Is that the one you read from earlier?

A Yes, it is.

Q All right. Let me show it. On Page 167 -- 187, excuse me, there where it says, "The threshold model" in the third paragraph down.

A Yes.

Q "The threshold model assumes some critical level of exposure below which the carcinogenic process will not be" -- is that word initiated?

A Yes.

Q "The arguments in support of no effect levels generally center around the concept of proper detoxification and adequate repair system, including DNA repair and immunosuppression."

So if those -- that thesis assumes that there is an adequate repair system, and so forth, is that right?

A That is correct.

MR. GILREATH: That's all we have.

MR. GENTRY: First, Your Honor, may I inquire of Mr. Gilreath if that's our book that's in possession of the witness?

MR. GILREATH: Yes.

MR. GENTRY: I have just two questions,

Your Honor.

REDIRECT EXAMINATION
BY MR. GENTRY:

Q Doctor, I will show you Exhibit 357, which is a run down --

MR. GENTRY: If the Court pleases. I'm sorry.

THE COURT: Yes, sir, go right ahead.

BY MR. GENTRY:

Q -- which is a run down of the Sterling and Johnson wells made by ERM, look at 10 and 12, and tell me if you can find benzene in any amount in that particular exhibit in either the Johnson or Sterling well?

A No, I do not find it.

Q Do you find naphthalene?

A In the Sterling well?

Q Yes.

A Yes.

Q All right. Do you find any reading above your reference ten parts per billion?

A No, I do not.

Q What's the highest?

A The highest is six point three parts per billion.

Q Are there any nondetectables there?

A Yes, there are.

Q Turn over to the Johnson well, if you will, please.

A Yes, I find naphthalene.

Q Any above your reference ten parts per billion?

A No.

Q What's the highest?

A The highest is two point seven parts per billion.

Q Any nondetectables?

A Yes, there are.

MR. GENTRY: All right, thank you. That's all.

MR. GILREATH: That's all we have.

THE COURT: All right. You may step down, please.

MR. GENTRY: If the Court pleases, may Dr. Harbison be excused?

THE COURT: Any objection, Mr. Gilreath?

MR. GILREATH: No, Your Honor.

THE COURT: All right.

(Witness excused.)

MR. GENTRY: If the Court pleases.

THE COURT: Yes, sir.

MR. GENTRY: May it be allowed for Mr. Hanson to leave the table? He's going to try

to take Dr. Harbison to the plane.

THE COURT: All right, sir.

MR. GENTRY: Your Honor, we have a couple of housekeeping matters which may or may not be mooted by some previous statement concerning how -- Exhibits.

Excuse me, Your Honor. It seems that I have to give the keys to someone.

THE COURT: All right.

Mr. Wharton.

(Whereupon, an off-the-record discussion was had.)

THE COURT: All right, Mr. Gentry, go right ahead.

MR. GENTRY: Your Honor, there is an exhibit 388 which contains a stipulation between the parties. That is the rather bulky exhibit that contained the various headlines from newspapers.

THE COURT: Yes.

MR. GENTRY: We have not read the stipulation into evidence. This was accepted into evidence and the better part of valor prompts us to ask the Court if the stipulation and the documents contained therein are indeed

in evidence for the purpose for which they were stipulated.

THE COURT: It is for the Court, because if you were to undertake to read that I would certainly help you find the solution to the problem.

MR. GENTRY: Thank you, Your Honor. That was a housecleaning job we wanted to make sure was finished.

THE COURT: Yes.

MR. GENTRY: We have one other item to which the Court can direct its attention and, under the Rules of Evidence as we understand them, take judicial notice. It is a portion of the Federal Register dated January 4, 1983, which announces a partial administrative stay with reference to the identification and classification and regulation of potential occupational carcinogens. That was the result of the colloquy -- I mean we proffered this as a result of the colloquy the other day as to whether or not there was -- whether it had been cancelled or whether it had been put in some kind of limbo, and we find that the proper words are partial stay.

And we would proffer this for the Court's perusal.

THE COURT: All right.

Any objection, Mr. Gilreath?

MR. GILREATH: No, Your Honor.

THE COURT: All right.

MR. GENTRY: We would like to mark it as an exhibit.

THE CLERK: It will be Number 507.

(Whereupon, the above-mentioned document was marked Exhibit Number 507 to the testimony of the witness and will be found among the exhibits hereto.)

MR. GENTRY: I'm about to utter words that I suspect will be of great relief to the Court.

That completes the defendant's defense.

THE COURT: All right, sir. It is a joy to hear those words. Of course, there are words that could be more joyful.

But I had better be serious on the record, Mr. Gentry. The Court understands.

Mr. Gilreath, it's up to you to say something.

MR. GILREATH: We are ready to go forward with our rebuttal.

THE COURT: All right. I take it there are no motions or anything at this point?

MR. GENTRY: Well, Your Honor, there are some motions that we would like to make. I was almost referring then to make a suggestion to the Court that perhaps as it relates to the proposed rebuttal proof we should have parameters. I can visualize a retrying of the plaintiffs' case if true rebuttal is not adhered to, and I don't know whether the Court has really --

THE COURT: Mr. Gentry, a week or so ago you all heard me tell a fine man standing there that the Court could not presume that the Internal Revenue Service would not follow the law. Well, I certainly can't presume that able lawyers such as Mr. Gilreath and Mr. Wilder and Mr. Garrety will not follow the law and the rules that apply any more than I could presume that you or Mr. Spragins or Mr. Mitchell would not follow the law.

So I think the Court has to assume that until the Court's assumptions are demonstrated to be misplaced assumptions.

MR. GENTRY: The simile is well taken,

Your Honor.

THE COURT: Thank you.

MR. GENTRY: I understand --

THE COURT: The other thing, it seems to me, is that it might be helpful for us to go ahead and complete the proof in this case. Then if it becomes necessary down the road, we can take up really any motions that might be necessary, and you have that flexibility where it's a nonjury trial.

MR. GENTRY: Very well, Your Honor. With that suggestion from the Court, we will not proffer our motions at this time.

THE COURT: All right, sir. And I think the Court ought to state on the record that neither side waives anything --

MR. GENTRY: Thank you, Your Honor.

THE COURT: -- in accepting the Court's suggestion.

MR. WILDER: Your Honor, I have one housekeeping matter too. When I was reviewing the transcript last week prior to Mr. Wade's testimony, I was going back and looking at Exhibit 276 that had been introduced for -- I thought as an exhibit introduced into the

record, but possibly there was a caveat put on the introduction of it by Mr. Spragins. This is the real estate notebook of Mr. Murdaugh's, and I believe the caveat was that if he saw any objection he would make it. If not, it would go into evidence. But I did not officially move it into evidence after Mr. Murdaugh's testimony and I would like to do that at this time.

THE COURT: All right. Is there any objection at this point, Mr. Gentry?

MR. GENTRY: I will defer to MR. Spragins, if the Court please.

THE COURT: All right, sir.

MR. SPRAGINS: I haven't thought about it for several months, Your Honor. My recollection is that I didn't have any objections. I will tell you for sure in the morning.

MR. WILDER: Very well, Your Honor.

THE COURT: Well, suppose we go ahead and admit it subject to whatever objections, if any, Mr. Spragins might come up with.

MR. SPRAGINS: That is all right.

MR. WILDER: Thank you.

(Whereupon, the above-referred to

document was marked Exhibit Number 276 to the testimony of the witness and same will be found among the exhibits hereto.)

MR. GARRETY: If the Court please, call Dr. Scott Clark.

THE COURT: All right, sir.

Do you gentlemen want Dr. Clark sworn again? I don't think it's necessary.

MR. GENTRY: No necessity for that, Your Honor.

THE COURT: All right, sir.