ORIGINAL

COMMONWEALTH OF PENNSYLVANIA

PUBLIC UTILITY COMMISSION

Letter of Notification of Philadelphia Electric Company relative to reconstructing and rebuilding of the existing 138 kV line to operate as a Woodbourne-Heaton 230 kV line in Montgomery and Bucks Counties.	Docket No. A-110550F055
Further hearing.	

Pages 296 through 433

Hearing Room No. 1
State Office Building
Broad and Spring Garden Streets
Philadelphia, Pennsylvania

Thursday, September 19, 1991

Met, pursuant to notice, at 1:05 p.m.

BEFORE:

HERBERT SMOLEN, Administrative Law Judge

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C O N T E N T S

E X H I B I T S

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P R O C E E D I N G S

ADMINISTRATIVE LAW JUDGE HERBERT SMOLEN: This is the further hearing in the matter of the letter of notification of Philadelphia Electric Company in Docket A-110550F055.

This afternoon's hearing is for the purpose of presenting the testimony and cross-examination of the OCA witnesses.

Are we ready to proceed, Ms. McCloskey. .

MS. McCLOSKEY: Yes, Your Honor. Thank you.

The Office of Consumer Advocate calls David Rosenbaum to the stand.

Whereupon,

DAVID M. ROSENBAUM

having been duly sworn, testified as follows:

JUDGE SMOLEN: State your full name and business address.

THE WITNESS: My name is David Mark Rosenbaum and my business address is Risk Analysis Corporation, Suite 202, 6723 Whittier Avenue, McLean, Virginia 22101.

JUDGE SMOLEN: Ms. McCloskey.

MS. McCLOSKEY: Thank you, Your Honor.

I would like to have marked for identification OCA Statement No. 2, which is the direct testimony of David M. Rosenbaum.

JUDGE SMOLEN: So marked.

(Whereupon, the document was marked as OCA Statement No. 2 for identification.)

DIRECT EXAMINATION

BY MS. McCLOSKEY:

Q. Mr. Rosenbaum, do you have before you a copy of your prepared prefiled direct testimony in this case consisting of nine pages of questions and answers and one exhibit?

A. Yes, I do.

Q. Was this testimony and was this exhibit prepared by you or under your direct supervision?

A. Yes, it was.

Q. Do you have any additions, corrections or modifications to make to your testimony or exhibits at this time?

A. I have one word that was inadvertantly left out in the typing. On page three, line 25, the sentence that starts, "These men were exposed to strong magnetic fields," there should be the word constant in there. It should say, "These men were exposed to strong constant magnetic fields." The word constant should be added for clarification.

That is the only correction or addition that I have.

Q. Subject to that addition is the testimony and the exhibit true and correct to the best of your knowledge, information and belief?

A. Yes, it is.

Q. And subject to that correction, if I were to ask you these questions today under oath would your answers be the same?

A. Yes, they would.

MS. McCLOSKEY: Your Honor, we ask that Mr. Rosenbaum's testimony marked for identification as OCA statement be admitted into evidence subject to any cross-examination or timely motions by opposing Counsel.

JUDGE SMOLEN: Hearing no objections, it is so received with those qualifications.

(Whereupon, the document marked as OCA Statement No. 2 was received in evidence.)

MS. McCLOSKEY: All parties and Your Honor were previously served with copies of Mr. Rosenbaum's testimony and I have provided two copies to the court reporter.

Mr. Rosenbaum is now available for cross-examination.

JUDGE SMOLEN: Mr. Watson.

MR. WATSON: Yes, Your Honor.

JUDGE SMOLEN: Are you prepared to proceed with

cross-examination?

MR. WATSON: Yes, Your Honor, I am. May I do it from here?

JUDGE SMOLEN: Yes, sir.

MR. WATSON: Thank you.

CROSS-EXAMINATION

BY MR. WATSON:

Q. Good afternoon, Dr. Rosenbaum.

A. Good afternoon.

Q. Dr. Rosenbaum, does the curriculum vitae that you have attached to your testimony provide a fairly complete list of the positions that you have held and the kind of work that you have performed?

A. Yes, I think so. I haven't actually looked at it very closely. The things in the past don't change much. Yes.

Q. You have a PhD. degree, is that correct?

A. Yes, I do.

Q. That is in the field of physics?

A. Theoretical physics.

Q. And you also have a masters degree in physics?

A. Yes.

Q. And your bachelors degree is also in physics?

A. Yes.

Q. And you don't have a medical degree?

A. None.

Q. Did your physics curriculum include any graduate level course in medicine?

A. None.

Q. The biological sciences?

A. No.

Q. Do you have any graduate level training in epidemiology?

A. No.

Q. Have you ever had responsibility for designing 60 hertz power lines for transmission of electricity?

A. No.

Q. Now, on page six of your written testimony you state that it is important to distinquish between ionizing and nonionizing --

A. Could you tell me the line?

Q. Yes. Line nine.

A. Okay.

Q. I believe you say there it is important to distinquish between ionizing and nonionizing interactions?

A. Yes.

Q. I suppose that is because ionizing radiation interacts differently with people than does nonionizing radiation?

A. Yes.

Q. For instance, you point out in your testimony that ionizing radiation was enough energy to remove electrons from the atoms and molecules of biological cells and tissue?

A. That is what ionizing means, correct.

Q. But the 60 hertz fields like those in this transmission line don't have that level of energy, is that correct?

A. That's right. I should say the level of energy that we're talking about here is the level of individual photons. But the import is the same, they don't ionize.

JUDGE SMOLEN: You have to keep your voice up so I can hear and so that the reporter can hear.

THE WITNESS: I'm sorry.

BY MR. WATSON:

Q. And I suppose we are talking about two separate bodies of research when we discuss ionizing versus nonionizing radiation?

A. Yes.

Q. Could you just to help us out identify some of the sources of ionizing radiation?

A. There are natural sources. Cosmic rays is one. Radioactive materials are another. Everything is radioactive and always has been, including all of us.

But the other sources of ionizing radiation such as accelerators and things are not usually present in the normal environment.

Q. So would you include, for example, X-rays as a source of ionizing radiation?

A. I didn't think of that. Yes. There are also medical things, yes. X-rays is another, and there are even more high powered things like gamma rays from cobalt, which is used in the treatment of cancer patients.

Q. Radon?

A. Radon is an example.

Q. Is there more than one kind of nonionizing radiation?

A. Depending on how you divide things, you could have several different kinds. But there are basically three kinds. There are alpha rays, which are helium nuclei. There are so-called -- these are all ancient names from the 1890s when radioactivity was discovered. There are beta rays, which are an old fashioned word for electrons. And there are gamma rays which are electro-magnetic fields, actually, they are electro-magnetic fields of very high energy.

There are also other kinds of things which are not usually present in most people's environment like

neutrons and other things which people don't usually come in contact with.

Q. Those alpha, beta and gamma rays, are they in the ionizing or nonionizing category?

A. You asked me for a characterization of ionizing radiation. That is one kind of breakdown.

Q. Let's move over to the nonionizing radiation area. Is there more than one kind of nonionizing radiation? I'm not asking for a formal physics definition.

A. It depends on what you mean by radiation. I mean, heat is a kind of radiation. But I assume what you mean is electro-magnetic fields. Is that what you have in mind?

Q. Well, for example --

A. I mean, radiation technically is anything that travels through space. I'm not sure what you mean.

Q. Maybe I can be clearer.

I don't think I'm asking for more than general terms. For example, would microwaves be an area that you would say is one area of nonionizing radiation?

A. Yes. The whole spectrum, the whole electro-magnetic fields come from zero frequency up indefinitely without any top limit and up to a point the individual photons are not -- the frequency is directly

proportional to the energy of the photon and when the energy of the photon, or the frequency, is not high enough then it does not ionize. It's when it gets above that it does. Gamma rays are in some sense the same thing as microwaves, which are the same thing as radiation from power lines, but the frequency is different so the effects are different.

Q. So if the frequency is different, if the frequency is low enough, it does not ionize?

A. That's right.

Q. And if it gets high enough it might ionize?

A. That's right. There is kind of an exception to this in the sense that if you have very intense radiation, say, microwave radiation which heats things enough the heat itself will ionize things. But that isn't the situation we're dealing with here.

Q. So radio waves would be an example of nonionizing radiation?

A. Yes.

Q. And radio waves would be different, at least in frequency, from the fields, electro-magnetic fields, that are created by, say, a power line?

A. Very different.

Q. Dr. Rosenbaum, I believe you may have made a reference in your testimony at some point to Dr. Janes'

statement and you have read his statement at least, did you not?

A. Yes, I did. And maybe you can find the reference if we want to talk about it.

Q. I just was going to ask you about something that I believe he said, that studies published in peer review journals have met the journal's standards for appropriateness and quality of experimental design, analysis of data and logic underlying the conclusions. Do you remember reading that statement?

A. No. But it sounds like a self-evident statement. If they had not met them the journal wouldn't have published them.

Q. So basically you would agree with the statement? I would be happy to show it to you.

A. Yes.

Q. Have you ever acted as peer reviewer for a physics journal, for example?

A. No, I never have.

Q. But in your work you do review studies?

A. I have reviewed things a lot for a long time, many of which were published. I mean, including my own papers but other people's papers also.

Q. When you are reviewing studies in the area of physics, do you carefully review the methods and the

design of the study, for example?

A. Yes.

Q. And do you analyze the results in the context of your knowledge of physics to place it in the context of your larger knowledge of the area --

A. I don't understand.

Q. -- to evaluate it?

A. I don't understand the question. I'm sorry.

Q. Well, when you look at the --

A. Maybe you can give me an example.

Q. I'm just asking when you look at a particular study do you analyze that study essentially in light not only of what the study provides but in light of your knowledge and background in the field of physics and what you know about physics?

A. Well, I would not want to confine this to physics because that is assuming they are the only papers I have done this with. But basically a paper from my point of view has to stand on its own. It can use references to other things but it has to stand on its own as a body of work. It has to be a logical consistent body of work that makes something worth publishing, if that is an answer.

Q. I think I understand.

And might you in determining whether it is logical

and consistent you might rely upon your knowledge of physics to see if you see something illogical or --

A. Well, certainly if it violated the laws of physics or something then it wouldn't be logical.

Q. Do you also pay some attention to the journal in which the study was published? Does it make a difference which journal?

A. Not in terms of reviewing a paper. I honestly feel that a paper stand on its own. It does not make any difference whether it is published or not published or where it's published. It is either a good paper or it isn't. I mean, a paper is supposed to stand on its own.

Q. So the particular journal that published it doesn't carry much import with you?

A. Not if I was reviewing a paper. It is true that I read some journals more than others but that is not only a question of that, it's a question of interest. There are thousands of journals. You can't read every one.

Q. So in evaluating an individual study, you are looking at the study, you are not too persuaded by which journal published it?

A. That's right.

Q. Is the analysis that you do during your review of a study, is that something that could be performed in

accordance with your professional standards by someone who was, for example a physics paper, not trained in physics?

A. Yes. I mean, there have been lots of outstanding physics work by people who are not physicists, who have never been trained for physics. There are famous people in physics who are now as we speak full professors at, like, Harvard who only have bachelors degrees in physics. I know of outstanding work, and I can give you lots of examples if you'd like, of work that was done by people who were never trained as physicists at all.

Christophoulos, for example, who I knew years ago, who was an elevator engineer in Greece. He came over here and he had a bachelors degree in, I don't know what, I suppose mechanical engineering in Greece during the war, and he was employed as an elevator -- I guess he designed elevators. He came over here and got interested on his own working as a I don't know what, he got interested in particle accelerators, high energy particle accelerators, and cyclotrons, which is a very esoteric and very difficult kind of experimental physics. And he had a good idea for them and tried to talk to people about it and he never was able to convince anybody.

He took a patent out on them. And years later they

were discovered independently by Brookhaven National Laboratory, who built one and Nick Christophoulos then went to court and pointed out that he had a patent on it and he became somewhat wealthier than he was before and was hired by Livermore as a distinquished physicist.

And I knew him and at that time he was a delightful, inventive man and he never had any training in physics at all. He was just a smart guy.

I can give you a lot of other examples if you want. It's not unusual. Certainly most people in physics follow sort of the standard track, but there are people -- like, there is a guy who is a friend of mine who I still know, Wally Gilbert, who was an assistant professor of physics at Harvard and instead of being a good guy and working hard to get tenure he started hanging around the biology laboratory at Harvard. He never had any biology at all. So he never got tenure in physicis, however he got tenure in biology and he won a Nobel prize in biology. He just did it.

Q. Sort of a genius type?

A. I don't think people are so compartmented. What he did partly was to use a lot of the skills he developed in physics to bear on biological problems which were very important.

Q. On page two of your testimony I believe you

were asked or you asked yourself -- I don't know quite how this works --

A. I asked myself.

Q. You asked yourself the question, "Are you an epidemiologist?"

A. Yes.

Q. And I believe you answered, "No, I'm not qualified to run an epidemiology study. However, I am qualified to judge the policy implications of a body of biological, epidemiological, engineering and physics literature."

A. That is true. That is what it says.

Q. When you review a body of literature such as you described is your greatest strength in the evaluation of the study in the area of physics?

A. I don't think so. Most of the studies done -- I mean, I have done an awful lot of that in my life. For example -- a lot of it -- for example at GAO, where I ran a major study on the somatic health effects of low level ionizing radiation. And EPA, where I was the director of the office of radiation programs, and a lot of other situations.

Physics is a small part of those problems. Physics is a small part of the problems in EPA, for example. But the kinds of skills you develop as a theoretical

physicists are useful in a lot of things. In fact, I never, even when I was an undergraduate, worked only in physics. I always did other things my whole career. I mean, I did present a thesis in biology even though I was majoring in physics, in radiation biology actually. So even though I didn't get a degree in that -- I think you have to be certifiably insane to get two PhD.'s, one was enough for me -- I still did a lots of other things and I always had an interest in radiation biology.

Q. I believe in your testimony you discussed and made reference to Mr. Janes' discussion of policy implications?

A. Yes.

Q. Do you recall that?

A. Yes. I have it right in front of me here.

Q. And I believe on page eight of your testimony, right up at the top of the page, starting around line one or two, I believe you say basically that reductions in average magnetic field levels of 50 to 75 percent over current practice should be possible at reasonable cost on new lines. Is that a fair representation of what you said?

A. That is exactly what it said.

Q. Could you explain what you would do to achieve a 50 to 75 percent reduction in the average magnetic

field level at a reasonable cost for this particular line?

A. No. But I will tell you where I got that statement from. I thought you might ask so I brought a little -- actually, I didn't bring it. But I will tell you where it came from anyway. It came from -- and I would be happy to supply it for the record -- it came from Pennsylvania Power & Light and a statement that they put out as to their future plans and a statement that it would not be unduly costly to do that. That is where I took it from.

Q. Okay.

A. And if you want I would be happy to supply that statement.

Q. You are sort of just going on the statement --

A. That is where I took that statement from.

Q. But you are not aware of a particular way in which we could do that for this particular line?

A. This actually doesn't refer to this particular line because it referred to newly constructed lines and this is not a newly constructed line. It was using a right-of-way that was already there and it was using basically the whole system that was there, all the structures and everything. So this statement doesn't refer to this line anyway.

Q. It doesn't apply to this particular situation?

A. No. That is why it said new lines. And that is what the Pennsylvania Power & Light statement said.

Q. And by new lines you didn't mean this line?

A. No. They said if they constructed a new line compared to their old types of construction they would be able to do this.

Q. Let me ask you this about that matter. For a particular right-of-way if you design a line that has lower fields than other design alternatives, would you consider that consistent with the concept of prudent avoidance? If it can be done at a reasonable cost, I should add.

A. Prudent avoidance means a lot of different things. Yeah. I mean --

Q. I'm not asking you if it is the only thing that could ever be --

A. Certainly it is an attempt to make fields lower to people in situations where they were liable to experience the field for a long time, as opposed to something you might drive under for a second. I would think that that would be something that people ought to try to do.

Q. And that would be consistent with this idea of prudent avoidance?

A. Yes.

Q. Now, I believe in your testimony with regard to the scientific literature or scientific studies on E/MF you basically discuss only the epidemiology studies?

A. Yes, I did only discuss the epidemiology studies.

Q. Did you limit your discussion to epidemiology because you're more familiar with epidemiology studies than, say, molecular genetic studies or endocrinology studies or immunology studies?

A. Yes. That is certainly true, but it was a question of dividing up the work.

Q. Basically you feel more qualified to evaluate the epidemiology studies than, say, molecular genetics, endocrinology, oncology, that sort of thing?

A. Yes. I have read things like that also, yes.

Q. But you felt more qualified in epidemiology?

A. I dealt much more with that, yes.

Q. Turning to the epidemiology studies that you referred to, would it be fair to say that there is more than one type of epidemiology study?

A. Yes.

Q. These may seem like mundane questions but in order to get it out on the record we have to ask them.

A. Yes.

Q. Could you tell us what the basic different types of epidemiology studies are?

A. Well, the three kinds that I am most familiar with, one is called the case control study in which one focuses on -- well, I guess these things do by example. You take as the cases the people who have some condition or disease or something you are interested in, cancer for example, and then you try to match them with one or more controls. And matching means -- I mean, this is one of the most usual kind of match study -- one or more controls which have similar characteristics in some group of things that you think might be important. That would depend on what you are going to do. An example might be age, sex, race. I don't know. It depends what you thought might be important. It could be a lot of different things. I mean, that is an example of some of the things.

Q. Are you now referring to a cohort study?

A. No. I was thinking of a case control study where you find controls which have similar characteristics as the people with the disease. The people with the disease -- let me make an example. Maybe it will be clearer.

You might look at people who had leukemia in Philadelphia. And you might try to find a group of --

and you might get those off a cancer registry or something. And then you might try to find a group of people who -- you would take one of these people and you would try to find somebody who was selected in some way, not prejudicial to the issue, who had, let's say, the same age or roughly the same age, the same sex, the same race, whatever you think might be important, and then you might ask do the people who get leukemia -- I forget what I used as an example, leukemia, let's say -- tend to live nearer power lines than the people -- than the cases who presumably are in, in some vague sense of the word random, some random set. That might be an example.

Q. Just for the record, could you explain the difference between the case control and the cohort study?

A. In a cohort study you don't focus so much on -- it isn't a question of picking the people who have leukemia. You take a set of people who were, for example -- I will try to give you analogous example. The people -- well, a perfect example would be to take all the people in Philadelphia. That would be sort of an example. And then out of that you would take some set that you think might be affected like telephone linemen, I don't know, something or other. And you would try to see if telephone linemen had a greater risk of getting whatever you were interested in, leukemia or something,

than people in general, the cohort.

Q. Would you examine the difference in their exposure to some particular agent?

A. That would depend on what you were interested in, yes.

Q. In the cohort study?

A. Yes. I mean, obviously, you would try to pick groups, you would try to arrange these things so they are meaningful to whatever it is you are worried about in the study. I mean, you might pick telephone linemen because you might think they were exposed -- I used that example -- to stronger fields because they tend to work on poles sometimes where there are distribution lines.

Q. So just in a nutshell for the record, what is the key difference between a case control and a cohort study?

A. In a case control study you focus, first of all, on the people who have the disease that you are interested in. In a cohort study basically you are focusing on a group of people who do something or other that you think might be risky.

Q. Now, is there also such a thing as a retrospective follow-up study? Is that one of the other types of epidemiology studies?

A. I don't think that is a separate thing. I

mean, most of these -- I mean, ideally, I suppose the way you would like to do this stuff is the way the Framingham study is done. You would like to take a large cohort of people, like the whole city of Framingham, and follow them for 50 years, keeping track of everything they do, and see what happens to them. But that is very hard to do because you don't know what you're going to be interested in. So generally things are retrospective. Almost all these studies are retrospective in the sense they go back and look at things that have happened in the past and try to reconstruct things.

Q. But Framingham, for example, would be an example of a retrospective follow-up study?

A. No. Framingham is in the future. Framingham is looking in the future. Retrospective is looking in the past.

Q. So you --

A. All these studies, I think, are retrospective.

Q. So you would consider both case controls and cohorts as also retrospective follow-up studies?

A. Well, actually, you could do a cohort study either way. You could do a case control study concurrently. You wouldn't know what the cases were if you did it retrospective.

Q. So you would just consider that a category --

I'm just trying to make sure we have the basic categories because I want ask you about some of these studies and where they fall in. So basically you have two categories and retrospective follow-up would fall into either of those?

A. You could do a cohort study in the future. You could take a cohort and follow it in the future as well as looking at the past. I don't think that has been done in any of these studies in this whole field, but you could do it. I mean, it's not impossible. I suppose in theory you could do a case control study but I don't know why you would want to do that. I mean, you would have to wait and see who are the cases in the future and then try -- it seems like that wouldn't be a sensible thing to do.

Q. I was just trying to find out if it is separate category.

A. I think it is a different kind of axis.

Q. Not a separate category?

A. Yes.

Q. Looking at these two, since you have talked about some of these studies, what would basically be the greatest strength of a case control study?

A. Well, it depends on the study.

Q. Just in general.

A. In general you need fewer -- since you are

focusing on the cases you don't need to handle such large sets of people. These are very rare diseases, so you can't find -- if you study the leukemias in Philadelphia over ten years you are not going to find 100,000 cases. So you don't have to find such huge numbers of cases. In cohort studies you usually need very large numbers of people.

Q. What would be the greatest strength of a cohort study?

A. Well, the problem with the case control study is that you never really know -- you're never absolutely certain that you have matched people in the right way. I mean, you try to take controls that are appropriate for the cases but if you don't really understand the disease very well it is very hard to do that, I mean, with any certainty. You are not so limited in that in a cohort study where you are studying a vast group of people.

Q. What would you say is the biggest weakness of a case control study?

A. Like I said, the biggest weakness of a case control study, I think, intrinsically is making sure that the controls are appropriate for the cases.

Q. And what about cohort studies? What would you say is the biggest weakness there?

A. I'm not sure how to answer that. I mean, the

cohort study requires huge amounts of people to follow so it tends to be much more expensive and it is also --

Q. I am talking design weakness, not the cost.

A. As I said in here, I'm not qualified to design studies. But, I mean, a cohort study -- I suppose the biggest problem is making sure that what you are interested in is really the relevant factor in what happens to the group you are focusing on. For example, telephone linemen. Even if you found out that telephone linemen have more leukemia, there is still a logical step to say that that was caused by the fields. But that would be true in a case control study too.

Q. And you rely on case control studies in your testimony?

A. That was not a plot. Maybe it came out that way as an example of things. I mean, I didn't set out to rely on case control studies.

Q. And I certainly didn't mean to imply that. My question is that you do in fact rely on some case control studies in your testimony?

A. Yes.

Q. You would know them if we --

A. Yes. I just didn't memorize them.

Q. Now, in a case control study the results are usually reported as an odds ratio, is that right?

A. There is some kind of risk ratio or something, yes, something which indicates whether things are more or less good for the set that you're commenting on. And usually one means you break even.

Q. And these studies basically also provide a calculation of statistical significance for the odds ratios?

A. Yes.

Q. Whether the odds ratio is or is not statistically significant?

A. Yes -- well, yes. Go ahead.

Q. If the odds ratio is not statistically significant would it be fair to say that you couldn't say much about the study with any scientifically accepted level of confidence about what it means?

A. Let me say something since you brought it up about confidence levels. The really difficult thing in statistics is not figuring out the risk ratios or odds ratios. The really difficult thing is figuring out the significance of them. Figuring out the ratios is fairly trivial. That's one thing.

A separate thing is significance doesn't mean anything in particular. If you say something, if you say a range, there is a range with 95 percent -- let me put it this way. If you say -- the way they do things here

is there is a range in which you can say, say, it's five percent or 95 percent, depending on how you characterize it --

Q. You are referring to a 95 percent level of -- I'm sorry to interrupt.

A. Significance.

Q. A 95 percent level of confidence?

A. Well, sometimes it's either five or 95 depending on how -- it's the same number.

Q. Right.

A. What that means is that there are five chances out of 100 or one chance in 20 that it will happen by accident. Even that is not clear because of how you calculate that. And that has come to be through a very arcane process used in the popular press as significant, that level, unless otherwise stated. My understanding from a rather very famous statistician who works for us sometimes was that that use of the word significance, not the calculation, came about because at one point a public polling group was hired many years ago to go out and ask the general public what odds they would consider significant. What they came out with was one in 20 so they just hung that on it.

But it would be silly to make a big deal of significance at a 93 percent level and significance to a

96 percent level or a 98 percent level. It is just an arbitrary line that is drawn. So I think really what one has to do is look at the level of significance, not just the term significant or not significant, if that answers your question.

I don't think you can chuck things just because they are slightly below the level, the five percent level or 95 percent level. And I don't think that you can pretend that things are absolutely proven in stone just because they reach the 95 percent level. I mean, it's a continuum, really.

Q. Let's talk about these odds ratios a minute. If a confidence limit drops below one in those studies would it be fair to say that you don't know whether the exposure in question creates a greater risk or a lesser risk?

A. I don't know what you mean by don't know. If an odds ratio drops below one it tends to mean the thing is good for you. It is above one it tends to mean the thing is bad for you. None of this should be taken very seriously unless you know with what level of confidence you are saying this. The number in itself doesn't mean very much. It means something, but the whole issue is to what weight you should give the number.

Q. And the researchers themselves pick the

confidence limits often that they will put into their published study, is that correct?

A. Well, the confidence levels are calculated.

Q. But they pick the level of confidence, like 95 percent?

A. Yes. The good papers actually say what they are saying. But the word statistically significant or not has come to mean in the popular press as far as I can see and sometimes in papers at the 95 percent level. And that has nothing to do with statistics or epidemiology. That came from a poll of what people in general would consider significant.

Q. These studies use different calculations to, I assume, to try to help you get some understanding of the meaning of the study, is that the idea?

A. They present all kinds of tables, yes, statements.

Q. One of the ones that are referred to in these epidemiology studies is the proportionate mortality ratio?

A. Yes.

Q. Can you explain what that is?

A. Proportional mortality ratio is the percentage of people who get what you are interested in, basically. I mean, essentially it is the chances of getting what you

are interested in versus the chances of getting something else. And the problem with that is that that proportional mortality ratio could go up just because the other things went down rather than the thing you are interested in going up.

Q. Can you explain to us what a standard mortality ratio is? That is used in the studies as well.

A. Yes, it is indeed.

(Pause.)

Q. That's all right. You don't --

A. I don't remember the definition of it. But they are basically the same. That is a little different, but the other ones are basically the same. The standard mortality ratio in meaning isn't very different than the risk ratio or odds ratio that is used generally. It doesn't have the same intrinsic problems like a proportionate mortality ratio.

Q. I believe you refer on page three of your testimony to the 1979 Wertheimer and Leeper study?

A. Yes.

Q. Would it be accurate to say that Wertheimer and Leeper did not actually measure the electro-magnetic fields in the homes that were involved in their study?

A. Let me get -- I brought all these.

Q. And maybe I will make it -- if I could complete

the question maybe I'll make it easier.

A. Yes.

Q. And instead they used a thing called wiring codes?

A. They did use wiring codes. And I am trying to remember -- I think they did some -- and I don't remember which one of their papers -- they did some measurement -- certainly a lot of people have done measurements -- to look at the correlation between the wiring codes and the actual measurements.

Q. I am just referring to the particular one on --

A. They actually did do measurements.

Q. -- page three that you referred to, the first one.

A. I am looking at it. I have it right here. In fact, they did do -- let me read it.

(Witness perusing document.)

A. I will read you a sentence from it. This is a quote from their paper, the first paper, 1979. "Our field measurements showed that on the average those types of wires associated with cancer in our study exhibited high magnetic fields. Compare Tables 1 and 3."

Q. Look at Tables 1 and 3. Does it give you measured fields or wiring code?

A. These give --

(Witness perusing document.)

A. Their results were given in terms of the wiring code.

Q. Go to Table 3 where they present correlations.

A. Yes.

Q. What do they use there?

A. They use wire codes. You asked whether they did any measurements. The answer is they did do measurements.

Q. Did they correlate their measurements with the endpoint of the leukemia in the study?

A. I don't think so.

Q. They just found a correlation with wiring codes?

A. Yes.

Q. And I believe in your testimony you said that they reported an increased cancer rate among others near primary and secondary distribution wires, right?

A. Yes.

Q. Those are the words you used?

A. Yes.

Q. When you used those words, those are a reference to the wiring code?

A. Yes.

Q. Now, the wiring code involved more than just

proximity to the wires, didn't it?

A. Yes.

Q. Such as thickness, number of wires, service drops?

A. Yes.

Q. Now, you also referred to a 1982 study by Wertheimer and Leeper on page five of your testimony?

A. Yes.

Q. And that study also did the correlations between the endpoint of the study, leukemia, and wiring codes rather than measured fields?

A. Yes.

Q. And I believe you relied on a study by Barregard on page three, lines 24 through 27?

A. Yes.

Q. And this was a study of occupational exposure to magnetic fields?

A. Yes.

Q. And I believe you note that in this study the workers were exposed to fields of about 100,000 milligauss?

A. Yes. As I pointed out, though, the word that I put in here. And I think it is a very important study. But it was a static magnetic field? Which means it was zero hertz. It was not varying in time. And this is

very important, I think, because it shows pretty definitely -- I don't think anyone has done a similar thing -- that even extraordinarily high static magentic fields didn't seem to do any harm at all.

Q. And those were measured?

A. Yes. And it is easy to measure. And in fact the odds ratio observed or affected is less than one. So I think that is a kind of definitive study. And in fact, since people were working in those rooms and they moved, they actually had the effect of generating currents in their bodies. However, the currents that would be generated at 60 hertz I have no idea what the size of them would be. There is no obvious way to figure that out. But it is certainly, even though it was a static field, it certainly generated currents in anybody moving in there.

Q. And they got their 100,000 milligauss number from doing actual measurements of the fields in that study?

A. Yes. Since it was in a room it was easy to do it.

Q. And they found no increase in mortality and cancer incidence?

A. They actually found a decrease.

Q. I believe you also refer to a study by Tomenius

on page three, line 29, and I believe it goes over to page four.

A. Yes. The reason I want to look at this is because I have these things in my book.

(Witness perusing document.)

Q. I will pause so you get time to find it in your book.

(Witness perusing document.)

Q. Now, Tomenius uses both measured fields and the distance from electrical installations in his study, is that correct?

A. Yes.

Q. Now, you relied also on a publication by Gordon at page four, lines seven through nine?

A. Yes.

Q. Just to be clear, the Gordon publication is not an actual epidemiology study, is it?

A. No. The Gordon publication was a study of other studies.

Q. It was an analysis of other studies?

A. Yes.

Q. And I believe you say that Gordon reports that the data from the Tomenius study can indicate a relative risk for people 100 to 150 meters from a powerline that is more than four times the relative risk for people

within 100 meters of a powerline?

A. Yes. That is exactly what it says.

Q. Does that mean that people who live close to the powerline have less chance of getting the disease in question?

MS. McCLOSKEY: I would object. I believe all he has done is discussed in the report. If you could rephrase the question to is what he reported, I think the way the question was phrased it asked for a conclusion from Dr. Rosenbaum.

MR. WATSON: I would be happy to have it either way. He is an expert. If he wants to offer a conclusion, fine. If he would like to simply report what the author said in the study he is citing that is fine, too.

THE WITNESS: Do you want to ask the question again? Do you want to ask a question that is acceptable to my Counsel?

MR. WATSON: We don't want to leave you out of this, Your Honor, but we're doing pretty well.

BY MR. WATSON:

Q. I was just asking with Gordon's reference to the Tomenius study did it mean that people who live close to the powerline had less chance of getting the disease. And I might say in fairness your Counsel objected and

said that maybe the question ought to be framed in terms of what Gordon reports. I will be happy with either. I am trying to figure out what the distances, how they compare with the disease.

A. I have to look at this for a minute.

(Witness perusing document.)

Q. Maybe I can give you the quote that I am referring to.

A. I mean, the answer is without levels of significance it is hard to tell what it means. It is true that those are the odds ratios, but -- so that, I mean, the answer is it is hard to know what level of significance to give that because they don't give in this thing any -- that statement about -- the sentence, which I can read for you, it says, "The overall odds ratio for exposure defined as a visible 200 kilovolt wire within 150 meters was 2.1 but within this distance the odds ratio for 100 to 150 meters was 6.9 which the odds ratio for zero to 99 meters was 1.7, analysis based on dwellings." There is no significance attached to those numbers so it is hard to tell what it means. I mean, it's hard to tell what the implications of the statement are. There is no significance quoted.

Q. Let me go back so we can clarify this. On page four of your testimony, line seven, eight and nine, it

says that Gordon reports that the data from the Tomenius study indicate a relative risk for people 100 to 150 meters from a powerline that is more than four times the relative risk for people within 100 meters.

A. That is true. That is exactly what the study says. But there are no significance levels attached to those numbers. I still think they are interesting to note, but there is no significance levels attached to them so it's hard to know what weight to give to them.

Q. So you just referred to Tomenius and Gordon?

A. Because I was trying to illustrate the confused state of the literature, and this is an example where the risk -- the odds ratios go down as you get closer. But as I said, it is very hard to know what significance to give that.

Q. Let's assume you used some accepted measure of statistical significance in that particular instance. Let's assume those numbers were indeed -- the odds ratios were statistically significant.

A. I think that is a bad assumption because in fact they would say it if it was. I am sure that having read the Gordon paper and what he said about other things that if these things had significance at some high level that they would in fact say it.

Q. So basically you're standing by what you said

Gordon says about the Tomenius study in your prefiled direct?

A. What I said is what Gordon says. It is just what he says.

Q. And if what Gordon says is true, the people would be better off living closer rather than further away?

MS. McCLOSKEY: I would object. I think that has been asked and answered.

MR. SUGARMAN: And I object on a further ground that better off may mean better than nothing or better than being further away. They have risk but they have less risk and that is still not better risk. That is worse off but less worse off.

JUDGE SMOLEN: We are just sparring with words but not the real import of the question. Maybe you ought to rephrase it to satisfy that objection.

BY MR. WATSON:

Q. Referring again to your description of the Gordon comment about Tomenius, taking what Gordon says would that mean that people living closer to the line would have a lower risk of getting the disease in question compared to people who live further from the line?

A. That is what it would mean if the statements

had a high level of significance, but I don't know whether they do. So I have no idea what import to give it.

And we tried to get the original Tomenius study and we had a very hard time getting it. That's the reason why I used this. This is the one instance in which I used Gordon as a summary because I had trouble getting the paper.

Q. Okay. Thank you. Hopefully the record is straight on that.

You also, I think, make reference to the Savitz study on page three, lines six and seven, and again on page four, lines 11 to 13.

A. Yes.

Q. I think on page three you don't say Savitz but I believe that is what you are talking about.

A. Where was it now?

Q. Page three, lines six through seven.

A. No. That was the reference. That was reference three. There is a reference -- there are reference numbers at the end.

Q. You don't use the name Savitz there. But on page four, lines 11 through 14, you do.

A. Yes.

Q. Savitz used both measured fields and wiring

code, is that correct, in his study?

A. Yes.

Q. Now, I believe on page three you say that sometimes there is no apparent correlation when actual measured short-term field strength is used instead of the surrogate?

A. Yes.

Q. And by the surrogate you are referring to wiring code?

A. Well, yes, generally.

Q. In this instance you meant wiring code?

A. Yes. There have been different wiring -- I only said it in that way because there has been more than one cut at what a wiring code ought to be.

Q. Yes. Understood.

And in fact Savitz used a somewhat different wiring code than Wertheimer and Leeper?

A. Yes, and Wertheimer and Leeper used somewhat different ones in their two studies.

Q. So is it your conclusion that the Savitz study showed no apparent correlation between actual measured field strength and cancer?

A. I didn't say that they didn't have any correlation. Maybe the easiest way is --

Q. I think I was just referring to your statement,

no apparent correlation between actual measured field strength and cancer. I don't want to mischaracterize your words.

A. It's not -- let me just look at this.

(Witness perusing document.)

Q. I think I can maybe help you a little bit. I don't mean to keep you in the dark.

A. It's an awful lot of paper.

Q. Page three, line six and seven. Here's what I am referring to.

A. I see what you are saying.

Q. I am just asking about that statement.

A. Yes, I understand. I just want to get the right place in the Savitz study so I can make a reasonable answer to your question.

(Witness perusing document.)

Q. I don't know if this would help any, but my question is really only is it your conclusion that the Savitz study showed no apparent correlation between actual measured field strength and cancer?

A. What Savitz actually says in his -- let me try to give you an answer to the question. What Savitz actually says is measured magnetic -- this is in his summary, abstract in the front of it -- measured magnetic fields under low power use had a modest association with

cancer incidence. Neither magnetic fields nor electric fields under high power use were related to total cancer. Wire codes associated with higher magnetic fields were more common among cases than control homes.

However, if you look at table six of Savitz, which is on page 33 of his paper, if you look at the actual numbers...

(Witness perusing document.)

A. This is probably not the right -- that is not the right --

Q. Try Table 3 on page 30.

A. Wait one second here.

(Witness perusing document.)

A. I'm sorry, but it's hard to remember all the tables from all the papers in your mind.

Q. Take a look at Table 3 on page 30. Maybe that would help you.

(Witness perusing document.)

A. This is a very -- I mean, none of these -- I guess the easiest way, the thing that I was saying as opposed to what Savitz is saying in this study, among other things, is that none of these odds ratios are anywhere near close to 95 percent significant or, I mean, they are not anywhere near. So it is difficult to know what to make -- it is difficult to say see any real

effect from his data as presented in his paper.

Q. Understood. And he used a 95 percent level of confidence?

A. That what he has listed.

Q. He is the one that picked that?

A. Yes.

Q. He is the author so he gets to pick that?

A. Yes.

Q. Okay. I think I understand.

A. I guess the point I was trying to make is it didn't seem to me that there was any way to attach any great weight to the risk when tabulated against the actual measured fields. But, of course, the measured fields are only for a short time.

Q. Now, you made also a reference to a study by Rodwall in Sweden?

A. Yes.

Q. I believe that is on page four, lines 16 through 19?

A. Yes. I should say this is a translation that came out of the same Gordon -- it was appended to the Gordon study. So it's not -- I mean, I --

Q. I am just going to ask a couple of general questions.

A. I have not seen the original article in

Swedish.

Q. This study used distance from powerlines and not measured fields?

A. Yes.

Q. And the cancer incidence was lower than normal for people who were near the powerline in that study?

A. Yes. I just looked at this. Yes, the cancer incidence was lower but quite close. Yes.

Q. Now, McDowell was another study I believe you referred to?

A. Again, it is hard to know what significance -- I should say about the Rodwall situation that there are no, again, levels of significance from the data. You can see you wouldn't think that it had very high levels.

Q. On the McDowell study, you refer to it on page three, lines ten through 11. You cite it there. And I believe you refer to it more specifically on page four, lines 21 and 23.

A. Yes.

Q. McDowell used distance from powerlines and electrical installations again and not measured magnetic fields?

A. Let me look at this for a second.

(Witness perusing document.)

A. He used distance, yes.

Q. Not measured fields?

A. That's right.

Q. Now, McDowell looked at a number of different endpoints for both men and women in this study?

A. Correct.

Q. Let me refer you to the abstract. And using whatever level of statistical significance that McDowell selected, is it fair to say that McDowell reported the only statistically significant excess mortality was for lung cancer?

A. Yes.

Q. In this study did the authors collect any data on smoking?

A. No.

Q. I believe you also referred to a study by Fulton?

A. Yes.

Q. I'm sorry. For some reason I didn't write down the reference, but it is page four, line 25.

A. I've got it. Right.

Q. And Fulton used a wiring code, shall we say, as distinquished from measured magnetic fields --

A. Yes.

Q. -- in the study?

A. Yes.

Q. And Fulton found no relationship between the wiring code and the endpoint of the study?

A. Yes. There has been a lot of criticism of that study, however.

Q. There were criticisms leveled at both Fulton and the Wertheimer and Leeper studies, is that fair to say?

A. There have been probably criticisms leveled at every study. I think that would be fair to say.

Q. That is probably fair to say, too. Okay.

And you referred to a study by Myers?

A. Yes.

Q. That takes us over to page five, line one to three. Myers used both distance from powerlines and calculations of magnetic fields, is that correct?

A. Let me look at this.

(Witness perusing document.)

A. Yes, that's right.

Q. And Myers found no relationship between distance from powerlines and the endpoint of the study?

A. Yes, that's right.

Q. And Myers also found no relationship between the calculations of the actual fields and the endpoint of the study?

A. Yes, that's right. No significance, yes,

that's right.

Q. Now, Coleman is the next one. That is on page five, lines five through seven. And this study used distance from powerlines rather than actual measured magnetic fields, is that correct?

(Witness perusing document.)

A. Yes. They did a sort of wiring code configuration thing.

Q. Distance related, among other things?

A. Yes. Well, in this case the lines are all the same, basically. They are similar. But, yes, they did their own wiring code configuration.

Q. But they did not run -- they did not study actual measured magnetic fields?

A. Yes. That's right.

Q. Is that correct?

A. Yes.

Q. And they found no relationship between cancer and the proximity to the lines, is that accurate?

A. I have to look at this.

(Witness perusing document.)

Q. I am referring, maybe, to page five, lines five through seven of your testimony.

A. What it says is no statistically significant excess of leukemia, which is the only thing he looked at.

Q. Okay.

A. The only thing he looked at was leukemia. It was a large study of leukemia itself. And in fact it used as the case controls mostly other cancer patients, although they had a small number of people from the general population.

Q. Now, let me refer to you the Severson study, which is on page five, lines nine through 11.

A. Yes.

Q. And in this study they used both wiring code and actual measured magnetic fields? They studied both?

A. I have to look. There are too many studies.

Q. It's not meant to be a memory test.

(Witness perusing document.)

A. Yes. That's right.

Q. And the author --

A. They also used wiring code configurations that were done by Kaune.

Q. And the authors observed no associations between the wiring code and cancer?

A. Yes. They only looked at acute non-lymphocytic leukemia. They didn't look at all possible cancers.

Q. And they observed no association between the disease endpoints studied and the actual measured magnetic field?

A. That's right.

MR. WATSON: Your Honor, that is all.

Thank you, Dr. Rosenbaum.

JUDGE SMOLEN: Ms. Khanwalkar.

MS. KHANWALKAR: I just have one question.

CROSS-EXAMINATION

BY MS. KHANWALKAR:

Q. In your testimony regarding the reduction achievable, it says on page eight of your testimony at lines two and three, you say, for example, reductions of 50 to 75 percent over current practice should be possible at reasonable cost on new lines?

A. Right.

Q. Is it your understanding that these reductions are always possible on new lines or only under certain circumstances they are possible?

A. I think that the way it was put by PP&L was generally possible. That was their goal that they expected to achieve.

Q. But you are not familiar with what circumstances allow such reductions to be achieved?

A. I am sure it is not possible in every circumstance. I didn't mean to imply that. That was the intent of words like should be.

MS. KHANWALKAR: That's all, Your Honor.

JUDGE SMOLEN: Ms. Burket.

MS. BURKET: I have no questions, Your Honor.

JUDGE SMOLEN: How about Mr. Sugarman?

MR. SUGARMAN: I have a few questions, Your Honor.

JUDGE SMOLEN: Go ahead.

MR. SUGARMAN: Thank you.

CROSS-EXAMINATION

BY MR. SUGARMAN:

Q. Mr. Rosenbaum, you indicated in your testimony that -- and specifically at lines 21 and 22 on page seven, going over to page eight -- that mitigative measures should be considered before construction begins and you listed some.

A. Yes.

Q. Have you found any evidence as to whether PECo considered either before or after the OCA addressed any questions to them, or to it, considered different locations for the line so as to address the issue, the first point that you make, or the first possibility, avoiding heavily populated areas?

A. Let me see if I can understand your question. The part I am trying to focus on, you said something about before --

Q. Right. There was reference in your testimony to the fact that PECo had only considered different

configurations of the line after the questions were raised by the OCA. My question is is there any evidence that they considered alternate locations either before or after?

A. I didn't look into that. I don't know.

Q. Did you review the PECo answers to interrogatories?

A. I reviewed all the answers to our questions very carefully, yes.

Q. Did you find any reference to any alternative locations?

A. I don't recall any.

Q. Now, you indicate in your testimony that reduction of 50 to 75 percent over current practice should be possible at reasonable cost on new lines. That is page eight, lines two and three of your testimony.

A. Yes.

Q. Does current practice -- you have reviewed the PECo answers to the OCA interrogatories, correct?

A. Yes.

Q. And among those answers was a computation of the basis of estimation and the tables of the anticipated magnetic field effect on the B field from induced current as well as from the line itself?

A. Yes.

Q. And you have also reviewed Mr. Boeggeman's testimony?

A. I read it and I was here. I don't remember it in detail.

Q. Do you recall he testified that at the loading of a thousand amps the level at the edge of right-of-way of milligauss would be approximately 70?

A. I don't recall that he said that.

Q. I will ask you to assume that he said that.

A. Let me say something that may make your time more useful. David Janes was far more involved -- we did in fact check PECo's calculations of the magnetic fields from the line. We actually did our own independent calculations. But David Janes knows about that in far more detail than I do, not that I want to pin it on him.

Q. I understand that, and I wasn't going to ask about the calculations.

JUDGE SMOLEN: One voice at a time.

BY MR. SUGARMAN:

Q. I wasn't going to ask about the calculations themselves.

A. Okay.

Q. I want you to take the PECo calculations on page nine of Mr. Boeggeman's prepared testimony --

A. I'm sorry. I don't have that with me.

Q. I understand. And I am going to give it to you so you will have it in front of you. Where he states the light, normal, heavy and emergency loading. And putting aside whether those loadings do in fact represent light, normal, heavy and emergency, but just taking those numbers as if they were accurate and reflect what will occur at the edge of the right-of-way in the four loading conditions that he has stated?

A. All right. Yes.

Q. Does your statement at page eight of your testimony, reductions of 50 to 75 percent over current practice should be possible at reasonable cost on new lines, does your testimony relate to those numbers that Mr. Boeggeman has given, that is, that those numbers can be reduced by 50 to 75 percent over current practice?

A. No. That statement referred to new lines, brand new lines.

Q. When you say brand new lines, you mean a line that has not been used before?

A. No. I meant a line that was designed on a new right-of-way and new -- I mean really new lines. So that you would have all the design parameters under control.

Q. Well, is there any -- so then in your testimony you are saying that there may be a problem in applying your estimate of 50 to 75 percent where a line for some

reason is not made a new line? In other words, you are assuming that the utility is allowed to construct on an existing corridor that doesn't meet criteria?

A. I don't understand the question. But that number, as I said, was taken from information put out by Pennsylvania Power & Light as to what they expected to be able to do in the future on new lines.

Q. Okay.

A. And I don't see any reason to doubt it. The current -- well, go ahead. I'm sorry. Lines that were designed a long time ago were not designed with any thought of the magnetic fields at all. They just weren't in the design criteria.

Q. From a policy point of view, what makes this an old line rather than a new line?

JUDGE SMOLEN: Let me interject here. I don't know what this witness can answer what the public policy is. The public policy comes from the legislature.

MR. SUGARMAN: I'll rephrase it.

BY MR. SUGARMAN:

Q. Isn't it a public policy issue as to whether this line should be treated as an old line or a new line?

A. I have no idea.

Q. But you assumed it's not a new line?

A. I was only commenting on my use of the word new

in my testimony that referred to this line.

Q. And your use of the word new assumes that a line that's being built on a pre-existing old right-of-way is not a new line?

A. It doesn't assume anything. That is how I was using the word.

Q. That is what I meant.

A. Yes.

Q. That is how you are using the word?

A. Yes.

Q. The word new doesn't include a new line on an old right-of-way?

A. Yes.

Q. Have you made any estimate as to the reduction that can be achieved in connection with the decision to construct a line on an old corridor such as that reflected here, involved here?

A. No. We didn't make -- we were not asked to buy OCA and we did not make any calculations at all about what reductions could be made on this line under any circumstances. What we did do was check the company's calculations of the fields that would come about.

Q. And I will save those questions for Mr. Janes.

A. Yes. But we did check the company's calculations carefully.

Q. Now, in your direct testimony you indicate that it is -- at page eight, line 12 to line 14, you state, "Nevertheless I believe it is prudent to take measures to lower the public's exposure to magnetic fields if this is not too costly."

A. Yes.

Q. And then you say, "Too costly is one of the things that needs to be worked out in public consultations with all affected parties."

A. Yes.

Q. Now, is one of the issues that should be considered under cost in regard to lowering the public's exposure the potential for the utility buying the properties of the public along the right-of-way in order to lower the public's exposure to magnetic fields?

A. I don't -- the things that ought to be considered are something that ought to be worked out among the parties and with the state and with the localities. It is not anything that needs to be listed in some agenda by me.

Q. Let me take you back to page seven of your testimony. At page seven you testify mitigative measures that be should be considered before construction begins may include but are not limited to avoiding heavily populated areas?

A. Right.

Q. Now, are there two alternate ways to avoid heavily populated areas? One to build where there are no homes and the other to remove the population?

A. I suppose those two things would lower the population. To what extent that needs to be done depends on the particular circumstances and what the cost is.

Q. Now, you indicated that there is a safety code at page eight, lines three to four. And you indicate designing a powerline using current codes may not minimize fields?

A. I didn't say that. What I said was, and I will read it, "Designing a power line using current codes may not minimize fields. The current codes were drawn up by concensus committees which did not even consider magnetic field strength."

Q. What codes are you referring to?

A. The codes I am referring to are things like to the IEEE.

Q. And is there a code standard on the width of transmission lines of various kilowattage -- kilovoltage?

A. Kilovotage, I think.

Q. Yes.

A. I don't remember the code in detail, but the

import of the code had to do with electric fields. It had to do with arcing, it had to do with people not getting electrocuted if they walked under the wires even under the worse circumstances. I mean, it had to do with things like that. At the time that these codes were drawn up -- it takes a long, long time to draw up a code. A decade would not be unreasonable. And at the time these codes were drawn up no one had any particular interest in magnetic fields so they weren't even considered.

Q. Do you know whether this line was designed in accordance with the minimum right-of-way widths of the code?

A. I have no idea. But I assume if it violated codes somebody would make some objection that it violated the code.

Q. Would you assume that if it was treated as an old line that it would necessarily be governed by the code? I'm asking a regulatory question.

A. I don't know. I don't remember at all the details of the code anymore. But what I said about it is right, but I mean I don't remember the details about it.

Q. Now, Mr. Watson asked you a series of questions about the studies that you reviewed and referred to in your testimony at pages three and four.

A. Yes.

Q. And after you go through those studies you state your conclusions about the implication of the epidemiological literature, and you state at lines 27 and 28 of page five, "Look how many decades it took to convince the medical establishment that smoking leads to lung cancer."

Now, is it the case to the best of your knowledge that there were a number of epidemiological studies that did not report an increased death rate from cancer associated with smoking?

A. I don't know what studies you are referring to. I mean, I have no idea. I know that there was a long period in which there were some people who maintained basically on epidemiological grounds, but certainly not all, that smoking was causing lung cancer and that that was resisted very heavily even up to ten years ago by some people.

Q. But my question is just carrying your parallel one step further, isn't it true that the absence of correlations being observed in some epidemiological studies can be attributable to latency, latency periods, or other variables that make it inappropriate to rely on the absence of correlation in various epidemiological studies?

A. I don't understand the question. Nobody is relying on the absence of correlations. I don't know what it means to rely on the absence of correlations.

Q. I'm not saying you are.

A. You are asking what conclusions can be drawn from the fact that some of these studies didn't find that?

Q. That's right.

A. The conclusion that I drew is just what I said. The issue was extremely confused and I think the analogy I gave to ionizing radiation is quite appropriate. But there, actually, it was simpler and it was even -- I mean, people really understood clearly by the early years of this century by 1903 or so that high levels of ionizing radiation could cause cancer. They understood it because there were definitive kinds of experiments done by accident, by people playing with these things and they weren't careful enough.

This is a much more confusing situation in which there are a substantial number of studies, some of them done by very good people, which show correlations which are worrisome and other studies -- and those studies have some problems -- and there are other studies which also have problems in which you don't find this effect. And it is difficult for me having dealt for a long time with

the policy, for example when I was at EPA, of what to do in the face of uncertain risk to know what to make of it in a scientific way. It's very confusing. And I think the answer is we don't have enough information to tell.

Q. To do what?

A. We don't have enough information to come to a conclusion as to whether these very low frequency electro-magnetic fields are dangerous to people, if they are under what circumstances, and if they are what characteristics of them might be dangerous.

For example, the wiring codes measure average -- the intent of the people using wiring codes is to measure average field exposure over a very long time. That is the whole rationale for them. It is not even clear that it is the average field that is the problem, if there is a problem. It is just not clear.

Q. My only question to you -- I understand what you are saying. I am only dealing with one aspect of the potential explanations of the deviation between those studies that identify an association and those that don't. And my question goes to the aspect of latency.

A. The latency was looked at in a number of studies in both things because it is an obvious thing to look at, and indeed Wertheimer and Leeper used latency. Certainly if a study doesn't come up with a correlation

between, you know, whatever cancer you are looking at or all cancers or all mortality and the thing you are worried about, for example these electro-magnetic fields, that doesn't mean there is no effect. It doesn't prove anything.

Q. Now, you analyzed the studies of the relationship between cancer or overall mortality and exposure to high voltage lines, among other things. Did you study the results or did you study the reports, and the epidemiological reports specifically, on the associations between long-term average field strength, et cetera, and mutagenic changes other than cancer?

A. The only results I know about that were experimental results, and Dave Janes is presenting that testimony.

Q. Now, were you familiar with and did you make an evaluation of the biological studies which concern or relate to the causation or lack thereof between exposure to E/MF and cancer or any other disease?

A. Dave Janes also looked at the biological studies.

Q. I'm sorry. In reaching your conclusion that the state of knowledge is confusing and that the prudent policy -- well, if I may restart my question.

JUDGE SMOLEN: Go ahead.

MR. SUGARMAN: Thank you.

BY MR. SUGARMAN:

Q. In reaching your conclusion that the picture is very confused did you consider and factor in the findings of the biological studies on the association between E/MF exposure and cancer? Or is your conclusion limited to your consideration of the epidemiological studies?

A. By and large it is limited to my consideration of the epidemiological studies. However, I'm not unaware of the other work. But I didn't go through it in great detail in order to prepare this testimony.

Q. The reason I am asking that question, and I will ask another question that will illustrate why I am asking it.

A. Go ahead.

Q. In order to fully develop a position, for the Commission to fully develop a position, on the extent to which E/MF has been established is it necessary or appropriate in your opinion for such a decision maker to consider both epidemiological and biological evidence?

A. Yes.

MR. SUGARMAN: Thank you very much. I have no further questions -- I'm sorry. One more question.

JUDGE SMOLEN: Go ahead.

BY MR. SUGARMAN:

Q. In your evaluation of prudent mitigative measures have you considered what mitigative measures you would recommend to the abutting residents if the line is energized as proposed? And if so, what is your recommendation?

A. The answer is no. I mean, I was looking at this as a point of view of public policy as to what institutions, like the utility company, like the state of Pennsylvania, ought -- what their point of view ought to be. And my feeling is that there is enough evidence here that people ought to consider prudent avoidance measures. I mean, the state and the company and people that have a responsibility for large numbers of people. That's a matter of public policy. I would say an institution like the utility company that deals with hundreds of thousands of people has a burden of worrying about public policy because they deal with a great number of people. As to what individual homeowners ought to do, I didn't consider that at all. I don't think that was part of the case and I don't have any particular thing to say about the actions of individual people as opposed to institutions.

MR. SUGARMAN: Thank you very much.

JUDGE SMOLEN: Redirect?

MS. McCLOSKEY: May we have just five minutes.

JUDGE SMOLEN: All right. Let's take a break, five

minute break.

(Recess.)

JUDGE SMOLEN: Back on the record.

Redirect, Ms. McCloskey.

MS. McCLOSKEY: Your Honor, the OCA has one redirect question but the company has asked to make one inquiry related to Mr. Sugarman's cross.

JUDGE SMOLEN: Let's do that first, then.

FURTHER CROSS-EXAMINATION

BY MR. WATSON:

Q. Mr. Rosenbaum, with reference to a question asked by Mr. Sugarman about standards and E/MF, standards for powerlines in terms of the code, that is the National Electric Safety Code, and E/MF, are you familiar with a statement by the IEEE power engineering society, electric and magnetic fields issue, position statement regarding, quote, standards, close quote? That states among other things, at least in the first sentence and continues on for two paragraphs, quote, currently there is no scientific basis for establishing numerical limits for power frequency, electric and magnetic fields, close quote.

A. I am familiar with it because you just showed it to me.

Q. Were you familiar with it at the time that you

answered the question from Mr. Sugarman about whether E/MF had been considered in terms of National Electric Safety Code standards for powerlines?

MR. SUGARMAN: Your Honor, I just want to object to one aspect of that. I never asked that question. The witness volunteered that he didn't know that they had been considered, but I never asked if it had been considered. My only question about the codes was do they set a minimum right-of-way width.

JUDGE SMOLEN: Do you want to rephrase your question, that at the time he previously answered...

BY MR. WATSON:

Q. At the time you previously answered, were you aware of this statement that I referred you to?

A. No. But it wouldn't change my testimony about the code. That is not a code. That is a statement of position. That is quite different.

MR. WATSON: Thank you. That's all, Your Honor.

JUDGE SMOLEN: Redirect.

MS. McCLOSKEY: Yes, Your Honor. Thank you.

REDIRECT EXAMINATION

Q. Mr. Rosenbaum, in response to Mr. Sugarman's question as to your consideration of the biological studies in your policy recommendation, for clarity could you please describe your consideration of the biological

studies in making your policy recommendation?

A. Yes. I want to be clear about this. I, of course, read Dave Janes' testimony. In fact, I quoted from it in my own testimony. And I also have read a number of papers in the area that he is going to testify on and I'm not without any knowledge on it at all by any means. And I have a pretty good understanding in general of the results in that area and I did consider that as well as everything else in the policy recommendation. And when I answered Mr. Sugarman I said something with the import that the Commission ought to consider all the evidence, including that, which is quite right.

MS. McCLOSKEY: I have no further redirect, Your Honor.

JUDGE SMOLEN: Anything else of this witness? Anything further?

MR. SUGARMAN: Yes, I have a question in response to that last answer.

JUDGE SMOLEN: Let's hear the question. We don't want you to testify.

MR. SUGARMAN: Did I say I have testimony? I said I have a question in response.

JUDGE SMOLEN: I thought you said and response.

RECROSS-EXAMINATION

BY MR. SUGARMAN:

Q. You said that you considered the biological studies and the results of the biological studies in formulating your policy recommendation. How would you characterize the state of the biological studies? Since you say you factored them in you must have reached a characterization in your own mind as to what they indicate.

A. All right. In the first place, I think the evidence is quite strong that electro-magnetic fields at the frequencies that we are considering can interact with human cells and cells in general. That itself is quite remarkable because I think the general feeling was 20 or 25 years ago that given that the wavelength of 60 cycle current, 60 cycle fields, is more than 3,000 miles the chance of them interacting with human cells was none, they couldn't do it. I think the evidence is very strong now that they do interact. So I think that is one conclusion that I would make and that makes one take the issue more seriously.

And there are results which are interesting in the current consideration of possible dangers from these fields and one of them is the effect on melatonin production. However, the results there in the biological

area are also confused and there are lots of -- it's a long way from taking the current biological data to making a firm biological connection between 60 cycle fields and cancer in humans. However, I think there is enough evidence -- it goes along with the epidemiological evidence that the problem ought to be taken seriously.

MR. SUGARMAN: Thank you, very much.

MS. McCLOSKEY: I have no further redirect, Your Honor.

JUDGE SMOLEN: Anything from any other Counsel?

MR. WATSON: No.

JUDGE SMOLEN: The witness is excused. Thank you very much for appearing and testifying.

(Witness excused.)

MS. McCLOSKEY: The Office of Consumer Advocate calls David E. Janes.

Whereupon,

DAVID E. JANES

having been duly sworn, testified as follows:

JUDGE SMOLEN: State your full name and business address.

THE WITNESS: My name is David Earl Janes. The address is Suite 202, 6723 Whittier Avenue in McLean, Virginia. The zip is 22101.

JUDGE SMOLEN: Ms. McCloskey.

MS. McCLOSKEY: Thank you, Your Honor.

Your Honor, I would like to have marked for identification OCA Statement No. 1, which is the direct testimony of David E. Janes.

JUDGE SMOLEN: So marked.

(Whereupon, the document was marked as OCA Statement No. 1 for identification.)

DIRECT EXAMINATION

BY MS. McCLOSKEY:

Q. Mr. Janes, do you have before you a copy of your prepared prefiled direct testimony in this case consisting of 14 pages of questions and answers and one exhibit?

A. I do.

Q. Was this testimony and was this exhibit prepared by you or under your direct supervision?

A. It was.

Q. Do you have any additions, corrections or modifications to make to your testimony or exhibits at this time?

A. I have one minor correction to make on page seven. At line 17, following the word system, the superscripted reference should be two instead of four.

Q. Now, subject to that correction is the testimony and the exhibit true and correct to the best of

your knowledge, information and belief?

A. It is.

Q. And subject to that correction if I were to ask you these questions today under oath would your answers be the same?

A. They would.

MS. McCLOSKEY: Your Honor, we ask that Mr. Janes' testimony marked for identification as OCA Statement No. 1 be admitted into evidence subject to cross-examination and timely motions by opposing Counsel.

JUDGE SMOLEN: It is so received subject to those qualifications.

(Whereupon, the document marked as OCA Statement No. 1 was received in evidence.)

MS. McCLOSKEY: All parties and Your Honor were previously served copies of Mr. Janes' testimony and I have provided two copies to the court reporter.

Mr. Janes is now available for cross-examination.

JUDGE SMOLEN: Mr. Watson.

MR. WATSON: Thank you, Your Honor. Your Honor, may I conduct cross-examination from Counsel table?

JUDGE SMOLEN: Yes.

MR. WATSON: Thank you.

CROSS-EXAMINATION

BY MR. WATSON:

Q. Good afternoon, Mr. Janes.

A. Good afternoon.

Q. Mr. Janes, I would like to get an understanding of your education and training first. Do you consider yourself to have special expertise in physics?

A. Yes.

Q. Do you consider yourself to be an expert in biophysics as well?

A. Yes.

Q. But you would not consider yourself to be an expert in medicine or internal medicine? You are not representing yourself as an --

A. I'm not representing myself as a medical doctor.

Q. --And you are not claiming to be an immunologist or endocrinologist or oncologist or other medical sub-specialist?

A. No. Although I have done some work with those systems I don't claim to be an expert in them.

Q. So with respect to issues involving, say, internal medicine or the sub-specialties like immunology and endocrinology and oncology, would you defer to a qualified specialist in those medical disciplines for

medical conclusions?

A. For medical conclusions, yes.

Q. Now, do you have an advanced degree?

A. No. I have completed all the requirements for a PhD. in biophysics save the completion and defense of a thesis.

Q. And you did that, I believe, at the Medical College of Virginia?

A. That's correct.

Q. And that was in biophysics?

A. That's correct.

Q. Now, on page one of your testimony I believe you define power frequency fields --

A. Yes.

Q. -- at line 25 through 27 as electric and magnetic fields from 50 or 60 hertz, cycles per second, alternating current, power transmission and distribution lines, is that correct?

A. That's correct.

Q. Are there other types of fields that have frequencies other than 50 or 60 hertz that perhaps we referred to earlier with Dr. Rosenbaum?

A. I'm not sure I understand the question.

Q. Well, are there fields that have frequencies, that are the results of frequencies other than 50 or 60

hertz?

A. Certainly.

Q. And that might be anything from ionizing radiation to microwaves to radio frequency?

A. Yes.

Q. And those would be different in frequency from the fields we are talking about involving a power distribution line in the U.S. at 60 hertz?

A. Well, there is a continuum -- as Dr. Rosenbaum said, there is a continuum of frequencies from zero up to the numbers that we can't count. And the frequencies in the radio frequency range are considerably above those at 60 hertz, for example, and others.

Q. And the radio frequency range, are those the ones I pick up when I turn my car radio on?

A. Ordinarily. There are some communications processes carried out in the extremely low frequency range, 45 and I believe it is 72 or 75 hertz. It is difficult to make a distinction. But ordinarily you think of the higher frequencies being used for communications, kilohertz and above.

Q. Like radio and TV?

A. Right.

Q. Now, you can have different intensities of power frequency fields, would that be correct?

A. That's correct.

Q. So you could, in talking about a 60 hertz magentic field, for example, you could have a magnetic field from one source that was only a few milligauss and another that might be hundreds or thousands of milligauss?

A. That's correct.

Q. Now, aside from the difference in intensity, from a physics viewpoint a 60 hertz field from one source is that basically the same as a 60 hertz field from another source, putting aside intensity?

A. If you are talking about configuration -- I'm not sure what point you are trying to reach. If you're talking about things like polarization, the fields from sources can be very different in terms of their spatial and their time distribution.

Q. Let's talk about fields, just 60 hertz fields. And, for example, let's take a 60 hertz field from a powerline and a 60 hertz field from an electric clock. Those two fields might differ in intensity, might they not?

A. Yes.

Q. Are they basically the same kind of electric and magnetic field otherwise?

A. From a principle standpoint, yes, basically

they are the same.

Q. Now, appliances are also a source of power frequency fields, aren't they?

A. Yes.

Q. And household wiring would be a source of power frequency fields?

A. Yes.

Q. And when I am referring to power frequency fields, you understand I am talking about in the U.S. 60 hertz fields?

A. Yes.

Q. And in Europe I believe they use, for example, 50 hertz fields?

A. Yes.

Q. Would it be fair to say that there are power frequency fields present whenever electricity is in use unless it has been specifically cancelled?

A. I get the gist of your question. One would not say absolutely yes because not all fields are 60 hertz fields. But if you are talking about running something from a 60 hertz line as a power source you would expect there to be 60 hertz fields present.

Q. I am talking about 60 hertz power frequency fields. They would be present whenever we had a flow of electricity in our normal electrical system in the U.S.,

is that correct? Fields would be present?

A. With current flowing you will find magnetic fields. You could have electric fields without having current flow.

Q. And are there power frequency fields in this room right now?

A. There are.

Q. Would you know, if you know, that transmission -- would power frequency fields be more common to people generally from exposure to powerlines or from exposure to non-powerline sources -- that is not that good of a question, is it? Let me try again.

MS. McCLOSKEY: I was going to object to that question. It has a lot of assumptions in it.

MR. WATSON: I think I beat you to it. Let me try again.

BY MR. WATSON:

Q. If you know, do people get more exposure from the electric and magnetic fields from powerlines or from non-powerline sources?

MS. McCLOSKEY: I would object again and ask the assumptions underlying, such as were the person lives.

BY MR. WATSON:

Q. I am just asking generically, including the entire population. If you know.

A. I really don't have detailed information to make a judgement in terms of intensity distribution, that sort of thing.

Q. Now, I believe in your testimony you relied upon a report written on behalf of the Congressional Office of Technology Assessment?

A. Yes.

Q. Commonly referred to as the OTA report?

A. Yes.

Q. And I believe you referred to it as a review written by experts in the field on page six, lines one through seven of your report?

(Witness perusing document.)

MS. McCLOSKEY: I think we need another reference. Did you say page six, lines one through seven?

MR. WATSON: Fifteen through 17. I'm sorry.

MS. McCLOSKEY: Okay.

A. Yes.

BY MR. WATSON:

Q. I believe it is one of those references, number 14?

A. Yes.

Q. Now, it looks like you have a book there with some of the things you cited?

A. That's correct.

Q. If I go too fast remind me to give you the time to look.

A. Okay.

Q. Let me refer you to the OTA report that you cite, page three, the last paragraph.

A. Page three, line...

Q. Page three, the last paragraph that begins "if".

A. Yes.

Q. Now, I want to make sure. This is the report that you say is literature on biological effects, they have been extensively review and analyzed by a number of experts. This is one of the pieces you are referring to there?

(Witness nodding in the affirmative.)

Q. Could you just read that last paragraph?

A. Certainly. It says, "If exposure to fields does turn out to pose a health risk it is unlikely that high voltage transmission lines will be the only sources of concern. Power frequency fields are also produced by distribution lines, wall wiring appliances and lighting fixtures. These non-transmission sources are much more common than transmission lines and could play a far greater role than transmission lines as a public health problem."

Q. Would you have any disagreement with that statement?

A. I don't generically disagree as long as one has an appreciation that there may be a dose response where effects are related to the intensity. There is a wide distribution of exposure to electric fields and one has to answer that kind of question in terms of what the actual exposure is to a given field.

Q. Now, just to go back for a minute to page one of your testimony at lines 25 through 27, where you were defining power frequency electric and magnetic fields, would it be fair to include in your list in addition to alternating current, power transmission and distribution lines to also include with that appliances, wall wiring and lighting fixtures as sources of 60 hertz fields?

A. Yes.

Q. Now, Dr. James, in your testimony you use the term weak fields. Do you recall that? You use that in a number of places.

A. Yes.

Q. And I believe the first place -- I don't know that I have them all, but pages two and three beginning at line 11?

A. Yes.

Q. Does that sort of bring you to the start?

A. Yes.

Q. Now, we already have electric currents inside our bodies even when we are not in the presence of an external field in the air from a 60 hertz source, is that correct?

A. Correct.

Q. And external air fields will induce a current in a body, is that correct?

A. That's correct.

Q. And you define an external air field as weak if the current that it induces in the body is smaller than the currents that already exist in the body? Is that a fair characterization of your testimony? And I would refer you to page two, lines 18 through 22?

A. Yes, that is fair.

Q. Now, to clarify for the record, you define any electric field that is less than 8.3 kilovolts per meter as a week electric field, is that correct?

A. Yes, as derived from the information that lies under that as stated in the testimony.

Q. And you define with the same qualification you define any magnetic field that is less than 5,300 milligauss as a weak magnetic field, is that correct?

A. Under the assumptions used both of those numbers lead to currents induced in a body, at least

predicted currents induced in a body less than a tenth of a micoampere per square centimeter, yes.

Q. With that qualification, the answer is yes?

A. Yes.

Q. Now, these numbers apply only to humans that are electrically grounded through both feet, is that correct?

A. That's correct.

Q. And if someone was wearing shoes they probably would not be fully electrically grounded through both feet, is that correct?

A. That's correct.

Q. And the effect of that is that if the person were wearing shoes then the electric field of 8.3 kV per meter that you discussed would actually induce a larger or smaller current inside the body?

A. It would be a smaller current.

Q. So if the person were wearing shoes the field levels would be even higher than though you describe in your testimony to be considered weak, is that correct?

A. It would require higher air fields to induce the same current density for an individual isolated from ground than in one who is in contact with ground, though the changes are not terribly large for an insulation that would be equivalent to a separation of ground by shoe

leather. There is some data on that given in one of the references if you want quantitative numbers.

Q. Let me refer you to page three of your testimony, lines one through seven. I believe there you discuss the electric field strengths from some high voltage transmission lines?

A. Some typical lines, yes.

Q. And you present those values in Table 1 that is one page four of your testimony?

A. That's correct.

Q. Now, the values in Table 1 come from two documents, is that correct? Reference 5, I believe, is one of them?

A. There are actually three citations here, perhaps four. Five and six, which are to some work that was done when I was at EPA, both calculation and some field measurements, and then for the information contained about the PECo line the references are to the PECo direct testimony.

Q. All right.

Now, Reference 5 is a document entitled An Examination of Electric Fields Under EHV Overhead Power Transmission Lines?

A. That's correct.

Q. And that was published in 1977?

A. That's correct.

Q. And you were one of the authors of the document?

A. That's correct.

Q. And that document provides data on both measured and calculated electric field strengths, among other things?

A. That's correct.

Q. And is my understanding correct that what was done was you identified a transmission line in each one of these classes on page four under line type?

A. Yes.

Q. And then the electric field under the line was measured and also calculated?

A. Certainly that is true for 500 to 765 kV. I would have to take a look at the reference to see if it was true for 345.

Q. For now that may be sufficient.

A. I mean, I can do that.

Q. And I believe one of the conclusions that you reached from this study was that field strengths for overhead transmission lines can be calculated with sufficient accuracy to preclude the necessity for field measurements?

A. That is the conclusion in that report.

Q. Page one, paragraph five?

A. Yes. I would only caveat that by saying that the field measurements that we made were under very good measurement conditions in the sense that we chose areas to make measurements where there were not interfering obstacles like close in trees and houses and that sort of thing. And subsequent to that it has become apparent that to calculate fields with more precision that one needs to take account of such things and some of the computer programs that are available to make those calculations do that now. But without some extraordinary interference, unexpected, then the calculations certainly give good predictions of measured values.

Q. And in fact Philadelphia Electric Company used one of those computer programs that does take into account of such factors, is that correct?

A. I do not know. I'm not familiar with ENVIROS directly. The EXPOCALC program that you can get from, I think it was an EPRI funded program, that is commercially available now does.

Q. That is the one designed by Intertech Consultants?

A. Yes.

Q. That one at least takes it into account?

A. Yes.

Q. Now, the values in Table 1 for the 765 line do come from this Reference 5, the study that you helped author?

A. Yes.

Q. And they represent the values for a 765 line owned and operated by Indiana and Michigan Electric Company?

A. I would have to look.

Q. Go ahead.

(Witness perusing document.)

Q. If you look at your Reference 5 on page two, I think you might find something. The second paragraph. And for the calculations on page three.

(Witness perusing document.)

A. Michigan Electric Company's Dumont substation, yes. South Bend, Indiana.

Q. And while we are there in that particular place, the 500 kV values in your Table 1 also come from Reference 5, is that correct?

A. Yes.

Q. I might refer you to figure three, page eight of Reference 5.

A. Yes.

Q. And those 500 kV values are also for a single line, this time one owned and operated by the Potomac

Edison Company, is that correct?

A. On page eight?

Q. Well, that is the next question. And the place to look for that is in your Reference 5, page 26, so you can check it.

(Witness perusing document.)

A. You said page 26?

Q. Yes.

A. Yes. Potomac Edison line for the 500 kV?

Q. Yes, down at the bottom.

A. Yes.

Q. Now, the 345 kV line which you referred to in Table 1 of your testimony, that also comes from -- double circuit 345 line -- also comes from Reference 5, and that is figure five, page ten of Reference 5.

(Witness perusing document.)

A. There is a point I believe we need to clarify. The figures that you are referring to at the front, for instance, on page five, are calculated values for various parameters. Now, there are other charts within that report that directly compare the calculated values for that particular line with the measured values. And I would refer you to page 25 of that for, say, figure 15, for the 345 kV line. And I will have to page through here.

The figures that you -- like, on page five, are calculated for a range of various line heights, and as I recall those ranges for line heights were taken from a design book for extra high voltage transmission. So one of these curves probably corresponds fairly closely to the line.

If you are interested in comparing the measured and calculated values for specific lines I think it would be better to refer to different figures than the ones we are dealing with here, I mean, if that is the point you want to get to exactly.

Q. I wasn't really trying to get to that point. I was just trying to identify which line it was. For example, as to the double circuit 345, if you look at page 25 of your reference.

A. Yes.

Q. Those numbers are for the twin branch 345 kV line owned by Indiana and Michigan?

A. Yes.

Q. I am just trying to identify which line at this point.

A. Right.

Q. And there are two things displayed?

A. Correct.

Q. Now, the values for the 115 kV double circuit

and the 230 kV double circuit lines that are referred to in your Table 1 in your testimony, those come from Reference 6, don't they?

A. That's correct.

Q. And the values you record for these two types of lines are based on line designs provided by Baltimore Gas & Electric, is that correct?

(Witness perusing document.)

Q. Maybe look at page two of your Reference 6.

A. I believe that's correct but let me verify it.

Q. Please.

(Witness perusing document.)

A. Yes.

Q. Thank you.

Now, the Philadelphia Electric Company Woodbourne-Heaton 230 kV line that we are here to discuss today is a single circuit 230 kV, correct?

A. Correct.

Q. Now, I just notice in the table that aside from the single circuit 230 kV line at issue in this proceeding, you don't have another value for single circuit 230 kV lines, correct?

A. That's correct.

Q. Now, what one of the sources you relied upon for information about field levels from transmission

lines is a publication entitled Electrical and Biological Effects of Transmission Lines, A Review, published by the Bonneville Power Authority, and it is your Reference 9?

A. Yes.

Q. Do you have that reference available to you, Reference 9?

A. The only piece of that reference that I have directly with me here today is the piece that addresses magnetic fields levels because that is what I specifically --

Q. Do you happen to have page 14 of your reference?

A. No.

Q. I will be happy to share it with you.

MR. WATSON: Your Honor, this is the book I'm going to show him. I think he now has a copy.

BY MR. WATSON:

Q. I don't know whether one is easier to see than the other. I am going to ask you a question about page 14. Is yours pretty clear?

A. No.

Q. Why don't I share --

A. This doesn't have any even numbered pages in it.

Q. Let me direct your attention to page 14 of the

BPA document, which is your Reference 9.

A. Yes.

Q. Does that page provide information on field levels from BPA's 230 kV single circuit line?

A. Yes, it does.

Q. Look over at page 11. It may be a little clearer, I believe, over there. There is a table that is sort of a key to the graphics.

A. Yes.

Q. I would just like to ask you a couple of questions about that. The BPA document states that the maximum electric field for a BPA single circuit 230 kV line is about 2.0 kV per meter?

A. Maximum on the right-of-way, yes.

Q. And also it states that the electric field level at the edge of the right-of-way for their single circuit 230 kV line design is about 1.5 kV per meter?

A. Correct.

JUDGE SMOLEN: I didn't hear an answer. Is there a answer on record?

THE WITNESS: I said yes.

JUDGE SMOLEN: All right. Go ahead.

BY MR. WATSON:

Q. Those are all the questions I am going to ask you about that.

MR. SUGARMAN: Can I take a look at that, please?

MR. WATSON: Sure.

(Document handed to Mr. Sugarman.)

MR. SUGARMAN: Thank you.

BY MR. WATSON:

Q. Now, in your prefiled direct testimony on page six, lines 15 through 17, you rely on several reviews of the E/MF literature?

A. Yes.

Q. Now, one of the reviews you rely upon is Reference number 13, a book published in 1990 and written by Dr. Wilson, Dr. Stevens and Dr. Anderson entitled Extremely Low Frequency Electro-Magnetic Fields: The Question of Cancer?

A. Yes.

(Pause.)

A. I have a copy.

Q. You have the actual book?

MR. WATSON: Does Counsel need to see this?

MS. McCLOSKEY: No. That is fine.

MR. WATSON: Mr. Sugarman, do you want to see this book before I ask some questions?

MR. SUGARMAN: No, but I would be happy to see it when you are done.

MR. WATSON: Sure.

BY MR. WATSON:

Q. Let me refer you to the last chapter and the final paragraph of the last chapter.

A. Is there a page number?

Q. Yes. Page 369.

Would it first be fair to say that this chapter is essentially a summarizing chapter for the book?

A. I think it is fair to say that for the record that I have studied some parts of this book very carefully and I have scanned other parts. And the summary chapter is the chapter that I have scanned. And with that proviso, yes.

Q. It is basically the summary?

A. Yes.

Q. That is really all I am asking at this point.

Can we agree that in this chapter that Dr. Wilson, who are authored this chapter, attempted to present a general model of cancer causation and discussed recent findings regarding biological effects of exposure to E/MF and discuss how these findings might relate to this general model of cancer? Is that a fair characterization?

A. That is a reasonable characterization.

Q. Do you need a moment just to read -- I am going to ask you a question about that last paragraph. Do you

need just a moment to read it?

A. Let me just look at it.

(Witness perusing document.)

Q. Now, in this last paragraph of the summarizing chapter I believe the author makes reference to future experiments and general models of cancer, is that a fair statement?

A. Yes.

Q. Is it also correct that the authors say, quote, it is not our intent -- it is not our intent -- to argue that ELF exposure increases cancer risk?

A. Certainly that is what is said here.

Q. And by ELF does that mean extremely low frequency?

A. That is my understanding.

Q. And would that include -- specifically is that another way to refer to powerline fields, among other types of fields that are in the extremely low frequency range?

A. Conventional nomenclature for all frequencies below 300 hertz.

Q. Powerline fields are 60 hertz in the U.S.?

A. Yes, so it would include that.

Q. I believe another of the papers that you rely upon as an expert report is a review that was written by

Asher Sheppard, Reference 1?

A. Yes.

Q. Now, that paper is one chapter out of a larger report prepared by the California Public Utility Commission and the California Department of Health Services, is that correct?

A. Prepared for.

Q. For. Yes. Issued by but prepared for.

A. Issued by, yes, but prepared for. Not by them.

Q. The Commissioners were not actually sitting there writing this out?

A. A number of experts prepared it.

Q. Various scientists wrote different chapters?

A. Correct.

Q. And Asher Sheppard wrote one of them?

A. That's correct.

Q. Do you agree with the recommendation of the California Department of Health Services when it states, quote, it is recommended that California take no action at the present to regulate electric and magnetic fields around electric power facilities?

MS. McCLOSKEY: I object. I think that goes to the policy questions which Dr. Rosenbaum addressed in his testimony and not to the current state of the biological studies that Mr. Janes addresses in his testimony. I

think it is beyond the scope of his testimony.

MR. WATSON: Your Honor, I am just really asking him -- he cited this reference and it has a conclusion in it and I am just asking him if he agrees with the conclusion.

JUDGE SMOLEN: I overrule the objection.

A. As with this book, there are some parts of this that I have read very carefully and some parts that I have scanned. I used this as a resource document to look at effects. And drawing a conclusion about the proper thing to do with respect to standard setting is beyond the scope of the things that I have addressed in my direct testimony. It is a very complex issue and it is not one that I feel I can address adequately here.

BY MR. WATSON:

Q. Now, let me refer you to page six of your testimony, lines 28 through 30.

A. Yes.

Q. There you make some comments about peer review studies, correct?

A. Correct.

Q. And I believe you say that studies published in peer review journals have met the journals standards for appropriateness and quality of experimental design, analysis of data and the logic underlying the

conclusions? Is that a fair characterization?

A. That is a direct quote.

Q. Would it be correct to say that different journals have different standards for what they publish?

A. From my own personal reading of journals that is an inference that one might draw. I'm not acquainted specifically with the written down requirements that each of the journals gives its reviewers, but it would appear to me from scanning through the literature, yes, there are different criteria for that for various journals.

Q. That's based on your experience?

A. As an inference, yes.

Q. You are not trying to cover the whole universe. I understand.

Let me ask you this: in your experience, articles published in peer review journals, are they always of very high quality based on your own professional standards?

A. One tends to give more credence to articles that are published in peer review journals than one does to symposia reports for reports of preliminary work. It is just one of a number of criteria that one can carry to make an evaluation of what is there. Obviously this is not a perfect world so there is bound to be a variation in quality and there are occasions when some very bad

papers get published even in spite of the peer review system. But it is still a reference that is useful.

Q. So there are times, for example, when something would be published in a peer review journal that might not meet your personal professional standards of quality?

A. It's a possibility.

Q. Have you ever found that to be the case?

A. I may have difficulty pulling up a particular example.

Q. I'm not going to ask for an example.

A. Let me be more direct. That is not a case with the peer review pieces that I cited in this testimony.

Q. Now, a research publication can be of very high quality if it has not appeared in a peer review journal, is that true?

A. It's possible.

Q. In the text of your written testimony you rely upon a study by Deno and Zafenella?

A. That's correct.

Q. That you identify as not being peer reviewed?

A. That's correct.

Q. And I assume that you judged that to be a well done piece of research that is worth relying upon?

A. I participated in that study.

Q. An even better reason.

In fact, a number of the publications you relied upon did not go through the peer review process, is that correct? And I would be happy to refer you to the specific ones in your references if that would help.

(Pause.)

Q. Can I withdraw that question and make it easier? Or you can feel free to answer either way.

A. Please.

Q. For example, References 1 -- you can look at your reference list. Are you there at your reference list?

A. Yes.

Q. Okay. I am going to refer you to the ones that I believe were not peer reviewed that you relied upon. One, 2, 5, 6, 9, 10, 13, 15, 16, 20, 21, 22, 35, 36. Those are all non-peer reviewed studies, is that correct?

A. That's true. I believe that you have taken my statement on reliance of peer review journals out of context.

Q. I'm not trying to argue with you. I am just trying to identify the ones that are or are not at this point, that are or are not peer reviewed.

A. That's correct. But --

Q. But in fact --

MS. McCLOSKEY: Excuse me. I think he wants to

clarify the answer.

JUDGE SMOLEN: Go ahead. You can explain.

MR. WATSON: I have no objection to him explaining his answer.

JUDGE SMOLEN: All right. Then let the witness explain. He can do it now or on redirect. So let him do it now.

A. In addressing the weak field effects past the point of Zafenella, that statement is said in the context of those references that follow that statement, not those that precede, and particularly to the effects piece and not to the generic issue of looking at all of the background materials here. That was my intent, to communicate that these studies that I described are drawn from the peer review literature.

BY MR. WATSON:

Q. So you don't just discard a publication because it has not appeared in a peer review journal and you don't just accept it because it has? Is that a fair statement?

A. Generically, yes, that is fair.

Q. And so you basically undertake some sort of independent evaluation of the study to determine whether you should rely upon it? Is that a fair statement?

A. That is certainly a fair statement.

Q. Now, in reference to some of these review papers where they are reviewing other people's work -- you have several of those in your references -- let me ask you this: if the goal is an objective review is it better to have the review conducted by the person who also conducted the research and authored the papers that are being reviewed or is it better to have the review conducted by a person who is qualified in the field but did not conduct the research being reviewed?

A. Better for what?

Q. Better for scientific objectivity.

A. I think it reaches to the purpose of the review. I don't know quite the context that you are asking it, but if an investigator has done a serious amount of work in an area that involves more than one publication and he goes and reviews and presents that work in the context of all of his work, I think that is a perfectly reasonable thing to do.

Now, I mean, if you are looking for some peer review evaluation of the adequacy of that work, then that is a different question.

Q. I am asking the latter. Would it be better to have the person who did the work do the peer review, the evaluation of its adequacy, or would it be better to have someone who didn't do the work --

A. I think it is sort of a statement in contradiction. I don't see how one can peer review their own work.

Q. Is that because one might tend to view his or her own work as being more important or accurate or meaningful than someone else might?

MS. McCLOSKEY: Objection. It calls for speculation, the conclusions about the perceptions of peer reviewers.

MR. SUGARMAN: And I object because it implies an answer to the previous question which the witness didn't give. His point was that the whole concept is inconsistent. He didn't say it was worse or better. He just said that a peer review can't be done by somebody that did the work.

JUDGE SMOLEN: I am going to sustain the two objections. Let Counsel ask it a different way or in a different fashion.

MR. WATSON: What I was trying to do, Your Honor, is follow up on his question. He said you really can't peer review your own work. And essentially I am asking why not.

JUDGE SMOLEN: Now you have a question. Why not?

THE WITNESS: Well, peer review -- I am having trouble with definition in this case. Peers are outside

of the individual. So just by definition I don't see how one can peer review his own work.

One can review his own work and that is a reasonable thing to do. But to ask -- I just -- I'm lost in the concept. I just am having trouble getting at what you mean by peer review. If you are asking can one objectively evaluate their own work, I would say some can and some can't. But that is just a general -- I'm not being specific with that at all.

BY MR. WATSON:

Q. I think I am getting at in the peer review process, is there a reason why in the peer review process, not keying off on the definition of pier, but in the peer review process is there a reason why you don't have the author of the studies being reviewed appointed to the peer review panel?

A. Because -- yes. Because he will address the comments of the peers and there is a process for doing that in the peer review process. People raise issues with respect to the work and that is peer review.

I can go on to say that often reviews of ones own work are of work, that is, when one tries to collect together and draw conclusions from it, have been made from literature that has already been peer reviewed.

Q. But essentially you don't ask people to review

-- if you are looking for an independent analysis you don't ask them to participate because it would not by definition be independent? Is that you're telling me?

A. If you are asking whether one can conduct an independent evaluation of their own work, probably not.

Q. So in looking at your independent evaluation of research, you conducted that as I think we understand whether the particular research has been published in a peer review journal or not, correct?

A. Not in this case. Not in this instance. What I attempted to do in discussing the effect on melatonin and on cellular systems and synthesis and this sort of thing was drawn from that literature which had been peer reviewed knowing that there are a lot of other things out there that impinge on that, but to bring a higher standard of criticism or critical review to these than one might have if one put his arms around everything that is out there. So that is why I took issue with you a little earlier about reliance on peer review, because I used that in the specific context of the studies. Maybe we need to go back and look at the specific language.

Q. What you did with the studies that you examined is you relied upon the fact that they were peer reviewed or reviews of those peer reviewed studies rather than your doing an independent evaluation of each study? I

don't want to put words in your mouth.

A. No, that is not correct.

Q. Okay.

A. This set of articles that addresses the melatonin work and addresses Goodman's work, those eight or nine articles that speak directly to effects at essentially the molecular synthesis level I drew exclusively from the peer review literature and I used peer review as one criterion for selecting quality work in that subset of things that we are looking at.

Now, I relied -- one reads a wide range of things and there were some points that I referenced sort of as a touch point. But in addressing the issue of whether exposure to these weak fields can produce effects one of the standards that I used for selecting the literature that is displayed here is that they must pass the peer review process.

It's not the only one. I brought some personal judgement to that as well. But that was the rationale here.

Q. So you did conduct an independent expert evaluation of each of the studies you cited?

A. I have read each of them carefully.

Q. And you evaluated them individually?

A. Correct.

Q. So if we have a study that reports a particular biological effect you would conduct an independent evaluation of that study before you would accept that the biological effect was in fact caused by exposure to the particular agent under study?

A. I would certainly read through the article, look at the conditions under which the study was taken, look at the reported data and draw some conclusions as to its validity, yes.

Q. I guess it goes without saying that you would not accept a biological effect as proven merely because some research that was reported in a peer review journal reported that effect?

A. Not in isolation.

Q. Just a factor.

(Witness nodding head in the affirmative.)

JUDGE SMOLEN: You have to answer so we can get it down rather than a nod.

THE WITNESS: I'm sorry?

JUDGE SMOLEN: You have to answer the question rather than nod your head because the reporter can't take down a nod. The answer to the last question was in the affirmative, correct?

THE WITNESS: Yes. I'm sorry.

JUDGE SMOLEN: All right. Next question.

BY MR. WATSON:

Q. And you would not reject the idea of a biological effect just because some research was published in a peer review journal that failed to show an effect?

A. That's correct.

Q. So an independent -- basically what we are saying is an independent evaluation of the research is what should be done?

A. Correct.

Q. I would just like to talk with you briefly about some of the individual studies that you have relied upon. I think you relied upon some studies on cellular systems. I would like to refer you to page eight, line 21, through page nine, line 15.

A. Yes.

Q. Now, I believe you stated on page eight, line 24, which is within that subset, one area where effects have been seen with some consistency is in the synthesis and activity of biologically important macromolecules such as ribonucleic acid, RNA, and proteins, correct?

A. Yes.

Q. That is a fair representation of what you said?

A. Yes.

Q. Now, just to be clear -- and I think we have an

answer to an interrogatory on this but it's not in the record so it may sound repetitious to you but I am going to ask you anyway. Just to be clear, when you say on page eight, lines 24 through 26, that the effects have been seen with some consistency you mean that there is internal consistency in the studies you are referring to, is that correct?

(Witness perusing document.)

Q. And I can refer you for convenience to the interrogatory, which is Interrogatory 3(b)?

A. Perhaps I can just read what is here.

Q. Sure.

A. It says, "The examples cited for effects observed in studies of cellular systems, that is References 29 through 34, are internally consistent in that the observed effects are consistent with changes in the synthesis and the activity of large biological molecules."

It goes on to say, "There are a large number of effect studies reviewed in References 1 and in 12 through 15. Some of these studies report effects; some report no effects." And the phrase seen with some consistency was meant to describe the internal consistency of these studies, of the cited examples.

Q. Thank you. And that is your reply to what is

meant by internal consistency?

A. Yes.

Q. Now, the studies cited in your testimony with regard to your conclusion that these effects have been seen in biologically important macromolecules, are those the only ones you rely upon for that conclusion, just the ones you cite?

(Pause.)

Q. This is not intended to be a tricky question. Maybe I should make it clear by referring you to the answer to Interrogatory 3(a). All I am trying to do is we have a clarifying question. I am just trying to get the clarifying information on the record so it is clear what your testimony is.

A. These are the specific studies I relied upon for this conclusion.

Q. And you didn't rely upon any other studies for this conclusion?

A. Not specific studies. One can't reject the large general background that one has from lots of reading.

Q. You can't erase your mind like a hard disk. Understood.

On page nine of your testimony you refer to work by Byus and co-workers on ornithine decarboxylase. And that

is referred to as ODC, correct?

A. Yes.

Q. It's specifically lines five through seven in Reference 33. And the co-workers involved there included Dr. Ross Adey?

A. That's correct.

Q. In Reference 33?

A. That's correct.

Q. This same Dr. Adey, I believe, wrote a chapter in the book by Wilson that we referred to earlier?

A. Yes.

Q. Your Reference number 9 -- not 9. Let's get the right number in the record here. That is Reference 13, correct?

A. Correct.

Q. Could you look at chapter ten of that reference, please, particularly page 237?

A. I am at page 237.

Q. And there Dr. Adey discusses his work on ornithine decarboxylase, correct?

(Witness perusing document.)

Q. Right at the top of 237?

A. Yes, I am there. Yes.

Q. Now, in that first paragraph Dr. Adey says basically that the relationship between E/MF field

exposure and ODC activity is a speculation that awaits further evidence. Is that a fair characterization of what he says?

A. I would not characterize it quite that way.

Q. Does he say that?

A. You would have to say some more about speculation as to what.

Q. Well, maybe we could just read -- maybe you could just read the first couple of sentences of that paragraph.

A. It says, "Since these data showed that EM field exposure is capable of increasing ODC activity it is conceivable that exposure to low energy fields may promote tumor formation in a fashion analogous to the formal ester compounds. However, this speculation awaits further evidence from animal or cell culture models for tumor formation."

Q. Do you agree with his conclusion?

A. I don't disagree with the conclusion. Let me say this: there has been a hypothesis generated on the basis of the ODC observations and that is not an extension that I made in my testimony.

Q. Now, on pages seven and eight of your testimony you discuss some research on circadian rhythms?

A. Yes.

Q. And I believe you are asked at least on page seven, line 26, what is a circadian rhythm, correct?

A. Correct.

Q. And you answered, "Circadian rhythms are biological rhythms that repeat at approximately 24 hour intervals," correct?

A. Correct.

Q. I had a little difficulty in understanding the response because it used the word rhythm to define circadian rhythm. Is there some other definition of circadian rhythm that you might offer that might make it clearer other than it is a rhythm at 24 hours? A rhythm of what?

A. Let's go on and look at the example that is displayed here. One of the reasons that I chose an example was temperature, normal body temperature. Normal body temperature goes through a cycle that repeats every 24 hours and it is -- the maximum temperature for most people who have lifestyles that don't involve shift work or working at nights, they see the maximum in their temperature in late afternoon, usually after some activity, food ingestion and this sort of thing.

And then if you continue to follow that cycle, that temperature will decrease and it will be a minimum at times usually when people are asleep prior to when they

wake up. The variations are small, but that variation repeats essentially every 24 hours. And the 24 hour repeat in that cycle is what is called the circadian rhythm.

Q. And the rhythm is the fact that it repeats and circadian is the fact it is 24 hours?

A. Correct.

Q. Now, the study of circadian rhythms, is that part of the medical specialty known as endocrinology, if you know?

MR. SUGARMAN: Your Honor, I object to the phrase "part of" because it implies -- it is unclear but it implies that it is only endocrinology that studies it.

MR. WATSON: I didn't make any implication, Your Honor. I'm just asking if it is part --

JUDGE SMOLEN: Overruled. You can answer.

A. It would be appropriate for an endocrinologist to be interested in circadian rhythms. Rhythms occur in other things besides endocrine systems.

Q. Now, I believe in your testimony you say that one consistently observed effect is that weak fields disrupt normal circadian rhythms?

A. Yes.

Q. And you cite two publications for that, References 20 and 21?

A. As general definitions, yes.

Q. Now, by consistently observed would it be fair to say that you are not intending to imply that disruption of circadian rhythms is seen in all studies?

A. That's correct.

Q. And you don't mean that every circadian rhythm has been shown to be affected, do you?

A. That's correct.

Q. Maybe it would be useful just to, if we could, can you just briefly list the known circadian rhythms that we have?

A. Not an exhaustive list. I can give some examples. Melatonin is one that is mentioned in the testimony. Rates of respiration, oxygen production and cardon dioxide production in animals are also circadian. It goes along with the activity of the animal. Some of the neurotransmitters display circadian rhythms. And I am sure there are others, but those are the ones that I am directly familiar with.

Q. In your testimony you spoke about normal body temperature having a circadian rhythm?

A. Yes.

Q. And you said it varies from person to person depending on their work style or something?

A. I'm sure that -- I have not studied on an

individual basis what circadian rhythms look like in individuals. The reference I made is that it is something that comes from the literature that indicates that those circadian rhythms are entrained with respect to a person's lifestyle and they are entrained to when a person is active and when they are quiescent. That is the general context in which I made that statement.

Now, body temperature is very complex. It doesn't normally show a circadian rhythm, it shows some smaller rhythms. I guess I'm not sure I've got the nomenclature but there are monthly cycles and cycles within a day. So there are in an individual's -- well, I have not studied individuals specifically. So I will leave the answer at that.

Q. So what you were saying earlier, as I understand it, in terms of the circadian rhythm and body temperature is it might vary between people depending on their lifestyle, whether they worked at night versus the day?

A. Correct.

Q. Now, let me ask you, is this rhythm and body temperature something that is important, the circadian rhythm and body temperature something that is important to human health?

A. That is a medical judgement. I don't believe I

should answer that question.

Q. Now, on page eight of your testimony you were asked to give some examples of weak field effects on circadian rhythms and I believe you talk about melatonin. Page eight, line six and on?

A. Yes.

Q. You define melatonin as a hormone that among other things regulates sexual function and development, is that correct?

A. That's correct.

Q. Can you tell us what is a hormone?

A. A hormone is an organic molecule that is manufactured in an endocrine gland and is distributed throughout -- has its physiological impact by entering the circulation and acting at sites remote from where it is synthesized.

Q. Just for background with regard to your reference here, about the role of melatonin, can you briefly describe the manner in which melatonin regulates sexual function in humans?

A. I think I would rely on what is here, the hypothesis, for detail. The general hypothesis is that the melatonin acts as an inhibitor of other hormones that have to do with the synthesis of molecules and cells that enter into the reproductive process. But I'm not going

to represent myself as an expert in that particular area. And that is why I referenced this description by both Reiter and Wilson, both well recognized experts in the area of melatonin.

Q. Do you know if melatonin alters gonadotropin levels in human, for example? Is that the kind of thing you're saying ask an endocrinologist about? Or do you want to answer that?

A. I could look it up in here. It is addressed here. But I don't recall.

Q. Now, many of the studies on melatonin function you cite are studies on rats, is that correct?

A. Correct.

Q. Could we agree that when it comes to sexual function and development rats and humans may be substantially different from one another?

A. I hope, yes.

Q. I hope so as well.

Now, I believe you stated on page eight, lines eight through nine, that exposure to 60 hertz electric fields suppresses nighttime concentrations of melatonin in the rats pineal gland, is that correct?

A. That's correct.

Q. Did the rats in these studies suffer from any problems with sexual function or development? Or did the

authors report any such problems?

A. That's two questions. No, the authors did not. And, two, the study was not designed to test that.

Q. Now, I believe you also rely on research by Kavaliers --

A. That's correct.

Q. -- and co-workers as examples of alterations in circadian rhythms that can be caused by exposure to fields?

A. That's right.

Q. Is this a study where the researchers basically shot up some mice with Morphine, for lack of a better phrase?

A. There is a difference in, at least in rodents, in the analgesia or the effect of injections of Morphine.

Q. But they did inject them with Morphine?

A. Yes.

Q. And then after they were on Morphine for a couple of days they put them on hot plates, is that right?

A. That's correct.

Q. And they measured how long it took them to start jumping around?

A. That's correct.

Q. Then about after eight days they exposed the

mice to 60 hertz fields?

A. I don't recall the timing involved. I would have to look.

(Witness perusing document.)

Q. I believe these were static fields. I shouldn't say 60 hertz fields.

A. Is that a question?

Q. No. I think I misstated the study when I said 60 hertz fields. I should have said static fields.

A. That is not correct either.

Q. Would you correct me? I seem to have gotten it wrong twice here. Maybe you can get me on the right path.

A. These were rotating static magnets. The magnetic field established with the magnet was static but the magnet was rotated.

Q. This was an actual magnet like you would use to pick up some bolts?

A. That's correct. And it rotated, as I recall, at about one hertz -- in terms of exposure, it was not exposure to a static field. It was exposure to a time varying field.

Q. And they just used a regular magnet?

A. Actually, two. They rotated in opposite directions.

Q. Materially different from the kind we used to play with as kids, just pieces of metal that are magnetized?

A. They appear in the schematic given in the paper to be horseshoe magnets. I refer you to figure 1.

Q. Okay. Now, after the eight days they, if I am right about the eight days, they exposed to the mice to these fields from the horseshoe magnets, is that correct?

A. I mean, if it is important to verify.

Q. The eight days is not critical. Sometime later?

A. I mean, we can take the time for me to look.

Q. Afterwards, they exposed them.

A. Yes.

Q. After they had been on Morphine for a while they exposed them to the fields?

A. Correct.

Q. Then they put them back on the hot plates again, is that correct?

A. That's correct.

Q. And they found that during the day the mice jumped the same whether or not they had been exposed to the magnets?

A. That is my recollection, yes.

Q. And at night they jumped a little slower if

they had been exposed to the magnets?

A. That is not my recollection.

(Witness perusing document.)

Q. If you want to supply that later...

A. My recollection of this subject is that there are day/night differences in the unexposed animals.

Q. Yes. I understand.

A. And that those day/night differences tend to disappear when the animal was exposed to magnetic fields.

Q. Now, in terms of magnetic fields, they were from 1.5 up to 90 gauss that the rats were exposed to?

(Witness perusing document.)

A. I have to find that.

Q. Would you accept that subject to check?

A. Yes, I would.

Q. Thank you.

Now, the transmission line in question in this case will not create any static magnetic fields, is that correct?

A. That's correct.

Q. Now, you also discuss neurotransmitters in your testimony, both in your direct and I think in response to some questions on cross here, correct?

A. Correct.

Q. Let me just for convenience refer you to page

eight, lines 16 through 19.

A. Yes.

Q. Where you use the word neurotransmitters. I believe you state that neurotransmitters act as chemical bridges between nerve cells and the transmission of sensation such as light, heat and pain?

A. Correct.

Q. Can you identify for the record what are the principal neurotransmitters in humans?

A. The set of catecholamines and indolamines. We're talking about epinephrine, norepinephrine, dopamine as examples. I don't think I can give you an exhaustive list.

Q. When you say that neurotransmitters act as chemical bridges between nerve cells, do I correctly assume that you are talking about nerve cells in the brain?

A. At any synapse, which could be in the brain or along the peripheral nervous system. They are released -- electrical signals are transmitted down the nerve fiber into the synapse and transmitting chemicals are released in the nervous system, which would include more than the brain. But in this study, the study was done on the brain.

Q. Now, are there particular nerve cells in the

brain that are responsible for processing information on light, heat and pain?

A. There are certainly principal pathways in the processing of signals from some censors, from the eyes, from censors in the skin, yes.

Q. Where are those nerve cells located in the brain? In what region?

A. I don't profess to be a neuroanatomist. I can give you a general answer but not a specific answer. I can't give you a medically precise answer.

Q. I believe you said earlier that neurotransmitters have circadian rhythms?

A. As seen in this study, yes.

Q. What about beyond that study? Is that a general proposition?

A. I will limit myself to this particular study. The unexposed animals displayed a circadian rhythm.

Q. But you would not know generally whether neurotransmitters have circadian rhythms for all parts of the brain in humans, for example?

A. No.

MR. WATSON: Thank you very much. I pass the witness, Your Honor.

JUDGE SMOLEN: Let's take a break.

(Recess.)

JUDGE SMOLEN: Let's go back on the record for further cross-examination of this witness.

Mr. Sugarman has asked that he go next, so we'll call on him.

CROSS-EXAMINATION

BY MR. SUGARMAN:

Q. Mr. Janes, in response to Mr. Watson you indicated in respect to peer review that it is not necessarily necessary -- does not necessarily provide an objective view.

Has there been concern in the scientific community that you're familiar with with respect to the objectivity of peer review in areas where there are interested entities that sponsor research and have large resources to do so?

A. I'm not sure I understand the question.

Q. Is there a concern about whether scientists are made into advocates by virtue of being the subject of sponsored research sponsored by entities that have an interest in the outcome of the research? And has that had an effect on the whole peer review --

JUDGE SMOLEN: Let's get one question at a time.

MR. SUGARMAN: Okay.

A. I don't have any objective information that would address that question.

BY MR. SUGARMAN:

Q. Now, in your testimony at page three you characterize the high voltage transmission line in terms of kV/m and in terms of milligauss. Just so it's clear, is it correct that the kV/m measurement relates to electrical fields?

A. That's correct, kilovolts per meter.

Q. And does it have anything to do with magnetic field measurement?

A. No. It is a measure of the electric field.

Q. And it has nothing to do with magnetic field measurement? That is to say, if you knew the kV/m associated with a transmission line that wouldn't help you to evaluate it in terms of magnetic fields?

A. That's true for this frequency, yes.

Q. And milligauss is a measure of what?

A. It's a measure of magnetic field.

Q. And lastly, in respect to your testimony at page nine, you indicate at the bottom of page nine starting at the bottom of line 23, in the effort to determine interaction mechanisms you state that one model that has been proposed involves changes in the cell membrane that affect cell function.

Are you aware of any scientific work which disproves the validity of that model?

A. No. I'm not aware of a study that would disprove that model.

Q. And then you state another is a resonance model which involves the magnitude and direction of the earth's static magnetic field, the direction and frequency of the applied time varying magnetic field and the ratio of the charge to mass of several biologically important ions. Are you aware of any study which disproves the validity of that model?

A. There are studies that I am aware of that are both consistent and inconsistent with the predictions of that model.

Q. And are those experimental studies?

A. They are experimental studies, yes.

Q. Has there been any concensus reached as to the validity of that model?

A. No.

Q. And when you say in your last sentence that these models have not been experimentally established, what do you mean by that?

A. That the experimental tests of the models are not robust enough or are not as well open to other explanations than those are the -- the few studies that have been designed to test these models.

As I said, they are both to figure something -- in

the context in which I meant these models have not been experimentally established would mean that one would have some concensus among the investigators in the field that these models are applicable and explain the results that were seen.

Q. So would it be fair to say that what you're saying is that the key word here is established, that there is no concensus on -- and you're using established as a synonym for concensus?

A. I'm using established in the sense of -- in the scientific sense that you would make predictions on the basis of these models and those predictions would be verified and subject to experimental work in a number of experiments in the hands of a number of investigators. And yes, that leads to concensus.

Q. Now, then when you say in your first sentence of that answer, "The mechanisms for these observed weak field effects are not known," the term not known, then, is qualified by the statement that you just made that the models have not -- that purport to offer such an explanation -- have not been subjected to sufficient experimental verification that the scientific community accepts them, or accepts their explanation, is that correct?

A. I'm hedging only because these studies that I'm

referring to are not in the peer review literature. So that they would not have been held up to the same standard as some other studies.

I am aware of studies that purported to test this hypothesis in essentially very similar experimental systems in which the data reported to date is positive in some instances and negative in others.

Q. And so that's the sense in which you mean not known?

A. That's correct.

MR. SUGARMAN: Thank you. I have no further questions.

May I be excused, Your Honor?

JUDGE SMOLEN: Yes.

Incidentally, of record we're going to discuss tomorrow Mr. Sugarman's advice concerning his witness, the availability and unavailability of his witness. That is Professor Liboff?

MR. SUGARMAN: Yes, Your Honor.

JUDGE SMOLEN: We will discuss that tomorrow with Mr. Sugarman's co-Counsel who will be here.

MR. BONNEY: Your Honor, I have some questions about who is going to testify tomorrow.

JUDGE SMOLEN: Of Mr. Sugarman?

MR. BONNEY: I have some questions. If --

JUDGE SMOLEN: Well, let's go off the record -- unless you want it on the record.

MR. BONNEY: I would prefer that it be on the record.

JUDGE SMOLEN: Let's go on the record. Go ahead.

MR. BONNEY: Your Honor, we had previously asked for identification of who would be testifying tomorrow, and at the hearing this afternoon I received a list of people who the Protestants intend to call tomorrow.

JUDGE SMOLEN: How many are on that list?

MR. BONNEY: Nine.

I may have some objection to some of these witnesses, and I guess I have some questions about them that may lead to some objections. If you would like to hear them at this time...

JUDGE SMOLEN: Well, Mr. Sugarman wants to leave, so I think -- what time --

MR. SUGARMAN: I would prefer that Mr. Bonney raise his questions when the witnesses are here, if that's all right.

JUDGE SMOLEN: Well, we don't want to bring anyone in who may not --

MR. SUGARMAN: We don't mind bringing them in.

JUDGE SMOLEN: Do you want to hold it until tomorrow?

MR. BONNEY: That's fine. We may not be in a position to cross-examine the witnesses based on some things indicated on this sheet that was given to us.

MR. SUGARMAN: They can come back if that's the case.

JUDGE SMOLEN: Mr. Sugarman has indicated that they would return. And we have to discuss a date for Professor Liboff. So let it stand at that.

I would also like to complete this witness tonight so we don't have to bring him back tomorrow. So let's go on with cross-examination.

Ms. Khanwalkar.

MS. KHANWALKAR: I just had one question.

CROSS-EXAMINATION

BY MS. KHANWALKAR:

Q. Is there any reason in your opinion that 60 hertz magnetic fields should be any more or less dangerous than magnetic fields from any other portion of the electro-magnetic spectrum, let's say, 80 hertz or a thousand hertz or radio frequency or visible light? I mean, as you go along the electro-magnetic spectrum is there anything special about 60 hertz magnetic fields?

MS. McCLOSKEY: I object. I believe that the question needs to be re-worded in that it asks whether there's any reason that 60 hertz fields would be more or

less dangerous. I don't believe it was his testimony that there was a danger, but that there was an effect on biological systems.

MS. KHANWALKAR: Okay. I'll rephrase it.

BY MS. KHANWALKAR:

Q. Would it have any more or less of an effect?

A. Magnetic fields you said?

Q. Yes. From 60 hertz.

A. From 60 hertz?

Q. Is there anything special about 60 hertz?

A. I'm trying to recall. Subject to verification, it seems to me that frequencies in the neighborhood of 60 hertz for direct contact, the levels of perception of 60 hertz are close to maximum sensitivity. And it may also be true for fibrilation currents. But that's not for externally enclosed fields. But that's the only piece of the low frequency range that I'm aware of where there would be some particular sensitivity to 60 hertz.

Q. And what is the implication of that?

A. This relates more to direct contact shock hazard, that is, contacting a conductor directly that's energized.

Q. Then you're talking about electrical fields. I asked for magnetic fields.

A. No, I'm not aware of any difference.

MS. KHANWALKAR: Thank you.

JUDGE SMOLEN: Is that it?

MS. KHANWALKAR: That's it.

JUDGE SMOLEN: Ms. Burket?

MS. BURKET: I have no questions.

JUDGE SMOLEN: Redirect? Do you want a little break?

MS. McCLOSKEY: Your Honor, I just need one minute. I don't believe I have any redirect. We did accept one thing subject to check. I just want to check it quickly.

(Pause.)

REDIRECT EXAMINATION

BY MS. McCLOSKEY:

Q. Mr. Janes, during the cross-examination by Mr. Watson concerning the Kavaliers study you accepted subject to check that the range in the exposure apparatus in that study was 1.5 to 90 gauss fields. Have you been able to confirm that?

A. Yes, I have.

Q. And is that correct?

A. That is correct.

MS. McCLOSKEY: Thank your, Your Honor. We have nothing further.

JUDGE SMOLEN: Anything further of the witness?

(No audible response.)

JUDGE SMOLEN: The witness is excused. Thank you very much for appearing and testifying.

(Witness excused.)

JUDGE SMOLEN: I think that wraps up today's session, and we'll all be back together again at 10:00 a.m. for further public witnesses and Mr. Bonney's comments or objections. And we want to discuss, as I said before, another date for Mr. Sugarman's expert witness.

With that we will adjourn today's session. The hearing is adjourned.

(Whereupon, at 4:50 p.m., the hearing was adjourned, to be reconvened at 10:00 a.m. on Friday, September 20, 1991, in Philadelphia, Pennsylvania.)

C E R T I F I C A T E

I hereby certify, as the stenographic reporter, that the foregoing proceedings were taken stenographically by me and thereafter reduced to typewriting by me or under my direction; and that this transcript is a true and accurate record to the best of my ability.

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BEFORE THE

PENNSYLVANIA PUBLIC UTILITY COMMISSION

DIRECT TESTIMONY

OF

DAVID M. ROSENBAUM

ON BEHALF OF

PENNSYLVANIA OFFICE OF CONSUMER ADVOCATE

PRUDENT POLICY IN THE FACE OF UNCERTAIN RISK

Risk Analysis Corporation
6723 Whittier Avenue, Suite 202
McLean, Virginia 22101

August 1991

DIRECT TESTIMONY OF DAVID M. ROSENBAUM

Q. Please state your name and business address.

A. David M. Rosenbaum, Risk Analysis Corporation, Suite 202, 6723 Whittier Avenue, McLean, Virginia 22101.

Q. By whom are you employed?

A. I am President of Risk Analysis Corporation.

Q. For whom are you appearing?

A. I am testifying at the request of the Office of Consumer Advocate of the State of Pennsylvania.

Q. What are your qualifications to testify as an expert?

A. I have over twenty years of experience in analyzing the effects and risks of exposure to ionizing and nonionizing radiation and other risks. I was in charge of writing the United States General Accounting Office report Somatic Health Effects of Low Level Ionizing Radiation. I was a Deputy Assistant Administrator of the United States Environmental Protection Agency and Director of Radiation Programs there. My responsibilities at EPA included nonionizing radiation. A personal resume is attached as Exhibit DMR-1.

Q. What are the purposes of your testimony?

A. The purposes of my testimony are to comment on the current state of knowledge of the effects of 60 hertz magnetic fields on people and to discuss the issue of prudent decision making in the face of uncertain risk and certain cost.

Q. Have you had any experience in statistics or epidemiology?

A. Yes. I have been involved in data analysis for more than twenty-five years. I co-authored *A Statistical Procedure for Testing Nuclear Powered Cardiac Pacemakers* and *A Statistical Procedure for Cluster Recognition with Application to Atlanta Leukemia-Lymphoma Data*, both published in prominent refereed journals. The major GAO study, cited above, which I directed, included a great deal of epidemiology. In my job as Director of Radiation programs at EPA, I was frequently involved in making decisions that were based on epidemiological evidence.

Q. Are you an epidemiologist?

A. No. I am not qualified to run a epidemiological study. However, I am qualified to judge the policy implications of a body of biological, epidemiological, engineering and physics literature.

Q. Have you read David Janes' testimony on the effects of power frequency fields on animal and cellular systems?

A. Yes. In particular, I note the policy implications of his conclusion that, "the possibility of harmful effects cannot be summarily or categorically rejected, and concerns about harmful effects are legitimate."

Q. Are you familiar with the epidemiological studies of the possible effects of low-level, power frequency, magnetic fields?

A. I am generally familiar with the literature, although I have not carefully studied every paper.

Q. What is the current state of knowledge of the effects of 60 hertz fields on people.

A. The present epidemiological evidence is suggestive, but far from conclusive. Several studies by well qualified epidemiologists have reported associations between what may be surrogates for long-term average field strength and various types of cancer.[1,2,3] Sometimes there is no apparent correlation when actual measured (short-term) field strength is used instead of the surrogate.[3,4,5] Other studies have reported either no significant correlation or no relationship between fields or field surrogates and cancer.[6,7,8] Authors of one study have observed negative correlations between exposure to high magnetic fields and cancer.[8] Another study reports increased cancer, but lower total death rates (due to less cardiovascular disease for those exposed to high fields).[9] One study reports higher cancer incidence for people farther from a power line than for people closer to a power line.[10] Excesses of different cancer show up in different studies.

Q. For the studies you cite, please describe what the authors investigated and what they reported their results were.

A. Wertheimer and Leeper performed a case-control study of childhood cancer death rates in the greater Denver area from 1950 to 1973.[1] They reported an increased death rate from cancer among those near primary or secondary distribution wires. They subsequently studied adult leukemia as well and reported similar results.[2]

Barregård *et al.* studied mortality and cancer incidence among workers employed in a Swedish chloralkali plant. These men were exposed to strong magnetic fields at work (about 100,000 milligauss) for several years. The authors observed no increase in mortality or cancer incidence.[11]

Tomenius performed a case-control study investigating the relation of childhood cancer incidence to exposure to above-ground power lines in Stockholm.[12] He used both

distance from power lines and measured fields rather than the classification used by Wertheimer and Leeper.[1] He saw only three-tenths of the expected number of cases of leukemia in those more highly exposed to magnetic fields; however, he noted an increase in the incidence of brain tumors and benign childhood tumors among those with higher field readings and those nearer the power lines.

Gordon *et al.* report that the data from the Tomenius study can indicate a relative risk for people 100 to 150 meters from a power line that is more than four times the relative risk for people within 100 meters of a power line.[10]

Savitz *et al.* later examined childhood cancer incidence data from the Denver area in a case-control study and reported only modest effects as a function of measured magnetic field strength in the homes. However, they did find stronger evidence that wire coding is associated with childhood cancer.[3]

Rodwall *et al.* studied individuals living within 200 meters of a 220 kilovolt (kV) power line in Sweden.[8] There were no childhood cancer cases at all, while 0.2 were expected. Cancer incidence for all ages was less than expected among those exposed; the authors observed 18 cases with 19.9 expected.

McDowell studied people of all ages exposed to overhead high voltage lines and substations in East Anglia, England.[9] The author reported that overall mortality was lower than expected and no evidence of major health hazards emerged.

Fulton *et al.* studied childhood leukemia in Rhode Island and observed no relationship between power line configurations and leukemia.[7]

Myers *et al.* made a case-control study of all ages in Yorkshire, England, and reported no apparent relationship between exposure to overhead power lines and incidence of childhood cancer.[4]

Coleman *et al.* reported no statistically significant excess of leukemia and no suggestion of an increased risk of acute myeloid leukemia in their study of leukemias in four adjacent London boroughs.[6]

Severson *et al.* performed a case-control study of adult acute nonlymphocytic leukemia in western Washington State as a function of magnetic fields in homes, and observed no associations between incidence and exposure.[5]

Wertheimer and Leeper in their 1982 study considered cases and controls of all ages to examine cancer deaths in Longmont, Boulder, Denver suburbs, and Central Denver.[2] The authors divided wire code classifications into "lower" and "higher" groups. The authors observed that among the cases of cancer, more people lived in higher wire code configuration residences.

Q. What conclusions have you drawn about the implications of the epidemiological literature?

A. In general, the picture is very confused. It is not even clear that even if exposure to power lines does increase the risk of cancer, it is the average magnetic field that is the cause.

It is very difficult to *prove* something with epidemiology. In fact, it is not at all clear what it *means* to prove something. Look how many decades it took to convince the medical establishment that smoking leads to lung cancer. Look at how the current wisdom about whether drinking moderate amounts of alcohol is good for you has changed

so many times. In addition, it is quite possible for something to be carcinogenic and still increase the average life expectancy by lowering the chances of other forms of death; *e.g.*, cardiovascular disease. Postmenopausal use of estrogen may be an example of this.

Q. How does the present state of knowledge of the effects on people of power frequency, nonionizing fields compare with our knowledge of the effects on people of ionizing radiation?

A. It is important to distinguish between ionizing and nonionizing interactions. The ultraviolet and higher frequency fields have enough energy to remove electrons from the atoms and molecules of biological cells and tissues. This process is called ionization, and the events accompanying ionization can have disastrous consequences for cells, including death, mutation, and the initiation of cancer. However, power transmission and distribution fields are nonionizing because they have energies that are too small to produce ionization; therefore, the mechanisms by which ionizing radiation produces damage in living cells do not apply to power frequency electric and magnetic fields.

Our understanding of the effects of ionizing radiation is far less certain than the public is led to believe. This is in spite of the fact that many billions of dollars have been spent on ionizing effects research and more than one hundred thousand papers have been written in the field. Our knowledge of the effects of nonionizing radiation is far less. I feel that, as a crude comparison, our knowledge of the effects of nonionizing radiation is about comparable to our knowledge of the effects of ionizing radiation in the 1920s.

Q. What is prudent policy in the face of such uncertainty?

A. o Research into the effects of electric and magnetic fields should be continued.

o The government and the industry should be aggressive in periodically informing the public about the latest information, stressing its uncertainty and changeability.

This needs to be done in an absolutely impartial manner and before it is required. Where this has not been done the public often comes to mistrust both the industry and the government, and for good reason. The attitude that things are too complicated and uncertain for the public to deal with, and that they will only get unnecessarily upset, is almost always fatal to rational decision making by the society.

- The public should be involved in the decision making process before critical decisions are made. This is not at all the same thing as having public meetings or private sessions with concerned individuals to convince them after the decision is made. Although the process of public consultation takes a lot of time, in the end it moves things much faster and more certainly, though not necessarily in the direction that would have been taken without public consultation.

- At the very least, companies considering power line projects should consider the cost and effects of possible mitigative measures before any construction is decided on. This was not done in the case of the PECO 230 kV line. All the calculations on alternatives were done after the line was virtually finished, and then only after a request from the Office of Consumer Advocate for such calculations.

Mitigative measures that should be considered before construction begins may include, but are not limited to:

- avoiding heavily populated areas
- avoiding parks, schools, and other public facilities
- widening rights-of-way
- limiting public uses of rights-of-way
- using higher ground clearances
- designing the power lines to reduce the fields

I believe that substantial reductions in average magnetic field strength can usually be obtained at reasonable cost. For example, reductions of 50 to 75 percent over current practice should be possible at reasonable cost on new lines. Designing a power line using current codes may not minimize fields; the current codes were drawn up by "consensus committees" which did not even consider magnetic field strength.

- In planning one should err on the side of safety, but not without considering the cost. Of course, people can differ as to what cost is reasonable in a given situation. Given the confusing and sometimes conflicting results of studies of low-level, power frequency, magnetic fields, it is not even entirely clear what erring on the side of safety means. Nevertheless, I believe that it is prudent to take measures to lower the public's exposure to magnetic fields if this is not too costly. "Too costly" is one of the things that needs to be worked out in public consultations with all affected parties.

Q. Please summarize your conclusions.

A.
- Research on the effects of electric and magnetic fields should be continued.
- The public should be informed about possible health effects proactively, impartially, and regularly.
- The public should be involved in critical decision making processes from the beginning.
- The cost and benefits of possible alternatives should be calculated before any construction decisions are made.
- Err on the side of safety, but not without considering the cost.

Q. Does this conclude your testimony?

A. Yes.

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2. Wertheimer and Leeper. Adult cancer related to electrical wires near the home. International Journal of Epidemiology 11:345–55, 1982.

3. Savitz *et al.* Case-control study of childhood cancer and exposure to 60-hertz magnetic fields. American Journal of Epidemiology 128:21–38, 1988.

4. Myers *et al.* Overhead power lines and childhood cancer. Proceedings of the International Conference on Electric and Magnetic Fields in Medicine and Biology, London.

5. Severson *et al.* Acute nonlymphocytic leukemia and residential exposure to power frequency magnetic fields. American Journal of Epidemiology 128:10–20, 1988.

6. Coleman *et al.* Leukemia and residence near electricity transmission equipment: a case-control study. British Journal of Cancer 60:793–798, 1989.

7. Fulton *et al.* Electrical wiring configurations and childhood cancer in Rhode Island. American Journal of Epidemiology 111:292–6, 1980.

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10. Tomenius. 50–Hz electromagnetic environment and the incidence of childhood tumors in Stockholm County. As analyzed in Gordon *et al.* Epidemiological Studies of Cancer and Powerline Frequency Electromagnetic Fields: A Meta-Analysis. Health Department, Victoria, p. 56.

11. Barregård *et al.* Cancer among workers exposed to strong static magnetic fields. Lancet, October 19, 1985, p. 892.

12. Tomenius. 50–Hz electromagnetic environment and the incidence of childhood tumors in Stockholm County. Bioelectromagnetics 7:191–207, 1986.

BEFORE THE

PENNSYLVANIA PUBLIC UTILITY COMMISSION

EXHIBIT DMR-1

OF

DAVID M. ROSENBAUM

ON BEHALF OF

PENNSYLVANIA OFFICE OF CONSUMER ADVOCATE

Risk Analysis Corporation
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August 1991

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EDUCATION

Ph.D., Physics, 1964, Brandeis University
M.S., Physics, 1958, Rensselaer Polytechnic Institute
Sc.B., Physics, 1956, Brown University

EXPERIENCE

March 1989 to Present

President, Risk Analysis Corporation.

As President of Risk Analysis Corporation, Dr. Rosenbaum is responsible for all financial, administrative and technical aspects of the company. He frequently consults and testifies on nuclear and fossil-fueled generating station performance, decommissioning of nuclear plants, statistics, environment and management issues.

October 1981 to Present

President, Technical Analysis Corporation.

June 1979 to September 1981

Deputy Assistant Administrator for Radiation Programs, U.S. Environmental Protection Agency.

Directed the Office of Radiation Programs (ORP), consisting of approximately 200 employees in three headquarters divisions and two radiological laboratories, with a total budget of about $15 million. ORP writes standards and guidance, monitors the environment, analyzes the movement and effects of radiation, plans and responds to radiation emergencies, and works closely with other federal agencies, states, and international bodies. Major accomplishments:

- Proposed standards for cleanup and disposal of uranium mill tailings.
- Proposed new federal guidance for occupational exposure to ionizing radiation.
- Developed draft standards for the management and disposal of high-level radioactive waste.

EXPERIENCE (Continued)

- o Established research program on the measurement, sources, prevalence, effects and remediation of indoor radon.
- o Furthered development of draft standards for the decommissioning of nuclear power plants.
- o Represented EPA on State Planning Council on Radioactive Waste Management, a presidentially appointed panel of 8 governors, 6 other local officials, and 4 federal representatives.
- o Developed national and international plans for monitoring radioactivity in the oceans.
- o Developed EPA plan for responding to radiological emergencies.
- o Reorganized ORP, including establishment of an in-house statistics and applied math group.

June 1976 to June 1979

Consultant to the Comptroller General, U.S. General Accounting Office (a full-time, three-year appointment). Assigned to the Energy and Minerals Division.

- o Consulted on and reviewed a large variety of energy projects.
- o Directed the Liquefied Energy Gases Safety Study, EMD-78-28.
- o Directed the Health Effects of Low-Level Ionizing Radiation Exposure Study, EMD-81-1.

December 1974 to June 1976

Senior Staff Member, the MITRE Corporation.

- o Developed a new type of statistic while directing study on the epidemiology of leukemia and lymphomas. (See publication #1.)
- o Directed MITRE study (MTR-7022), The Threat to Licensed Nuclear Facilities, for the Nuclear Regulatory Commission.
- o Directed Nuclear Energy Centers Workshop East for the Nuclear Regulatory Commission.

April 1974 to December 1974

Conducted investigation of technology transfer to the Soviet Bloc for the Senate Permanent Subcommittee on Investigations (on loan from the U.S. Atomic Energy Commission). This investigation involved interviewing the top executives at many of the United States' largest Corporations. It led directly to a fundamental change in the law governing high technology exports.

EXPERIENCE (Continued)

July 1973 to April 1974

Full-time Consultant to the Director of Licensing, U.S. Atomic Energy Commission, on a wide range of management and technical problems.

- Did internal management study that led directly to organizational changes.
- Initiated first full-time statistical work in the regulatory part of AEC.
- Directed Special Safeguards Study (Rosenbaum Report): reprinted in the Congressional Record, Volume 120, Number 59, April 30, 1974.

November 1972 to July 1973

Assistant Director for Analysis and Assistant Director for Administration Systems and Computerization, Office of National Narcotics Intelligence (ONNI), U.S. Department of Justice. Supervised all of ONNI, except liaison.

November 1970 to November 1972

Senior Staff Member, the MITRE Corporation.

- Wrote The Structure is the Policy (M72-74), one of the first plans for comprehensive reorganization of energy institutions.
- Directed MITRE study (MTR-6093), Domestic Crude Oil Deliverability, for the Office of Emergency Preparedness, Executive Office of the President. This work required interviewing top executives of the largest oil companies.
- Directed various environmental studies.

July 1972

Chairman, Engineering Foundation Research Conference on Subversive Disruption of Urban Areas.

1970 to Present

Associate Editor, Networks (Wiley).

EXPERIENCE (Continued)

October 1968 to July 1970

Founder, President, and Chairman of the Network Analysis Corporation, Great Neck, New York. Network Analysis Corporation is now a Division of Continental Telephone.

- Network Analysis Corporation introduced sophisticated network planning to industry and government.

April 1969 to December 1971

Member of the Board of Directors, Beta Instrument Corporation, Newton, Massachusetts.

- During this period, the company successfully went public, developed a major new product line, and merged into Gould, Inc., a large public conglomerate.

September 1968 to June 1969

Associate Professor of Electrical Engineering, Polytechnic Institute of Brooklyn (now Polytechnic Institute of New York). Did research and taught electromagnetic theory and circuit theory.

October 1967 to September 1968

Expert, Office of Emergency Planning, Executive Office of the President, Washington, D.C. Founder and director of network analysis group and in charge of planning a Presidential communications system. Did a major investigation of Presidential emergency relocation sites which involved extensive interviewing of top military officials.

September 1965 to October 1967

Senior Staff Member, Institute for Defense Analyses. Did technical work on lasers, plasmas, ballistic missile defense, over-the-horizon radars, network analysis, studies on urban insurgency and crisis management.

June 1965 to September 1965

Conducted special study (funded by DARPA) on three modern Western revolutions against the British; Ireland, Palestine, and Cyprus. Analyzed appropriate literature and conducted interviews with former members of the Irish Republican Army, the Haganah, and Irgun Zvai Leumi.

September 1964 to June 1965

Assistant Research Professor of Physics, Boston University. Did research on and taught electromagnetic theory and quantum mechanics.

EXPERIENCE (Continued)

January 1960 to September 1964

Senior Staff Member, MITRE Corporation. Worked on electromagnetic theory, plasmas, military systems, nuclear weapons effects, urban insurgency.

June 1959 to September 1959

Staff Member, Smithsonian Astrophysical Laboratory. Worked on distortion of solar magnetic fields by flares.

June 1957 to September 1957

Systems Programmer, Datamatic Corporation (now Minneapolis Honeywell Computer Division). Wrote the digital sorting routine for Datamatic-1000, which was then the largest business computer.

June 1956 to September 1965

Lecturer in logical design and logical designer, Datamatic Corporation.

AWARDS AND COMMENDATIONS

- The Energy and Minerals Division Director's Award from the U.S. General Accounting Office for "landmark report on Liquified Energy Gases Safety which will be the definitive work in the area for years to come." (1977)
- Letter of commendation from Senator Abraham Ribicoff for "advice you gave in the drafting of the reorganization legislation [which] contributed substantially to the safeguards provisions [in the Energy Reorganization Act which created the Nuclear Regulatory Commission]." (October 1974)
- Letter of commendation from Richard Ichord, Chairman of the Committee of Internal Security, U.S. House of Representatives, for "your vast knowledge of modern day terrorism and your forthright analysis [which] have provided...a contribution to our record...of a substantial nature." (August 1974)
- Letter of commendation from the Director of Licensing, Atomic Energy Commission, for "statistical techniques introduced at your initiative [which] continue to prove their value to the licensing process." (June 1974)
- Letter of commendation from the Director of the Office of National Narcotics Intelligence, Department of Justice for setting up and directing that agency's administrative operations. (June 1973)

AWARDS AND COMMENDATIONS (Continued)

- Certificate of Appreciation from the Executive Office of the President "in recognition of your vision and ingenuity in effectively applying network analysis theory to the solution of major problems of the nation." (September 1968)

TESTIMONY

Testified as an expert on many occasions before committees of the House and Senate on: energy problems, nuclear proliferation and terrorism. Testified frequently before State and Federal regulatory bodies.

SPEECHES

Has been invited to speak on a variety of topics at meetings around the world: in Japan, spoke on the structure of American energy regulatory bodies; in Germany, on the problems of radiation in the environment; in Sweden and Finland, on problems of nuclear energy generation as well as on nuclear terrorism; in Israel, on network analysis; in Paris, on nuclear proliferation.

ORGANIZATIONS

American Physical Society
Sigma Xi
Institute of Electrical and Electronic Engineers

PUBLICATIONS

1. "A Statistical Procedure for Cluster Recognition with Application to Atlanta Leukemia–Lymphoma Data" (with D.J. Kleitman), Studies in Applied Mathematics 68:61–88, 1983.

2. Testimony before the Subcommittees on International Security and Scientific Affairs and on International Economic Policy and Trade, House of Representatives. "Hearings on Export of Nuclear Technology," August 10, 1982, U.S. Government Printing Office.

3. Health Effects of Low-Level Ionizing Radiation Exposure Study, A Report Of The Comptroller General Of The United States To The Congress, EMD–81–1, January 2, 1981.

4. "A Statistical Procedure for Testing Nuclear Powered Cardiac Pacemakers," Technometrics, Volume 20, Number 3, August 1978.

5. Liquefied Energy Gases Safety, A Report Of The Comptroller General Of The United States To The Congress, EMD–78–28, July 31, 1978.

6. "Nuclear Terrorism," International Security, 3, Winter 1977.

PUBLICATIONS (Continued)

7. A Study of the Geographic Patterns of Chronic and Acute Leukemia, WP-11513, the MITRE Corporation, May 1976.

8. The Threat to Licensed Nuclear Facilities, MTR-7022, a MITRE Corporation report for the Nuclear Regulatory Commission, September 1975.

9. Testimony before the Committee on Government Operations, U.S. Senate. "Hearings on Export Reorganization Act," April 24, 1975, U.S. Government Printing Office.

10. Testimony before the Committee on Internal Security, House of Representatives. "Hearings on Terrorism," Part 4, August 20, 1974, U.S. Government Printing Office, Stock Number 5270-02654.

11. Special Safeguards Study (with John M. Googin, Robert M. Jefferson, Daniel Kleitman, and William C. Sullivan), Congressional Record, Volume 120, Number 59, April 30, 1974.

12. "Behind U.S. Fuel Crisis: A Lack of Energy and Will Power," AFL-CIO Free Trade Union News, Volume 29, Number 1, January 1974, under the pseudonym of Damord Virkse.

13. The Structure is the Policy, M72-74, the MITRE Corporation, June 1972.

14. (*et al.*), Monitoring the Environment of the Nation: A Report to the Council on Environmental Quality, MTR-1660, the MITRE Corporation, October 1971.

15. "Comprehensive Environmental Data Systems" (with R.P. Ouellett and R.S. Greeley), Datamation, April 15, 1971.

16. Water Indices, WP-7538, the MITRE Corporation, April 1971.

17. "Optimal Design of Offshore Natural Gas Pipeline Networks" (with H. Frank, B. Rothfarb, K. Steiglitz, and D. Kleitman), Operations Research, 18, 992-1020 (1970).

18. Redundant Networks (with Joyce B. Freidman), MITRE Corporation Report.

19. "Super Hilbert Space and the Quantum Mechanical Time Operator," Journal of Mathematic Physics, Volume 10, 1969.

20. "General Space-Momentum Commutation Relation," Journal of Mathematic Physics, Volume 8, 1967.

21. "Proof of the Impossibility of a Classical Action Principal for Magnetic Monopoles and Charges With Subsidiary Condition," Physical Review, Volume 147, 1966.

22. Hamilton's Equations and Hamilton-Jacobi Theory in Quantum Mechanics, Institute for Defense Analyses Research Paper, P-248.

23. A Quantum Mechanical Investigation of Exploding Wires, W-3030, MITRE Corporation Report.

24. Magneto-Ionic Theory, W-4421, MITRE Corporation Report.

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BEFORE THE

PENNSYLVANIA PUBLIC UTILITY COMMISSION

DIRECT TESTIMONY

OF

DAVID E. JANES

ON BEHALF OF

PENNSYLVANIA OFFICE OF CONSUMER ADVOCATE

THE EFFECTS OF POWER FREQUENCY FIELDS ON ANIMAL AND CELLULAR SYSTEMS

Risk Analysis Corporation
6723 Whittier Avenue, Suite 202
McLean, Virginia 22101

August 1991

DIRECT TESTIMONY OF DAVID E. JANES

Q. Please state your name and business address.

A. David E. Janes, Risk Analysis Corporation, Suite 202, 6723 Whittier Avenue, McLean, Virginia 22101.

Q. By whom are you employed?

A. I am Vice President of Risk Analysis Corporation.

Q. For whom are you appearing?

A. I am testifying at the request of the Office of Consumer Advocate of the State of Pennsylvania.

Q. What are your qualifications to testify as an expert?

A. I have over thirty years of experience in analyzing the effects and risks of exposure to ionizing and nonionizing radiation. A personal resume is Exhibit DEJ-1.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to explain the basis for my conclusion that power frequency electric and magnetic fields affect animal and cellular systems. Power frequency fields are electric and magnetic fields from 50 or 60 hertz (cycles per second) alternating current, power transmission and distribution lines.

Q. Does exposure to power frequency electric and magnetic fields affect biological systems?

A. Yes. Exposure to power frequency electric and magnetic fields produces demonstrable, measurable effects in humans, animals, and experimental cellular systems. For example, one can feel hair movement on the back of the hand when the arm is raised above the head in an electric field[1*] and strong magnetic fields can be sensed through the flickering light flashes (magnetophosphenes) they produce in the visual system.[2] The fields that produce these two effects are not commonly encountered in environmental exposures. However, exposure to weaker electric and magnetic fields also affects biological systems.

Q. What do you mean by a "weak" field?

A. Electric and magnetic fields induce currents in objects placed in the field. Current is the flow of electric charge and is measured in amperes. The density of this current in biological studies is most conveniently expressed in millionths of amperes per square centimeter or microamperes per square centimeter.

I call electric and magnetic fields "weak" if the current density they induce in tissue is too small to affect the function of critical tissues such as the heart and the central nervous system.[2] The normal current densities associated with the electrical activity of the brain and the heart have lower limits of 0.1 and 1 microampere per square centimeter, respectively.[3]

Using data from Tenforde and Kaune[4] for an adult human electrically grounded through both feet, this corresponds to unperturbed, 60 hertz, electric fields of 8.3 and 46 kilovolt per meter (kV/m), respectively. The 60 hertz magnetic fields which produce 0.1 microampere per square centimeter in the brain and 1 microampere per square centimeter in the heart have been calculated to be 5,300 and 44,000 milligauss, respectively.[2]

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* Numbers indicate references listed as endnotes.

The electric field strengths for some typical high voltage transmission lines are given in Table 1.[5,6] The maximum electric field occurs on the right-of-way and ranges from about 1 to 12 kilovolts per meter and fields at the edge of the right-of-way range from 0.3 to about 3 kilovolts per meter. For its 230 kV single circuit line, PECO has calculated the maximum right-of-way fields to be 1.9 to 2.3 kV/m and the fields at the edge of the right-of-way to be 1.2 to 1.3 kV/m.[7,8]

Magnetic fields under high voltage transmission lines are variable; they depend on the line current which varies with the transmitted power. Typical values fall in the range of 20 to 140 milligauss[9] and maximum values probably do not exceed 350 milligauss.[10] For its 230 kV single circuit line carrying a normal load current of 360 amperes,[11] PECO has calculated the maximum right-of-way field to be 42 milligauss and the field at the edge of the right-of-way to be 25 milligauss.[7] During heavy loading (600 amperes) and emergency maximum loading (1000 amperes) the magnetic fields will be higher.[11]

Since most environmental exposures to electric fields are less than 8 kilovolts per meter and environmental exposures to magnetic fields are well below 5,300 milligauss, environmental exposures involve weak electric and magnetic fields, *i.e.*, in humans they induce axial currents less than 0.1 microampere per square centimeter.

Q. How do power frequency electric fields interact with people and animals?

A. The interaction of power frequency electric fields with humans and animals results in intensified electric fields at the outer surface of the body and electric fields and currents inside the body.

Table 1. Transmission Line Electric Field Strengths in Kilovolts per Meter.

LINE TYPE	MAXIMUM FIELD (kV/m)	EDGE OF ROW* FIELD (kV/m)
115 kV double circuit	0.97 – 1.1	0.4 – 0.6
230 kV PECO single circuit	1.9 – 2.3	1.2 – 1.3
230 kV double circuit	2.3 – 3	0.3 – 0.8
345 kV single circuit	4.5 – 8	1.2 – 1.5
345 kV double circuit	5 – 7	0.7 – 1.5
500 kV single circuit	6 – 7	1.4 – 1.7
765 kV single circuit	8 – 12	2.0 – 2.3

* ROW = right–of–way

If an electric field exists at some location, say on a transmission line right–of–way, and there are no objects in the field between the conductors and the ground, the field is called an unperturbed electric field. Conducting objects placed in an unperturbed field have surface fields that are more intense than the unperturbed field. Some peak and average surface electric fields for different species placed in an unperturbed 1 kilovolt per meter field are shown in Table 2.[4] This table illustrates the need to scale exposure fields. For example, an exposure (unperturbed) field must be increased by almost 5 times to produce the same peak surface field in the rat as in the human and almost four times to produce the same average field.

Table 2. Peak and average electric field intensities, E, at the surfaces of grounded humans and animals exposed to a vertical, 1 kilovolt per meter electric field.

SPECIES	AVERAGE E (kV/m)	PEAK E (kV/m)
Human	2.7	18
Swine	1.4	6.7
Rat (resting)	0.73	3.7
Rat (rearing)	1.5	*

* Not available

The electric fields induced inside the body are very much weaker than the external unperturbed and surface electric fields. The internal fields and their associated current densities depend on body shape and orientation with respect to the field direction. In humans, current densities induced along the long axis of the body are of the order of 0.01 to 0.03 microamperes per square centimeter per kilovolt per meter of vertical, unperturbed field.[4] For the laboratory rat at rest, the currents induced along the long axis of the body

are considerably less, 0.0002 to 0.003 microamperes per square centimeter per kilovolt per meter.[4] This means that larger unperturbed fields must be used in laboratory studies of small animals to obtain current densities equivalent to those induced in humans.

Q. How do power frequency magnetic fields interact with people and animals?

A. The interaction of power frequency magnetic fields with humans and animals causes currents inside the body, but unlike electric fields, magnetic fields are not intensified at the surface of the body. The magnitude of the induced currents are proportional to body size. This means larger magnetic fields must be used in laboratory studies of small animals to obtain current densities equivalent to those induced in humans.

Q. Does exposure to weak electric and magnetic fields affect biological systems?

A. Yes. The literature on the biological effects of exposure to power frequency electric and magnetic fields is large and has been extensively reviewed and analyzed by a number of experts.[1,12,13,14,15] A number of these studies involve exposure to weak fields using the definition of "weak" fields I have adopted. These studies have investigated a wide variety of biological effects in humans, animals, and cellular systems. Both positive and negative results have been reported. In general, many things are unaffected by exposure to weak electric and magnetic fields, including: growth and development, morbidity, blood cell populations, serum chemistry, and cardiovascular function.[12] However, there is solid experimental evidence that some effects occur in exposed animal and cellular systems.

I will not attempt a comprehensive review of the literature on the effects of weak fields; instead, I will give some examples of studies in which effects have been reported. With the exception of Deno and Zafenella's results on human perception,[16] these examples have been selected from published, peer reviewed literature. Studies published in peer reviewed journals have met the journal's standards for appropriateness and quality of experimental design, analysis of data, and the logic underlying the conclusions.

Q. Are humans and animals able to detect weak electric fields?

A. Yes, one biological effect is perception. Humans and animals can sense the presence of electric fields. The median threshold unperturbed electric field in which humans feel hair movement is about 7 kilovolts per meter, but is as low as 2 kilovolts per meter for some people.[16] The intensified surface electric field responsible for hair movement in humans lies within the range of 30 to 65 kilovolts per meter and detection sensitivity is influenced by humidity; higher humidities give lower detection thresholds.[17]

Rats perceive unperturbed electric fields in the range 3 to 15 kilovolts per meter[18,19] although the mechanism of detection is not clearly understood.[19]

Q. Are humans and animals able to detect weak magnetic fields?

A. No. Humans and animals do not perceive magnetic fields in environmental exposures. Humans can sense magnetic fields above 100,000 to 200,000 milligauss through the flickering light flashes (magnetophosphenes) they produce in the visual system,[4] but fields this large are only found in experimental, industrial, or medical applications.

Q. Can you give some other examples of the effects of weak electric and magnetic fields on animals studied in the laboratory?

A. One consistently observed effect is that weak fields disrupt normal circadian rhythms.[20,21]

Q. What is a circadian rhythm?

A. Circadian rhythms are biological rhythms that repeat at approximately 24-hour intervals. For example, normal body temperature has a regular daily cycle of about one degree Fahrenheit. The times of the maximum and minimum temperature depend upon lifestyle;

for most people, the maximum occurs in the late afternoon and the minimum in early morning.[22]

Q. Can you give some examples of weak field effects on circadian rhythms?

A. The concentration of melatonin (a hormone that, among other things, regulates sexual function and development) has a daily rhythm, high at night and low during the day. Exposure to 60 hertz electric fields in the range 1.7 to 39 kilovolts per meter suppresses nighttime concentrations of melatonin in the rat pineal gland.[23,24,25] Kavaliers and coworkers report that their observation of the effect of a static magnetic field (rotating at about 1 hertz) on the nocturnal response of mice to morphine is consistent with a reduction of nocturnal pineal gland activity and levels of melatonin.[26] The suppression of the nocturnal rise in melatonin in rats is apparently reversible; melatonin levels returned to preexposure levels within three days after exposure was stopped.[27]

Neurotransmitters also have circadian rhythms which are altered in the brains of rats exposed to 39 kilovolt per meter, 60 hertz electric fields.[28] Neurotransmitters act as chemical bridges between nerve cells in the transmission of sensations such as light, heat and pain.

Q. Can you give some examples of effects observed in studies of cellular systems?

A. As in the studies of animals, a wide variety of effects has been examined in cellular systems. One area where effects have been seen with some consistency is in the synthesis and activity of biologically important macromolecules such as ribonucleic acid (RNA) and proteins. Among other things, RNA copies information from DNA so that proteins can be produced.

Goodman and coworkers have investigated the effects of magnetic fields on the transcription of ribonucleic acid[29,30] and on protein synthesis[31] in the salivary gland

chromosomes of the gnat, *Sciara coprophila*. They have also investigated the effects of magnetic fields on protein synthesis in tissue culture preparations of human cells.[32] They found alterations in the synthesis of both RNA and proteins.

Byus and coworkers have reported that exposure to 60 hertz electric fields alters the activity of ornithine decarboxylase, the controlling enzyme in the cellular synthesis of polyamines.[33] Ornithine decarboxylase levels increase in growing and replicating cells.

Ross in a study which combined extremely low frequency magnetic fields (16, 75, or 100 hertz) with static magnetic fields reported small decreases (5 to 8 percent) in the proliferation of cells (rabbit-ligament fibroblasts). The magnitudes of the magnetic fields were chosen to give a constant ratio of frequency to field strength.[34] In a parallel experiment in which the frequency of the magnetic field was held constant at 100 hertz and its amplitude varied, cell proliferation first decreased and then increased as the amplitude of the magnetic field was increased.

Q. What are the mechanisms responsible for the weak electric and magnetic field effects observed in exposed animals and cellular systems?

A. The mechanisms for these observed weak field effects are not known. The induced current densities in these studies are, in general, less than 1 microampere per square centimeter and this makes any direct stimulation of the central nervous system unlikely.[3] Several speculative models for interaction mechanisms have been suggested. One involves changes in the cell membrane that affect cell function.[35] Another is a resonance model which involves: the magnitude and direction of the earth's static magnetic field, the direction and frequency of the applied time varying magnetic field, and the ratio of the charge to mass of several biologically important ions.[36] These models have not been experimentally established.

Q. What do you conclude from these studies of the biological effects of exposure to weak power frequency electric and magnetic fields?

A. The interrelated conclusions I draw from my analysis are:

- Weak electric and magnetic fields affect biological systems.

- The biophysical and biological mechanisms that give rise to the observed effects of exposure to weak electric and magnetic fields are either not known or poorly understood at this time.

- The effects seen in cellular systems are useful for investigating mechanisms and generating hypotheses to test in animal studies. Because isolated cells or cell preparations may function and react differently than the same cells in a live animal the results of these studies cannot be directly extrapolated to animals.

- The weak field effects observed in animals are subtle and often transient or reversible; therefore, the connection between these effects and any harm to human health is unclear.

- Since weak electric and magnetic field effects occur, the possibility of harmful effects cannot be summarily or categorically rejected, and concerns about harmful effects are legitimate.

Q. Does this conclude your testimony?

A. Yes.

REFERENCES

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6. Wigdor, M (1980): "Electric Fields Under Power Lines (Supplement to An Examination of Electric Fields Under EHV Overhead Power Transmission Lines). U.S. Environmental Protection Agency ORP/EAD 80–1, Silver Spring, MD: USEPA.

7. Boeggeman CJ (1991): Testimony before the Pennsylvania Public Utility Commission on Behalf of Philadelphia Electric Company, PECO Exhibit No. 2, p. 2 and pp. 7–8.

8. Boeggeman CJ (1991): PECO Response to Office of Consumer Advocate Interrogatory Set 1, Question 2, p. 4.

9. Lee JM, Chartier VL, Hartman DP, Lee GE, Pierce KS, Shon FL, Stearns RD, Zeckmeister, MT (1989): "Electrical and Biological Effects of Transmission Lines: A Review." Portland, OR: Bonneville Power Administration, p. 19.

10. WHO/IRPA Task Group on Magnetic Fields (1987): "Environmental Health Criteria 69: Magnetic Fields," Geneva: World Health Organization, p. 37.

11. Boeggeman CJ (1991): Testimony before the Pennsylvania Public Utility Commission on Behalf of Philadelphia Electric Company, PECO Direct No. 2, p. 8.

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BEFORE THE

PENNSYLVANIA PUBLIC UTILITY COMMISSION

EXHIBIT DEJ-1

OF

DAVID E. JANES

ON BEHALF OF

PENNSYLVANIA OFFICE OF CONSUMER ADVOCATE

Risk Analysis Corporation
6723 Whittier Avenue, Suite 202
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August 1991

DAVID E. JANES

RISK ANALYSIS CORPORATION
6723 Whittier Avenue, Suite 202, McLean, Virginia 22101, (703) 883-3719

EDUCATION

Postgraduate, 1988-present, Secondary Education, The George Washington University
Postgraduate, 1960-64, Biophysics, Medical College of Virginia
Postgraduate, 1956-57, Radiological Physics, University of Washington
A.B., Physics, 1956, William Jewell College

EXPERIENCE

March 1989 to Present

Vice President, Risk Analysis Corporation.

August 1982 to September 1989

Director Analysis and Support Division, Office of Radiation Programs, U.S. Environmental Protection Agency.

Directed a division responsible for: (1) the Agency's response to nuclear emergencies, (2) risk and economic assessments for radiation regulations, (3) environmental analyses and risk assessments for sites contaminated with radioactive materials, and (4) guidance to control radiofrequency radiation exposure. (This is a Senior Executive Service [SES] position.)

- Directed Agency's program for controlling exposure of the public to electromagnetic fields, including power line fields, radiowaves, and microwaves.
- Supervised a diverse, highly technical staff (chemistry, economics, engineering, geology, health physics, oceanography, pharmacology, physics, radiobiology, statistics, and veterinary medicine) organized into three branches, approximately 30 people.
- Represented the Agency on the Science Panel of the Office of Science Technology Policy's Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) and on the Food and Health Effects Advisory Committee for the reentry of the COSMOS 1900 Soviet satellite.
- Received EPA's Gold Medal for managing the Agency's response to the Chernobyl nuclear accident.

EXPERIENCE (Continued)

April 1981 to August 1982

Director, Surveillance and Emergency Preparedness Division, Office of Radiation Programs, U.S. Environmental Protection Agency.

Directed a division responsible for: (1) development of regulations for the ocean disposal of radioactive waste, (2) environmental ionizing and nonionizing radiation measurements, (3) public information, and (4) the Agency's response to nuclear emergencies. (This is an SES position.)

- o Directed Agency's program for controlling exposure of the public to electromagnetic fields, including power line fields, radiowaves, and microwaves.
- o Supervised a highly technical staff (aquatic biology, engineering, health physics, oceanography, physics, and writing--editing) organized into three branches and the Three Mile Island Field Station, Middletown, Pennsylvania, approximately 30 people.
- o Represented the Agency on the Federal Radiation Preparedness Coordinating Committee (FRPCC)

June 1972 to April 1981

Chief, Electromagnetic Radiation Analysis Branch, Office of Radiation Programs, U.S. Environmental Protection Agency.

Managed a program to assess the effects of nonionizing radiation on human health and the environment, including the development and deployment of an instrumented van in a national study of environmental radiofrequency levels.

- o Served on the Interagency Committee on Electric Field Effects from High Voltage Lines and on the Interagency Task Force on the Biological Effects of Nonionizing Electromagnetic Radiation and was the Agency liaison to the National Telecommunications and Information Administration's Interdepartment Radio Advisory Committee and its Electromagnetic Radiation Management Advisory Council.
- o Served on the National Academy of Sciences Panel on the Extent of Radiation from the PAVE PAWS Radar system.

January 1971 to June 1972

Chief, Electromagnetic Studies Branch, Twinbrook Research Laboratory, U.S. Environmental Protection Agency.

Managed a laboratory research program on the biological effects of nonionizing radiation and conducted research on the effects of radiofrequency radiation on molecular systems of biological importance, principally proteins.

EXPERIENCE (Continued)

May 1966 to December 1970

Senior Investigator, National Center for Radiological Health, U.S. Department of Health, Education and Welfare.

Conducted studies on the long term effects of low-level, nonionizing radiation emphasizing physical interactions and effects on macromolecules.

June 1964 to April 1966

Director, X-ray Exposure Control Laboratory, Division of Radiological Health, U.S. Department of Health, Education, and Welfare.

Directed a staff of 25, including medical doctors, dentists and radiologists in applied research on ways to reduce the exposure of both patients and health care personnel to medical and dental x-rays.

July 1960 to May 1964

U.S. Public Health Service Trainee, Department of Biophysics, Medical College of Virginia.

Conducted research on rotational diffusion of macromolecules in solution as Ph.D candidate; completed course work in 1964, passed written and oral comprehensive examinations in 1970 as an out-of-residence student; thesis, "Rotational Diffusion Studies of Changes of Protein Shape in Solution," is incomplete.

September 1957 to June 1960

Health Physicist, Radiological Health Program, U.S. Department of Health, Education, and Welfare.

Assignments included: technical and supervisory positions in the Public Health Service's Radiation Surveillance Network, a nationwide program monitoring radioactive fallout from atmospheric nuclear weapons tests; radiological safety officer for Utirik Atoll during "Operation Hardtack", the last series of atmospheric nuclear weapons tests conducted at the Pacific Proving Grounds; and developing methods for assessing the radiation hazards of x-ray equipment, including a "mail-order" survey for dental x-ray units.

September 1957 to September 1989

U.S. Public Health Service Commissioned Officer, retired at Grade 06, equivalent to Navy Captain.

AWARDS AND COMMENDATIONS

- Distinguished Career Award, EPA, 1989.
- Public Health Service Citation, 1989.

AWARDS AND COMMENDATIONS (Continued)

- Gold Medal for Exceptional Service, EPA, 1986.
  (Management of the Agency's response to the Chernobyl Nuclear Accident)
- Public Health Service Commendation Medal, 1975.
- Public Health Service Graduate Traineeship, 1960.
- AEC Radiological Physics Fellowship, 1956.

COMMITTEES

Participant in numerous standards and advisory committees including the Office of Science and Technology's Committee on Interagency Radiation Research and Policy Coordination, American National Standards Institute: C-95 Committee on Radiofrequency Hazards, and the National Academy of Science's Panel on the Extent of Radiation from the PAVE PAWS Radar System.

PRESENTATIONS

Numerous scientific and technical presentations on radiation related topics, especially in the areas of environmental electromagnetic field levels and effects on molecular systems.

REVIEWS

Reviewed articles for Health Physics, IEEE Transactions on Microwave Theory and Techniques (Special issue on Biological Effects of Microwaves), Journal of Microwave Power, and Radio Science.

ORGANIZATIONS

American Association of Physics Teachers
Biophysical Society
Bioelectromagnetics Society
Health Physics Society and Baltimore Washington Chapter
Institute of Electrical and Electronics Engineers and Power Engineering Society
Commissioned Officers Association of the U.S. Public Health Service

PUBLICATIONS – NONIONIZING ELECTROMAGNETIC RADIATION

1. "An Examination of Electric Fields Under EHV Overhead Transmission Lines," (with R. A. Tell, J.C. Nelson, D.L. Lambdin, T.W. Athey, N. N. Hankin), Publication No. EPA–520/2–76–008, U.S. Environmental Protection Agency, Silver Spring, MD [NTIS Order No. PB 270 613(*)] (1977).

2. "Background Information on High Voltage Fields," Environmental Health Perspectives, 20:141–147 (1977).

3. "Is There an Environmental Radiofrequency Radiation Problem?", Proceedings of the Eleventh National Conference on Radiation Control, Oklahoma City, OK, May 6–10, 1979, Publication FDA 81–8054, U.S. Department of Health and Human Services, Rockville, MD (1981).

4. "Population Exposure to Radiowave Environments in the United States", Life Cycle Problems and Environmental Technology, Proceedings of the 26th Annual Technical Meeting of the Institute of Environmental Sciences, Philadelphia, PA, May 12–14, 1980, Institute of Environmental Sciences, Mt. Prospect, IL, (1980).

5. "Radiation Surveys––Measurement of Leakage Emissions and Potential Exposure Fields", Bulletin of the New York Academy of Medicine, Second Series 55(11):1021–1041, December, 1979.

6. "Radiofrequency Environments in the United States", ICC '79 Conference Record, Vol. 2, Paper 31.4 79CH1435–7, Institute of Electrical and Electronics Engineers, New York, NY (1979).

7. "Current Status of Environmental Findings", Proceedings of the Tenth Annual Conference on Radiation Control, Publication (FDA) 79–8054, U.S. Department of Health, Education, and Welfare, Rockville, MD (1978).

8. "Nonionizing Radiation Levels and Population Exposure in Urban Areas of the Eastern United States," (with T. W. Athey, R. A. Tell, N. N. Hankin, D. L. Lamdin, and E. D. Mantiply), Publication EPA–520/2–77–008, U.S. Environmental Protection Agency, Silver Spring, MD [NTIS Order No. PB 292 855 (*)] (1978).

9. "Results of the EPA Environmental Radiofrequency Radiation Measurements Program," (with F. L. Galpin, T.W. Athey and N. N. Hankin), Proceedings of the IXth Annual Conference on Radiation Control, Publication (FDA) 78–8054, U.S. Department of Health, Education and Welfare, Rockville, MD [GPO Order No. 017–015–00148–2(**)] (1978).

10. "Nonionizing Radiation Levels in Urban Areas of the United States," (with R. A. Tell, T.W. Athey and N.N. Hankin), Proceedings, IVth International Congress of the International Radiation Protection Association, Paris, G. Bresson, Ed., Vol. 1, pp 329–332 (1977).

11. "Radio–Frequency Radiation Levels in Urban Areas," (with R. A. Tell, T. W. Athey and N. N. Hankin) in Special Supplement in Biology to Radio Science, A. W. Guy and D.R. Justesen, Eds., 12(6S):49–56 (1977).

12. "Pseudosubstrate Binding to Ribonuclease During Exposure to Microwave Radiation at 1.70 and 2.45 GHz", (with J. W. Allis, M. L. Fromme), Biological Effects of Electromagnetic Waves, C. C. Johnson and M. L. Shore, Eds., Publication (FDA) 77-8011, U. S. Department of Health, Education and Welfare, Rockville, MD, 1976, pp. 366-376.

13. "An Automated System for Determining Environmental Radio-Frequency Field Intensities: II,"Measurements for the Safe Use of Radiation (with R. A. Tell, N. N. Hankin, J. C. Nelson, and T. W. Athey), Special Publication 456, S. P. Fivosinsky, Ed. National Bureau of Standards, Washington, DC, 1976, pp. 203-213.

14. "Aircraft Radar Measurements in the Near Field," (with R. A. Tell and N. N. Hankin), Operational Health Physics: Proceedings of the Ninth Midyear Topical Symposium of the Health Physics Society, P. L. Carson, W. R. Hendee and D. C. Hunt, Eds., Central Rocky Mountain Chapter, Health Physics Society, Boulder, Co. 1976, pp. 239-246.

15. "High Power Radiofrequency and Microwave Radiation Sources: A Study of Relative Environmental Significance," (with N. N. Hankin, R. A. Tell, T. W. Athey), Operational Health Physics: Proceedings of the Ninth Midyear Topical Symposium of the Health Physics Society, P. L. Carson, W. R. Hendee and D. C. Hunt, Eds., Central Rocky Mountain Chapter, Health Physics Society, Boulder, Co. 1976, pp. 239-246.

16. "Broadcast Radiation: A Second Look,", Biological Effects of Electromagnetic Waves (with R. A. Tell), Selected papers of the USNC/URSI 1975 Annual Meeting), C. C. Johnson and M. L. Shore, Eds., Vol. II, Publication (FDA) 77-8010, U. S. Department of Health, Education and Welfare, Rockville, MD [GPO Order No. 017-0127-3 (**)], 1976, pp. 363-388.

17. "Crossed-Beam Apparatus for Simultaneous Spectrophotometric Observation and Microwave Exposure of Biochemical Samples," (with J. W. Allis and C. M. Weil), Rev. Sci. Instrum., 46(1):1344-1349.

18. "The Use of an Automated Population Data Base in Population Exposure Calculations," (with T. W. Athey and R. A. Tell), Proceedings of the Helath Physics Society Eighth Midyear Topical Symposium, H. C. Hart, R. H. Richie, and B. S. Varnadore, Eds., Publication CONF-741018, USAEC Technical Information Center, Oak Ridge, TN [NTIS Order No. CONF-741018 (*)], 1974.

19. "Nonionizing Measurement Capabilities: State and Federal Agencies," (with N. N. Hankin), Publication EPA 520/2-73-001, U. S. Environmental Protection Agency, Washington, DC [NTIS Order No. PB 226 778 (*)], 1973.

20. "Nonionizing Radiation in the Environment," (with W. A. Mills, R. A. Tell and D. M. Hodge), Proceedings of the 3rd Annual National Conference on Radiation Control, Publication (FDA) 72-8021, U. S. Department of Health Education and Welfare, Rockville, MD, 1971, pp. 200-211.

21. "Studies on the Effects of 2450 MHz Microwaves on Human Immunoglobulin G", Biological Effects and Health Implications of Microwave Radiation, (with G. P. Kamat), S. F. Cleary, Ed., U. S. Department of Health, Education and Welfare, Rockville, MD [NTIS Order No. PB 193 898 (*)], 1970, pp. 104-110.

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22. "Effects of 2450 MHz Microwaves on Protein Synthesis and on Chromosomes in Chinese Hamsters," (with W. M. Leach, W. A. Mills, R. T. Moore and M. L. Shore), Nonionizing Radiation 1:125–130. [Reprinted in Review of Electronic Products Radiation Hazards, Hearing Before the Subcommittee on Public Health and Welfare, Serial No. 9121, U. S. Government Printing Office, Washington, D.C., 1969, p. 313.]

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23. "Radiation Contaminated Sites", (with R. B. Greear and G.B. Snodgrass), Proceedings of the Twentieth National Conference on Radiation Control, Nashville, TN, May 15–19 1988, Publication 88–6, Conference of Radiation Control Program Directors, Frankfort, KY (1988).

24. "A Medical X-Ray Survey Packet," (with T. Ditchek and A. Frisoli), Health Physics, 12:341–344 (1966).

(*) Available from U. S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

(**) Available from Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 29492.