UNITED STATES OF AMERICA

BEFORE THE

NUCLEAR REGULATORY COMMISSION

In the Matter of:	I	
	I	
HOUSTON LIGHTING & POWER COMPANY	I	Docket No. 50-466
	I	
Allens Creek Nuclear Generating Station, Unit 1	I	

Krost Hall Auditorium
Bates College of Law
University of Houston
Houston, Texas

Tuesday
March 3, 1981

PURSUANT TO ADJOURNMENT, the above-entitled matter came on for further hearing at 9:00 a.m.

APPEARANCES:

Board Members:

SHELDON J. WOLFE, ESQ., Chairman
Administrative Judge
Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

GUSTAVE A. LINENBERGER
Administrative Judge
Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

DR. E. LEONARD CHEATUM
Administrative Judge
Route 3, Box 350A
Watkinsville, Georgia 30677

APPEARANCES: (continued)

For the NRC Staff:

RICHARD L. BLACK, ESQ.
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

For the Applicant - Houston Lighting & Power Company:

J. GREGORY COPELAND, ESQ.
Baker & Botts
One Shell Plaza
Houston, Texas 77002

JACK NEWMAN, ESQ.
-and-
DAVID B. RASKIN, ESQ.
Lowenstein, Reis, Newman, Axelrad & Toll
1025 Connecticut Avenue, N. W.
Washington, D. C. 20037

For the Intervenors:

JOHN F. DOHERTY
4327 Alconbury
Houston, Texas 77021

WAYNE E. RENTFRO
P. O. Box 1335
Rosenberg, Texas 77471

JAMES SCOTT, JR., ESQ.
Texas Public Interest Research Group, Inc.
13935 Ivymount
Sugarland, Texas 77478

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P R O C E E D I N G S

9:02 a.m.

JUDGE WOLFE: The hearing is resumed. It is now 9:02 a.m.

Making their appearance this morning are Mr. Newman and Mr. Copeland representing the Applicant; Mr. Black for the Staff; Mr. Doherty and Mr. Rentfro.

We resume with the cross-examination by Mr. Doherty.

Whereupon,

DR. FRANK G. SCHLICHT

having been previously duly sworn, resumed the stand as a witness and was examined and testified further as follows:

CROSS-EXAMINATION
(Continued)

BY MR. DOHERTY:

Q Dr. Schlicht, I only have a little more to do with you, so it should not be very long.

What is the most favorable -- What are the most favorable characteristics for a roosting ground for geese?

A Well, generally, sir, they roost on the water bodies.

Q Well, can you give me more than that -- more

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specific. They don't go in the middle of the ocean.

MR. COPELAND: Objection, Your Honor. He needs to specify what more specificity it is that he wishes to have from the witness.

BY MR. DOHERTY:

Q Do they roost on water?

MR. COPELAND: Asked and answered.

BY MR. DOHERTY:

Q Do they roost on land?

JUDGE WOLFE: Now just a moment here --

MR. DOHERTY: Excuse me.

JUDGE WOLFE: Your question ... as attempting to make more specific your original question, was: Do they land on water?

Now was there an objection to that?

MR. COPELAND: Yes, sir. That was his last answer.

He asked -- His very first question was what kind of roosting grounds -- where do they roost?

And Dr. Schlicht said on water. Then he said, "I need more specificity." I objected to that.

He said, "Do they roost on water" again. That was his next question.

It wasn't, "Do they land on water," I don't believe.

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JUDGE CHEATUM: His last question was: Do they roost on land.

JUDGE WOLFE: Yes, but there was an objection.

I will sustain the objection to the first clarifying question.

Now you asked -- your second question was: Do they roost or land on land? Is that correct?

MR. DOHERTY: Yes.

JUDGE WOLFE: All right.

THE WITNESS: Is the first part, "Do they roost on land" -- I believe, as I testified before, they will roost on what one would probably term land, provided that, you know, there is water covering the land.

I'm speaking here in terms of these rice fields, if they have water in them due to heavy rainfall. The water may be just a few inches deep.

And during that period when they're holding water, they will roost there.

Now whether or not they will roost on dry land or not, I don't think they do as a rule.

Now with respect to that -- Well, I guess that covered your question, as I understood it.

MR. DOHERTY: Yes, that does.

BY MR. DOHERTY:

Q Is it the fact that there is grain available to

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eat that makes it attractive; or is it the fact that the water is just about a certain height, such that they can sort of ... whatever they do -- but accommodates them?

A For roosting purposes it is the water itself that makes it attractive and suitable.

Q Okay.

What is the waterfowl population on the upper Texas coast?

A Bear with me just a moment.

(Pause.)

The latest figures that I have and have been able to acquire come from Job Performance Report as required by Federal Aid in Wildlife Restoration Act/Texas, Texas Waterfowl Program.

This is a Texas Parks and Wildlife Department publication dated July 30, 1980.

The population varies from year to year. The figures that are presented in this document are largely for snow geese and blue geese. And they vary from month to month, but generally somewhere in the neighborhood of anywhere from about 300,000 to over a million geese may be on the prairie area.

Now this is the entire Texas coast. Those figures for the white-fronted goose, they vary from about 30,000 to over 130,000 geese.

The duck figures for the lower coast are in excess of 300,000. And the figure for the upper Texas coast is in excess of three million.

Q All right, thank you.

Now I had a question with regard to your knowledge of the general geography of the Brazos River in close locality to the ACNGS site.

Are there any ox bow lakes --

MR. COPELAND: Asked and answered.

MR. DOHERTY: -- in the Brazos River between Rosenberg and the ACNGS spillway ... proposed?

THE WITNESS: Yes.

BY MR. DOHERTY:

Q Are any of those ox bow -- Excuse me. Would you refer to page 14 of Dr. Reed's testimony again.

Are there any ox bow lakes in the so-called duck feeding area identified in that figure, which is on both sides of the Brazos between Rosenberg and the ACNGS site, to your knowledge?

A Well, sir, this figure itself is does not show the ox bows.

It is my best recollection that there are some ox bows in that area, primarily on the east side of the river.

It is my personal opinion that it is probably

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largely because of the presence of ox bows in that area that this duck area extends down as far south as it does.

Q Okay.

Now on the transmission line system itself, will there be any lightning interceptor lines required on the system?

A Sir, that is what these static wires are that we have referred to previously.

Q It would be those.

A They constitute a lightning rod, if I can use that term, system on these towers.

Q Okay.

When you went to Washington -- You spoke of going to Washington quite a number of years ago on the issue of moving Line 2A away from crossing the lake, but ... apparently north.

Did the NRC at that meeting ask you about a program to have downed birds which had hit power lines reported to you from the public?

A No. No such request was made.

Q Okay.

I think we discussed earlier the ability of migratory birds to perhaps recall a familiar area where power lines might be, and thus avoid them through what

probably was called memory.

Do you have any references to any studies that report this?

A. Well, yes, sir. I believe I cited a paper earlier, one by James and Haak, H-a-a-k; work that they did for Bonneville Power Administration, which they state that these birds apparently do learn the location and learn to avoid them.

Q. Okay, thank you.

Now we had a couple of questions from Mr. Black yesterday with regard to the Brazos River bottomland. Do you know -- Can you give a rough estimate of how widely the bottomland forest extends from the river?

A. No, sir, I can't. That's very highly variable throughout that bottom area.

Q. Now on the power lines themselves, are there -- are any of these power lines planned in such a way that there will be a road that runs underneath them? Not a public road, but a private road, to your knowledge.

A. I don't know of any roadway that would be a maintained roadway, no.

In other words, shell or some surface that would facilitate access under all weather conditions. No, there's nothing like that planned for any of it to my knowledge.

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Q All right.

Has it been the company's plan, to your knowledge, to simply restore or let the land under the wires be used as it normally would?

MR. COPELAND: Asked and answered, Your Honor.

JUDGE WOLFE: Sustained.

(Pause.)

MR. DOHERTY: All right, Dr. Schlicht. Thank you very much.

JUDGE WOLFE: Is there redirect, Mr. Copeland?

MR. COPELAND: No, sir.

JUDGE WOLFE: We will now go to Board questions.

BOARD EXAMINATION

BY JUDGE CHEATUM:

Q Dr. Schlicht, in response to one of Mr. Black's questions regarding the nature of the bottomlands along the Brazos River, the vegetative characteristics, et cetera, you talked about the woodlands in this area.

And then I think Mr. Black asked you whether or not these woodlands were unique in any way, or perhaps you described the woodlands as being unique in character ... as sort of unique.

Now what I'd like to know is how, in what way, are these woodlands unique?

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A. Well, sir, I believe, as I stated in that response yesterday, as far as the species composition, et cetera, they are not unique.

They are unique -- and I use that word simply to describe that we have a small pocket or a small area of woodlands paralleling the river. That river in this area runs through what has been characterized as a tall grass prairie, so that it is along the river where we have a different type of habitat than that that prevails in the geographical area.

And they are unique only in the sense that they do provide a forest-type habitat. And compared to the total area of the coastal prairie here, that is a very small percentage of the total area.

So it's unique only in that it is different. It is small, and it is confined largely to the riparian area of the river.

But there's nothing about the species composition of plants or animals that make it unique.

Q. In our site visit you spoke of the original prairie grasses being still persistent in the park area, I believe it was.

And then when you talk about the tall grass -- prairie grass, is that what you said --

A. Well, here again, the area was originally a tall

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grass prairie. And we do have a 40-acre (approximate) tract on the site that is still predominated by those native grasses.

Now most of this prairie area -- I say "most" of it -- a very large percentage at any rate, has been converted from an original tall grass prairie over to pasture land and agricultural lands for cropping, so that the bulk of the area is today not anywhere like it was in the early days of this state.

But in the relatively undisturbed areas, that is, those areas that are not plowed and put into crops, where the native vegetation has come back, it is a short grass/tall grass mix. And, unfortunately, a lot of species have encroached that are characteristic of vegetation that encroaches upon over-grazed lands -- the mesquite and wesatch are two examples.

Q Okay.

As I understand it then, it's not unique in the sense of having unique species, but unique in the relationship between the wooded areas and the other vegetative associations which are relatively unique for this part of Texas?

A That is correct. In other words, an example here would be, I think, possibly an oasis in the desert area.

You know, the oases themselves may all be alike. But by virtue of the fact that they're widely separated, they do provide a unique habitat for that immediate area. It is different.

Q One other question: In connection with your testimony, you very frequently used the word "significant" in terms of impact. "Significant loss," for example.

I think you defined it in an answer to Dr. Marrack's question regarding your concept of what constitutes a significant loss.

I believe you answered it in terms of impact on the capability of the species to maintain its population; that the loss would be significant if it were such that it endangered the survival of that particular population. Is that correct?

A Yes, sir. I used the term "significant" in a biological sense, that the loss -- or the impact would be significant to the population if the losses were great enough that the species could no longer maintain the kinds of population levels that it would be capable of maintaining without these losses.

Q Well, is there any other consideration which might be taken into account in defining losses as significant?

A Well, yes, sir, you could do this, I think,

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mathematically ... take a look at the percentage of the population that is lost, and then pick some arbitrary percentage and say that any losses above that would constitute a significant loss; and anything below that would be an insignificant loss.

This would be a biological approach...another biological approach.

And then I think there's another realm here, and this might be looking at significance in terms of what I might call the social effects of this; in other words, the birds have aesthetic value. They are appreciated by the people, even if it's for no other purpose than to go out and see the large concentrations and to photograph them.

And you would have a significance of loss there, if ... you know, the losses are such that the people can no longer enjoy these birds when they come down, or wherever they might go.

Q Don't you suppose it would be very significant to the Houston Lighting & Power Company if the public became aware that there were literally hundreds of waterfowl being killed on their transmission systems? Don't you think that would be a significant loss?

A Yes, sir. This again would fall into this social category, if ... you know, the people deemed that

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the numbers being lost is intolerable, then that would be a significant loss.

Q Well, this is really what I was trying to get you to recognize ... that there are other terms of significance that don't relate necessarily to a biological --

A That is correct. And I am fully well aware of those.

JUDGE CHEATUM: I guess I have no more questions.

JUDGE WOLFE: Judge Linenberger.

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BOARD EXAMINATION

BY JUDGE LINENBERGER:

Q Sir, if I missed the thrust of part of your previous answer to Dr. Cheatum, I'm sorry. But in terms of significance, how does one rank hunting losses?

A Well, sir, I guess my own personal reaction to that is they do not really consider this to be a significant loss, looking at it in a biological sense, as I have used the term "significant," because these bird populations are able to recover from that loss annually in their spring reproductive period, and to, therefore, maintain basically the same kinds of population levels that they have historically.

And to take one particular species, the Greater Canadian goose, I just recently noticed a little comment to the effect that in spite of the kinds of hunting pressure that are put on that particular species, that the population wintering in the Atlantic flyway (predominantly in the Chesapeake Bay area) now numbers in excess of one million birds.

And the U. S. Fish and Wildlife Service people are of the opinion that this is the largest number of birds in that population since the days of the colonists. Probably the numbers are greater than they have ever been before in history.

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And this is really a consequence of the management of the species.

In this instance, they very obviously have been able to sustain the hunting pressure ... the losses, but still the population has increased over time.

So in that sense, sir, I don't think the hunting losses would be classified as a significant loss.

And I believe the figures run something like 30 to about 35 percent of the population is harvested ... waterfowl in general in the U. S. annually by hunting.

Q All right, sir.

Then putting together everything you said in this answer and previous ones this morning, I would then infer that for transmission line impact fatalities amongst waterfowl to be, quote, significant, in your sense of the meaning of that word, those losses would have to approach in magnitude something on a reasonable order of the hunting losses?

A Well, no, sir --

Q Is that a correct inference?

A No, sir, not necessarily.

If I may, just for exemplary purposes in responding to that, let's assume that a 50 percent loss of the population annually is that breaking point, where any losses above that that they cannot sustain their

populations.

If we assume a 35 percent hunting loss annually, then you would need to add only a 16 percent further loss to that, let's say, to bring that up then to a total annual loss of 51 percent, then to put that particular species or the entire group in jeopardy in terms of being able to maintain the kinds of population levels that they have been maintaining for the past several years.

It's an additive effect ... or cumulative.

Q All right, sir.

Does that then -- that kind of consideration then permit people such as yourself to establish what might be a -- I'm sure this is the wrong way to phrase it, but I'll say it anyway -- what might be a maximum tolerable impact fatality loss?

A Yes, sir.

I think it is conceivable that it could be done. You go to ... you know, using statistics on the number of young that are hatched, the number of old birds, you know, the number that are still in the reproductive period, and then the annual mortality rates, and you can calculate an approximate population number of reproductive age birds that have to be maintained year in and year out for the population to maintain itself.

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And by knowing the age composition of the population, yes, sir, you can arrive at an approximate value for that.

Q Now then, are you aware of whether or not this has been done?

A I'm not aware of whether it has been done or not. I feel very confident that it has.

My own personal opinion is that, in essence, this would be pretty much a prerequisite to any major management program in a way.

In other words, for setting of season limits -- that is, the number of days, daily bag limits on a species, they're going to have to know what percentage of that population that goes to the nesting grounds is still of reproductive age, how many young they should hatch and rear on an average, so that they can give some predictive estimate of how many birds would be produced.

Q Okay.

Now so far as you are aware personally and of your direct knowledge, has there ever been an instance where the incidence of fatalities from collision of migratory waterfowl with transmission lines has been sufficiently large as to result in a downward adjustment of the hunting bag limit in order to prevent this decline?

A No, sir.

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All of the figures that I have seen and all of the studies that are available to me all show that less than one percent of the population in a given area where studies have been conducted have been lost.

Most of these figures are in the three-tenths, four-tenths, six-tenths of a percent range.

Q There have been parts of your testimony at various times on this subject that has indicated that -- well, for example, Applicant does not have a program for placement of signs along the transmission corridor admonishing hunters to report what would appear to be collision casualties, no firm internal company administrative procedures for -- to establish reporting requirements.

You indicated that, I believe, if I recall your words correctly, that the last time you spoke to someone in the transmission line department about keeping an eye out for these sorts of things was back in 1971, I think you said.

Adding these statements up and interpreting them for my purposes in their worst light, the sum total of those kinds of things could say to me that the Applicant really doesn't care what's happening to the birds.

Now that may be an inaccurate conclusion on my part; it may not be. Would you care to comment on it,

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please, sir?

A. Well, sir, I can definitely perceive where that kind of impression is conveyed and has been conveyed.

I think the real thrust here is that because of the fact that we have never had any reports of a problem ... you know, more than maybe one bird being sighted at a time, such as in the case of the four heron-type birds. These were reported over a four- or five-year period.

-- that, you know, there has been no real problem. Therefore, there has been ... you know, no real need for us to expend the kind of effort that you have described ... you know, such as ads in the paper as I was asked about yesterday, putting signs up along the rights-of-way; perhaps contacting the professional waterfowl hunting guides in the area and asking them to report these kinds of things.

I think we have assumed that because of the magnitude of hunting pressure that is put on these birds in this area, the tremendous number of people coming from all over the U. S. to capitalize on the excellent hunting here, that if this were in fact a real problem, that someone would have brought it to our attention.

As I testified yesterday, the land owners or

the farmers themselves get back into these fields just as rapidly as weather permits, after the crops are harvested. They are plowing their fields, cultivating them. The geese are there following right along behind them as they plow.

Many of these cultivate their fields directly under these transmission lines. And if these kinds of collisions were a problem, that someone out of this group would have brought it to our attention.

But since they have not, we do not deem it to be a problem at all, and, therefore, have not taken the kinds of measures which, if I may characterize it -- has led me to give what might be interpreted as some negative testimony on this with respect to the company's actions in this matter.

Q Thank you.

Would you look at page three of your prefiled testimony, please.

A Yes, sir.

Q At the top of the page there's a paragraph that carries over from the preceding page. And the last sentence in that paragraph relates to agricultural production not being interrupted except at the base of the transmission towers.

Now I just wanted to -- and therefore, it's

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concluded that no significant loss of feeding area will occur.

I wanted to probe that just a bit. Does the company -- Does Applicant maintain beneath or alongside the transmission line corridor a right-of-way for its maintenance and inspection equipment to traverse the corridor?

A Okay, sir. In this type of situation, particularly in the agricultural lands, we do not buy the right-of-way in fee.

We lease an easement. The land owner retains full right to continue to use that land, as he has done so historically.

We do not maintain any kind of roadway along the line in that area.

Now if the gentleman has crops in the field and if we have to go in to that segment of that line and perform maintenance, if we damage his crop -- in other words, we take our equipment, we go through his fields.

Now we try to minimize the damage to his crop. But, obviously, some will be lost as a consequence of our having to get in there.

In an instance such as this, then we reimburse him for the crop loss. We would pay him damages.

Q All right.

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Now let's look at it from a slightly different perspective. Suppose that it's land that is being used for rice farm. And I believe there's a certain amount of flooding that goes on at a certain stage of the life cycle of the rice plant.

And let's assume that this land is flooded when you need to get in there with your equipment and perform some maintenance.

Does this turn the coin over -- instead of your interfering with agriculture, does agriculture ever interfere with you?

A Well, it does in the sense that it complicates the situation.

But, sir, we do have equipment available to us that has ... you know, large balloon tires that enables us to get into the wetlands, the marshlands where we have these rights-of-way.

And that kind of equipment would be used in this instance.

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Q In discussing bird types at one point, you used the word passerine, p-a-s-s-e-r-i-n-e.

What is the meaning of that term?

A These are generally the perching type birds.

This is a classification of birds. It includes such things as the verios, I guess the sparrows, robins and those types of birds.

Q You also used the term riparian woodlands.

What does the word riparian mean.

A Sir, this refers to woodlands along river banks or channels.

It literally means from bank to bank and any woodlands inside those banks.

Q All right, sir.

One final question. Do you have any evidence to indicate that birds are a significant hazard to the transmission system?

A That the birds are a hazard to the transmission system?

Q Yes, sir.

A They do cause us problems on occasion on these transmission lines.

I believe as I testified earlier, you know, occasionally the larger birds will nest in the towers.

We have a situation where I believe it is

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the Louisiana egret that nests in them.

The bird droppings across the insulators cause shortages and, therefore, outages on the line.

In this particular instances, these birds use some rather large boughs, sticks for their nests; and they will occasionally drop those out in the nest building activities that do cause instantaneous outages on the lines.

To the best of my knowledge, that is the only direct hazard that they pose to the transmission system.

An indirect hazard might be particularly associated with the migratory waterfowl. And, this would be people hunting along the right away and shooting insulators and shooting the wires and perhaps cracking or breaking the insulators.

JUDGE LINENBERGER: Thank you Dr. Schlicht.

No further questions.

BY JUDGE WOLFE:

Q Following along Judge Linenberger's initial questioning, Dr. Schlicht, do you know, and if you know how do you know, the annual hunting kills of ducks and geese in the area along the proposed lines and in the concentration areas identified in Figure 1 of the Reed testimony?

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A. Well, sir, the Texas Parks & Wildlife Department does have a system whereby they can get an approximate estimate on the number of birds killed.

These gentlemen who operate as professional waterfowl hunting guides are required to keep a daily log.

The name of every hunter that is taken out, the hunting license number is all recorded; and then, when he has finished his hunt they are required to record the total number of geese that each hunter has bagged; and the total number of ducks that each hunter has bagged.

At the end of the hunting season, then that professional guide or lease operator then is required to return that book to the Texas Parks & Wildlife Department and then their people do the tallying and determine to the number of birds killed.

Now one shortcoming of this process is that if a small group of three or four, maybe ten individuals go out and lease the rights from the landowner to hunt his property, they do not have to keep these kinds of records.

The State of Texas has a constance of many years of experience of doing this do have a correction factor.

There is a breakdown of what percentage of hunters, you know, have to report because they are hunting

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with professional guides or on preserves; and what percentage do not hunt.

Then, they can take the average number of birds killed by those who do have to report, multiply that to arrive at approximate number of birds harvested.

Another thing that is done is the U.S. Fish & Wildlife Service, particularly if you buy your waterfowl hunting stamp through a U. S. Post Office, you fill out a card.

That is sent into the Fish & Wildlife Service and, then, they at the end of the season will send you a form asking you to report your seasons kill records.

Myself being a waterfowl hunter, I in addition to that CARE package from them this year with an envelope for each duck wing that I bagged.

They wanted me to send them a wing from each bird.

So, there are methods for arriving at the the species composition, the age group that is most frequently bagged and the total number of birds that are bagged.

Q All right.

Can you answer, then, the second question.

Do you know?

A No, sir. The second part of your question I

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do not know what the annual average kill is in this area.

It is several thousands of birds of both categories of migratory waterfowl, i.e. ducks and geese.

Q And when you say several thousands, what --

A I base that, sir, on the extrapolation from the Barrow Ranch over in Chambers County, to the east of us.

I have seen figures where the ranch manager has reported a number of birds killed on that particular ranch.

That is about a 19,000 acre area; and his numbers have run as high as 16,000- 17,000 ducks killed there during the season.

And, 7,000 or 8,000 geese killed on that 19,000 ranch alone.

And, when you take into consideration the fact that the hunting pressure, although it is substantial, that is put on that ranch is probably not near as great as that put on the Katy-Brookshire Prairie area because they have a much larger area out here.

And, the concentration of birds is comparable in both areas.

It, to me, would stand to reason by extrapolation that the kill on the Katy-Brookshire Prairie is probably much greater than that on the Barrow Ranch

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alone.

Q In your opinion, would the annual number of kills of migratory waterfowl along the proposed -- two proposed routes approach several thousand yearly?

A It could very easily depending upon the amount of hunting pressure that the landowners permit.

Many of the landowners don't permit any hunting at all.

But, assuming all the landowners out there would permit hunting on their property. Yes, sir.

In other words, if the hunter had access to hunt along that transmission route.

Q I'm sorry. Maybe I misstated my question or maybe you misunderstood me --

A I may have misunderstood your question, sir.

Q My question is, in your opinion, what do you think the annual kills by virtue of impact on transmission lines in the two proposed areas would run in the several thousands annually?

A Oh. I understood you to say hunters kills. I'm sorry.

Q Maybe I misstated myself. But, that was the intent of my question.

A No, sir.

The kills would not number that. Again, based

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on the figures and the literature, you are looking at less than one percent of the total population of birds that would utilize that area along the transmission lines.

I might point out at this point that the literature demonstrates that geese are much less susceptible to colliding with these lines than are ducks.

The studies at Lake Sangchis, if I recall correctly, was less than two-tenths of one percent to the total population of geese, whereas in one species of duck it was something like close to two percent of that population.

But, an average figure of less than one percent for the total waterfowl.

JUDGE WOLFE: We'll now have cross-examination on Board Questions.

Mr. Black?

MR. BLACK: I have no questions.

JUDGE WOLFE: Mr. Doherty?

FURTHER CROSS-EXAMINATION

BY MR. DOHERTY:

Q Dr. Schlicht, a question from Dr. Linenberger with regard to losses, you stated, "The studies showed always less than one percent."

Well, is that one percent per year?

A That is one percent of the total population

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that is utilizing the area during the study year.

Yes, sir.

Q Okay.

Now, in response to another question with regard to the company's policy of -- Or, perhaps, it was only your own policy expecting hunters to generally report downed animals.

Would you expect out-of-town hunters on a weekend to do this kind of thing?

A Well, they don't necessarily contact HL&P directly, but, here again, I think the inference is that, you know, if they observe this and people are coming in from out-of-town generally are being taken out by some of the professional guide operations that operate in the area.

You know, their going to bring this to someone's attention; and, you know, it is kind of a domino effect, I guess. That we would expect if this were a real problem somebody would say something and we would ultimately hear about it.

Q All right.

Now, there was a question with regard to roadway towers that you referred to on page 3 of your written testimony.

I'm curious to know, what is the average distance between the towers there?

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A Approximately 800 feet, I believe.

Q All right.

Now, one last question I guess.

Do you have with you the environmental report there -- Or, I would like for you to look at Figure 3.9-2.

A I believe I have that.

Yes.

Q All right.

A In the supplement?

Q No, sir.

In the original report. It may be no different, but I have on the original report.

A Okay.

Q Do you have that?

A Yes.

Q You have that?

A 3.9-2.

Q All right.

A Topography of Transmission Line Routes, Wallis Section?

Q Yes.

Now, it's a long page, 14 inches.

At the top where it says Route 2A, now, isn't that heavily wooded land up at the very top where Route 2A goes through?

2-10
cf

A It shows it to be.

Yes. That'll be woodlands.

Q All right.

Now, is that heavily wooded land of the same type as the wooded land along the -- along Allens Creek just south of the site there where that triangle and square are together?

A Could you be a little more specific about south of Allens Creek?

Q Well, practically the very door step of the proposed plant.

There appears to be some heavily wooded land.

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A You're talking about the black triangle associated with the square there?

Q Yes. Um-hmm.

A Yes, that's pretty heavily wooded in the creek bottom.

Q Okay.

MR. DOHERTY: No further questions from me, Your Honor.

JUDGE WOLFE: Is there redirect, Mr. Copeland?

MR. COPELAND: No, sir.

JUDGE WOLFE: Is the witness to be permanently excused?

MR. COPELAND: Yes, sir.

For once and for all.

(Laughter)

JUDGE WOLFE: The witness is permanently excused.

(The witness was permanently excused.)

JUDGE WOLFE: We will have a five minute recess.

(A brief recess was taken.)

JUDGE WOLFE: All right.

The hearing is resumed.

Mr. Black do you have a witness?

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cf

MR. BLACK: Yes.

The Staff would like to call Mr. Gerald Gears to the stand, and ask that he be sworn.

Whereupon,

GERALD E. GEARS

a witness herein, having been duly sworn and cautioned to testify the truth, the whole truth and nothing but the truth, was examined and did testify upon his oath as follows:

DIRECT EXAMINATION

BY MR. BLACK:

Q Mr. Gears do you have before you a document entitled NRC Staff Supplemental Testimony of Gerald E. Gears on Transmission Lines/Health Effects Pertaining to Marrack Contention 2(b), Rentfro Contention 2?

A I do.

Q Do you also have before you a statement of professional qualifications attached to that testimony, Professional Qualifications of Gerald E. Gears?

A I do.

Q Do you have any additions or corrections to the testimony or to the statement of Professional Qualifications?

A No, I don't.

Q As constituted to you adopt this testimony

2-13
cf

as your testimony in this proceeding and is it true and correct to the best of your knowledge and belief?

A I do.

MR. BLOCK: Mr. Chairman, at this time we would request that the testimony of Gerald E. Gears on Transmission Lines/Health Effects and Statement of Professional Qualifications be incorporated into the record as if read and constitute evidence on behalf of the Regulatory Staff.

JUDGE WOLFE: Any objections or Voir Dire or whatever?

Mr. Doherty?

MR. DOHERTY: Yes. A couple of questions on Voir Dire for the witness.

VOIR DIRE

BY MR. DOHERTY:

Q Mr. Gears, have you ever given testimony on the health effects of transmission lines to any government regulatory agency?

A I hesitate because I gave testimony in front of NRC. But, if you are excluding NRC, no I haven't.

Q Well, that does clarify things a little bit.

Now, how about in front of the NRC. They are federal regulatory agency, I believe, or government regulatory agency.

2-14
cf

A Yes, I have given testimony for the NRC at Marble Hill.

Q All right.

Was it a construction licensing?

A Yes.

Q Kind of a historical question, when did you begin writing this testimony, the submitted testimony, the written testimony?

A I was first asked to submit this testimony sometime around 1978, after the Final Supplement of the FEIS came out.

And, I submitted at that time I believe sometime in '78 or early '79.

Q All right.

You note on page 1 of your qualification that you developed safety guidelines for transmission lines, sort of at the end of the first paragraph, for an interagency committee.

That involved funding research.

Did that require you to evaluate grant proposals?

A It involved a variety of roles, and does involve a variety of roles.

Not only are you reviewing grant proposals, but also reviewing on-going research throughout the world.

2-15
cf

Visiting test facilities, bringing people in who would like to be granted money for research, reviewing their previous work, discussing with other federal agencies their research areas along these lines. Any guidelines that they may be thinking about developing.

Q I see.

Well, now in any of these grant proposals, were their any by Dr. Solomon Michaelson that you recall?

A Yes.

Q Okay.

Now, in your opinion -- All right. Strike that.

You mentioned in the second paragraph your formal education program, and you have listed quite a large number of these in that second paragraph, second sentence.

I'm wondering which of these do you feel most prepare you to testify on health effects of transmission lines?

A Are we talking about the sentence that starts with "My formal education. . ."?

Q Yes. That's right, sir.

A I don't think that those highlight any of the areas specifically which would help qualify me for this

2-16
of

area. I mean I would, for example, say that I had also had advanced education in biochemistry which I don't cite there, which has been a great use in this area.

Q So, then actually, is it correct to say that you didn't actually cite what you think is the most relevant here?

A No.

I generally outlined areas --

Q Um-Hmm.

Okay. In any of your course work did you ever have physics course? A straight physics course?

A I had an undergraduate level straight physics course.

Q Did you have any other undergraduate physics courses than the basic undergraduate physic course?

A No.

Just basic physics.

Q Did you ever study electrical engineering?

A Not -- I had taken courses in electrical engineering, but never taken a basic electrical engineering course.

The computer modeling course is analogue computering, -- computers were offered in electrical engineering at the University of Florida.

Q Did you ever study non-ionizing radiation

2-17
cf

in any of your courses?

A No.

Not formally.

Q Did you ever study general ecology?

A Yes.

Q Okay.

What does a land-use analyst do?

A I inherited that title recently.

Q All right.

A I used to be a terrestrial biologist, but in the way things worked out in promotions, I was suddenly merited the titled of land-use analyst.

I basically do the same thing I have always done which is dealing with terrestrial issues in siting of nuclear facilities.

And, also, I have the charge of dealing with all the transmission line siting issues and health effects dealing with transmission lines.

Q Um-Hmm.

Do you belong to any professiona organizations or --

A No, I don't.

MR. DOHERTY: No further questions, Your Honor.

JUDGE WOLFE: Any Voir Dire, Mr. Rentfro?

2-18
cf

MR. RENTFRO: No, sir.

JUDGF WOLFE: Any objection to the testimony of Mr. Gears being incorporated into the record?

(No response.)

All right. Absent objection, the written direct testimony of Mr. Gears including his professional qualifications are incorporated into the record as if read.

(See attached Testimony of Gerald E. Gears.)

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
HOUSTON LIGHTING & POWER COMPANY	)	Docket No. 50-466
	)	
(Allens Creek Nuclear Generating Station, Unit 1)	)	

NRC STAFF SUPPLEMENTAL TESTIMONY OF GERALD E. GEARS

ON TRANSMISSION LINES/HEALTH EFFECTS

MARRACK 2(b), RENTFRO 2

Q: Will the witness please state his name, place of employment, and duties he performs?

A: My name is Gerald E. Gears and I am employed by the Environmental Engineering Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. I am a Senior Land-Use Analyst. A copy of my professional qualifications is attached to this supplemental testimony.

Q: What is the purpose of your testimony?

A: The purpose of my testimony is to respond to the following contention:

Marrack Contention 2(b) and Rentfro Contention 2 allege that the potential health hazards associated with living in proximity to high-voltage transmission lines have not been adequately evaluated.

Q: Have you participated in the review of the potential environmental impacts associated with the operation of the proposed Allens Creek Nuclear Generating Station (ACNGS) transmission system?

A: Yes.

Q: What has been the nature of your involvement in that review and assessment?

A: My involvement has included the review of the terrestrial ecology and land use sections, including those pertaining to transmission lines, and I helped prepare Sections S.3.4, S.5.1.2 and S.11.2 for the Final Supplement to the Final Environmental Statement (FSFES).

Q: In response to the above-listed contention, what is the general scope of this supplemental testimony?

A: The Staff has considered the effects of electromagnetic field on humans in the Sections S.3.4, S.5.1.2, and 5.11.2 of the FSFES. The purpose of my testimony is to supplement the above document as related to humans, plants, and animals.

Q: What are the potential environmental effects of electromagnetic fields in biological systems?

A: There are two areas of prime concern: induced shock currents and potential biological effects of electromagnetic fields.

Q: Would you explain in greater detail each of these areas?

A: Yes. I will first outline the issue of potential shock hazards associated with operating extra-high voltage (EHV) systems such as the proposed 345,000 volts (345 kV) Allens Creek transmission system.

Q: What causes electrical "shocks" from transmission lines?

A: The proposed 345 kV transmission lines will induce an electric charge and proportional voltage on insulated conducting objects on or near the right-of-way (R/W). Transient currents (or "spark discharges")[1],[2] are encountered when an individual comes into contact with a charged object that is at a different electric potential than the individual. If the potential difference between the object and the individual is sufficient, a small arc ("spark") may be established just prior to initial contact. Once contact is established a continuous current flows through the body of a person who may be in contact with the charged object. This current is called a steady state (or "short circuit") current[1],[2]. The level of the induced charge will vary with a host of factors, including: voltage (which affects electric field strength), transmission line conductor-to-ground clearance (which is affected by line loading and ambient temperature) (the lower the clearance, the greater the charge), size of the insulated conducting object (the larger the object, the greater the induced charge),

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[1] United States Department of Interior. Electric and Biological Effects of Transmission Lines, A Review. Bonneville Power Administration, June 1977.

[2] United States Department of Agriculture. Electrostatic and Electromagnetic Effects of Overhead Transmission Lines, Rural Electrification Administration, May 1976.

degree of insulation of the conducting object, and spatial relationship of the insulated conducting object to the transmission line conductors. The levels of steady state or transient currents experienced will also be affected by the degree to which the person touching the insulated object is effectively grounded.[3]

Q: What physical injury results from a shock hazard?

A: For steady state currents, direct physical harm occurs only above the "let-go" level -- where involuntary muscle contraction makes the person unable to release the conducting object. The minimum "let-go" level for men is about 9 milliamperes (mA) and that for women about 6 mA. Adequate data are lacking on the "let-go" threshold for children. This threshold has been estimated to be in the range of 4.5-5.0 mA.[4] The National Electrical Safety Code[5] specifies 5 mA as the maximum allowable short circuit current for the largest vehicle expected beneath a transmission line. At some point above the let-go level, respiratory arrest and consequent suffocation may occur if the current flows through certain parts of the body for a sufficient time. Below the let-go level but above the threshold of perception, steady state current flow may cause anything from mild surprise to a sudden, involuntary "startle" reaction of part or all of the body. While about 1% of children and small adults can perceive steady state currents of about 0.1 mA, the threshold of perception for 50% of the population is

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[3] T. D. Bracken. 1976. Field Measurements and Calculations of Electrostatic Effects of Overhead Transmission Lines, IEEE Trans on Power Apparatus and Systems, Vol. PAS-95(2):494-504.

[4] ITT Research Institute. Evaluation of Health and Environmental Effects of EXTRA HIGH VOLTAGE (EHV) Transmission. Prepared for U.S. Environmental Protection Agency, February 1979.

[5] National Electrical Safety Code. Institute of Electrical and Electronics Engineering, Inc., National Bureau of Standards, ANSI C2. 1977.

about 1.0 mA[6,7]. For transient currents, spark discharges at the maximum levels predicted for the proposed 345 kV transmission line will not cause any direct permanent physical harm.

Q: Can any precautions be taken by the applicant to reduce the potential for physical injury?

A: To protect people not only against direct permanent physical harm but also against possible indirect or secondary injury that might occur from an involuntary reaction to a shock current -- such as from jerking a hand back and catching it in moving machine parts, a program of grounding -- or grounding and bonding of stationary, fixed conducting objects on or near the R/W (like metal buildings, roofs, or fences), without any change in voltage or facility design will be initiated by the applicant (FES Suppl. Sect. S.11.2 and S.A-23) to prevent shock hazards. Vehicles which may use or cross the R/W, however, present a more difficult problem, since they may not be equipped with grounding straps or chains. The National Electrical Safety Code covers this problem in Section 23 - Clearances.

Q: What will be the applicant's proposed minimum clearances and the effects of such clearances?

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[6] C. F. Dalziel and W. R. Lee. 1969, Lethal Electric Currents, IEEE Spectrum, February, pp. 44-50.

[7] J. C. Keesey and F. S. Letcher. 1970, Human Thresholds of Electric Shock at Power Transmission Frequencies, Arch. Environ. Health, Vol. 21:547-552.

A: Minimal clearances that will meet the 5.0 mA steady state current limit (National Electrical Code Sec. 232, B.1.c) for all vehicles reasonably anticipated to travel on or across any part of the R/W will be provided by the applicant. No currents above that limit would be experienced from touching a school bus, a milk tanker, a bucket truck or a combine operating on the R/W away from roads.

Q: What are your conclusions about potential shock hazards based upon the foregoing analysis?

A: I believe that HL&P's present design clearances that maintain a maximum inducted current of 5.0 mA rms when the largest anticipated truck, vehicle or equipment under the line is short-circuited to ground for the proposed 345 kV line provide adequate protection from induced shock currents.

Since the applicant has committed to design the 345 kV line for a 5.0 mA steady state limit, it is highly improbable that indirect injuries, caused by involuntary reaction to shocks will occur. Therefore, these proposed transmission facilities do not require additional protection features. If additional data from research and other sources determine the necessity of additional protection against indirect injury, operating conditions providing some type of public educational program about these hazards may be warranted.

Q: Are there any other possible harmful effects to humans other than shock hazards, of electromagnetic fields?

A: Yes, electromagnetic fields may result in other potential biological effects of humans.

Q: What are the sources of those potential biological effects?

A: There are two other potential sources of biological effects: corona discharge resulting in the generation of ozone; and electric field effects other than shock hazards.

Q: How do transmission lines generate ozone?

A: Corona is a phenomenon that occurs in the immediate vicinity of the transmission line conductors due to the strong electric fields that exist at the conductor surface. Corona discharge frequently results in the production of ozone.

Q: How much ozone is generated by extra high voltage (EHV) transmission lines such as the ACNGS 345 kV lines?

A: Results of six extensive field tests concerning the measurement of ozone from EHV lines indicate that ozone concentrations due to transmission lines were barely distinguishable from the ambient background ozone concentrations.[8,9] All reported field measurements resulted in no more than 1 ppb ozone under fair weather conditions. During foul weather,

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[8] G. F. Schiefelbein. Alternative Electric Transmission Systems and Their Environmental Impact. NUPEG-0316. Battelle Pacific Northwest Laboratories, August 1977.

[9] IIT Research Institute. Evaluation of Health and Environmental Effects of Extra High Voltage (EHV) Transmission. Final Report Prepared for the Environmental Protection Agency. February 1979.

small amounts of ozone (20 ppb) were measured at the approximate height of a transmission line but no ozone was detected at ground level. Thus, if ozone is produced, it should not result in any significant or detectable health effect.

Q: What other electric field effects may result in potential biological effects to humans?

A: The passage of an electric current through any unshielded conductor produces both electric and magnetic fields in the surrounding medium. The effect of electric fields on humans has been and presently still is being studied extensively throughout the world. As transmission designs result in larger and larger voltages, more intense fields that cover wider areas may result. For an overhead AC transmission line, the three separate phases create an interference pattern so that the strongest field exists in the area below the outer phases, approximately 20 to 60 feet from the centerline. The field drops off moderately as one moves closer to the centerline, and falls off rapidly as one moves further away from the facility. A 345 kV facility may produce a peak electric field of 5 to 6 kilovolts per meter (kV/m) at ground level, dependent upon conductor configurations, and the field drops off to about 1.6 kV/m at the edge of right-of-way. The magnetic field produced by a high voltage transmission line has similar characteristics. The maximum calculated magnetic profile at 1.5 m above the ground is about .6 G (gauss).

Q: Are any harmful biological effects expected from magnetic fields under transmission lines?

A: No. Magnetic field levels at which biological effects occur are generally much higher than levels under power lines. Safety standards for whole body exposure to magnetic fields for long periods have been recommended at 200 to 300 G[10] (gauss) as opposed to the 0.6 G produced by high voltage transmission lines.

Q: Are there any current guidelines established for exposure to electric fields?

A: Precautionary electric field guidelines have been established by the Russians for substation and transmission line workers[11]. More recently the Russians established general exposure guidelines for the local population and agricultural workers[12]. Using the Russian general population guidelines, HL&P's 345 kV lines would be permitted*.

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10 U.S. Department of Interior (Bonneville Power Authority), pp. 17-19.

11 "Rules and Regulations on Labor Protection at 400, 500, and 750 kV AC Substation and Overhead Lines of Industrial Frequency (in USSR)". 1972. Translated by G. G. Knickerbocker in Special Publication No. 10, Power Engineering Society (IEEE), 1975.

12 Y. I. Lyskov, Y. S. Emma, and M. D. Stolyarov. 1975. Electric field as a parameter considered in designing electric power transmission of 750-1150 kV; the measuring methods, the design practices and direction of further research. Trans. by G. G. Knickerbocker in Special Publication No. 10, Power Engineering Society (IEEE), 1975.

* These guidelines established higher acceptable gradient standards of transmission lines in accordance with these direct quotations (from Lyskov, et al. 1975):

(continuation of footnote from page 9):

"In designing the O. H. 750-1150 kV line, considering that cumulative effect of the field due to an infrequent and non-systematic exposure of the local population and the agricultural workers can practically be disregarded, as permissible magnitudes of the field intensity the following higher standards were accepted:

20 kV/m for difficult terrain,
15-20 kV/m for non-populated regions,
10-12 kV/m for road crossings.

"The permissible field strength must not be exceeded at the center of the span at the height of 1.8 meters above ground and at the lowest sag (at the maximum 15 year temperature).

"The permissible values of field intensity were chosen with consideration of favorable operating experience in over 150,000 km/years in O. H. 500 kV lines, for which the designed field intensity is for similar conditions from 10 to 14 kV/m."

However, a Russian paper by U. D. Dumanskiy, et al. entitled "Hygienic Evaluation of Electromagnetic Field Generated by High-Voltage Power Lines" (in Gigiyena I Sanitariya-No. 8:19-23, 1976), obtained by the Staff, states that laboratory test animals (albino rats) undergo changes in behavioral reactions when subjected to fields in the range of only 1 to 5 kV/meter. These field gradient levels are considerably below the general population standards quoted above.

Current research is being funded and guided by the Federal Interagency Advisory Committee on Electric Field Effects on which NRC Staff actively serves to determine if more definite guidelines are necessary.

Q: What are the biological effects to humans as a result of exposure to electric fields?

A: Current research has produced statistically significant effects in the areas of neonatal development, endrocrinology, hematology, neurophysiology, neurochemistry, urine volume and chemistry, sympathetic nervous system, and behavior in tests on mice and rats.[13] These effects were found at field strengths scaled to man of about 4-20 kV/m[14],[15]. A 4-20 kV/m field strength is typical for the maximum values measured near the ground under 345-745 kV transmission lines near the center of the R/W. Maximum field strengths at the edge of the R/W, as stated earlier, fall off rapidly and would be about 1.6 kV/m at the edge of the R/W or less for a 345 kV line and, therefore, biological effects to humans would not be expected.

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13 Biological Effects of Electric Fields on Small Laboratory Animals. R. D. Philips; Battelle Memorial Institute-PNL; Richland, Washington. U.S. Department of Energy, Office of Electric Energy Systems - 1980 Contractors Review Meeting; November 18-19, 1980.

14 S. V. Kolesnikow and B. A. Chukhlovin. 1978. To the Interaction Phenomena Between Industrial Frequency AC (50-Hz) Field and the Organism of a Human and an Animal. Translated from "Letters to Journal of Technical Physics" (USSR). Volume 4, Issue 15, August 12, 1978, pages 935-939.

15 W. T. Kaune and R. D. Phillips. 1980. Comparison of the Coupling of Grounded Humans, Swine, Rats to Vertical, 60-Hz Electric Fields. Bioelectromagnetics 1:117-129.

Q: Are you familiar with any public hearings dealing with the health and safety of transmission lines?

A: Yes, I have followed the extensive New York State Public Service Commission (NYPSC) hearings on the health and safety of 765 kV overhead transmission systems. Upon completion of these hearings, the NYPSC commissioners concluded that "risks, if any, of long-term exposure to 765 kV transmission in the areas traversed by PASNY's line and any future 765 kV lines will be no greater than those, now widely accepted, of long-term exposure to the 345 kV lines operating throughout the State." (State of New York Public Service Commission. Opinion No. 78-13. Cases 26529 and 26559. June 19, 1978, p. 41.)

Q: What are your conclusions and recommendations concerning the health and safety of HL&P's 345 kV lines?

A: Based on the foregoing facts, it is my opinion that there is no evidence at this time that the operation of 345 kV power lines will have a significant effect on the health of humans. If ongoing research were to conclude that protective measures were warranted, a variety of actions could be considered including, but not limited to: increasing the width of right-of-way to limit the field strengths to which the public would be exposed at the edge of the right-of-way; potential rights-of-way users be given specific warnings of possible risks; use of shield wires or other types of retrofitting techniques which could reduce field gradients to a prescribed level.

Although the staff does not believe that additional protective measures are warranted at this time, we are keeping abreast of these studies and will take any new information into consideration during our review of transmission line operation at the operating stage.

Q: Were the effects of electromagnetic fields on plants and animals addressed in the FES or FSFES?

A: The Staff did not address the question of field gradient effects on plant or animal life along the transmission line in the FES or the FSFES for two distinct reasons:

(1) It is our position that any effects attributed to the electric field on humans would generally include large animals, since most of these animals have a territorial range extending beyond the right-of-way and therefore would not be exposed for long periods to field gradients. Smaller animals which exhibit a more limited range would most likely be shielded extensively from electric field gradients at ground level by surrounding shrubs, grasses, etc., and therefore would not receive a high cumulative exposure dose.

(2) Field tests and studies of biological ill effects of field gradients conducted on plants and animals have generally indicated that no significant effects are attributable to electric fields predicted to occur from the operation of 345 kV systems.

Q: What does the latest data pertaining to electric field effects on agriculturally related plant life indicate?

A: Results of ongoing research[16] on electric field effects on growth and development of plants and animals indicate that neither gross injuries nor gross abnormalities were apparent from a 50 kV/m field.

Some minor physical damage, barely perceivable along corn, bluegrass, and alfalfa leaf tips was indicated in fields from voltage gradients of 25 kV/m and above. The same series of studies investigating electric field effects on small animals indicate that no major abnormalities in behavior, activity, or outward appearance have been demonstrated from high fields of 50 kV/m. The preliminary results further substantiate published data which to date have not indicated any hazardous effects to laboratory and agricultural animals from fields generated from existing transmission systems[17].

Q: What are your conclusions about potential effects of electromagnetic fields on plantsand animals?

A: Based on the above findings, which indicate no substantial damage to plants or animals, I do not believe that changes in the applicant's proposed

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16 The Effects of High Voltage Electric Lines on the Growth and Development of Plants and Animals. J. W. Bankoski, H. B. Graves, and G. W. McKee. Proceedings of the First National Symposium on Environmental Concerns In Right-Of-Way Management. Mississippi State University. 1976.

17 Biological Effects of High Voltage Electric Fields: State-of-the-Art Review and Program Plan. IIT Research Institute, Chicago, Illinois. November 1975.

transmission line design are warranted. As in the case of human ill effects, additional extensive studies are currently being conducted. The Staff is keeping abreast of these studies and of any guidelines resulting from them, and will reconsider the impacts of the transmission line operation prior to or at the time of the operating stage review, taking into consideration any new information. At that time, mitigating measures, if warranted, can be considered and implemented.

PROFESSIONAL QUALIFICATIONS
GERALD E. GEARS
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C.

I am currently employed as a Senior Land-Use Analyst in the Office of Nuclear Reactor Regulation, Division of Site Safety and Environmental Analysis, in the Environmental Specialists Branch, USNRC. As a member of the Terrestrial Resources Section of this branch since 1974, I have responsibility for the review of applicants' Environmental Reports at both Construction Permit and Operating License Stage for completeness and environmental acceptability of proposed projects as they may affect natural ecological resources, agricultural resources, land use pattern and other impacts on the terrestrial environment. It is also my responsibility to provide written evaluation of terrestrial resources for inclusion in both FES-CP and FES-OL Stages. I also act as a consultant to other NRC branches and provide analyses of terrestrial problems through technical assistance requests from other groups. Review and modifications of applicants' environmental technical specifications at the operating license stage is another of my responsibilities. My work also involves the preparation of environmental standard review plans, regulatory guides and staff position papers dealing with terrestrial resources. As a Terrestrial Ecologist I have among other tasks in recent months prepared analyses on alternate site selection and alternative transmission corridors for the Palo Verde Nuclear Generating Station Units 1, 2, and 3, written the terrestrial resource-related sections for the Palisades Nuclear Generating Station and Arkansas One, Unit 2, Environmental Impact Statements (EIS), and the Indian Point, Unit 2, and Indian Point, Unit 3, EISs pertaining to closed-cycle cooling alternatives, and the Watts Bar-OL EIS. I have prepared and presented testimony as the staff's expert witness in the contested North Anna Nuclear Power Station, Marble Hill and Seabrook environmental hearings. I am a member of the Interagency Advisory Committee on Electric Field Effects from High Voltage Lines which is charged with the task of funding research to develop safety guidelines for transmission lines. I am also the NRC representative on a Fish and Wildlife Service Review Committee charged with the development of a manual for improving transmission system rights-of-way construction and operation practices.

I have a Bachelor of Science in Agronomy from Oregon State University (1972), a Bachelor of Arts and Science in German and Russian from Villanova University (1966), and a Master of Science in Agronomy from the University of Florida (1974). While at the University of Florida (1972-1974), I undertook research in the areas of Resource Management and Ecosystem Modeling. My formal education program has encompassed and emphasized studies in agriculture, economics, botany, soil fertility, including tropical and arid soils, plant physiology, crop production, range resources, aquatic plant ecology, computer modeling and resource assessment techniques. Using analog and digital computer hardware combined with an energy based resource analysis language, I developed and expanded various ecosystem models for the study of alternative uses of native vegetation and urban wastes in cooperation with members of the Department of

Agronomy, the Department of Forestry (Resource Management Section) and the Department of Environmental Engineering of the University of Florida.

From 1969 to 1970, I was employed as a teacher at Aquinas Institute, a secondary school in Rochester, New York.

From 1966 to 1969, I was employed as an agricultural extension agent by the Indian Government in cooperation with the Peace Corps in the State of Maharashtra. I organized and conducted demonstration projects in this capacity in order to investigate the feasibility of employing alternative methods of crop production in village level situations. This assignment provided experiences in the utilization and evaluation of alternative agricultural resource management methods in a unique cultural setting.

3-1
cf

JUDGE WOLFE: Is there cross-examination, Mr. Newman?

MR. NEWMAN: Yes, a bit. Shall I proceed?

JUDGE WOLFE: Yes.

CROSS-EXAMINATION

BY MR. NEWMAN:

Q Mr. Gears, I want to direct your attention to page 4, and in particular the first full answer on that page that talks about shock hazards.

You identify some minimum "let-go" levels.

Would those "let-go" levels be firm minimums for the different categories of individuals you describe or is there a range of "let-go" levels for men, for women, for children?

A There based on a series of tests -- field tests, laboratory tests, actually, that were done for men and women. Not for children, but for men and women.

The range, therefore, one could derive an average value, which I in my testimony have not used. I have used a minimum level which says that was the lowest measured in a group of people.

The average value per men is somewhere around 16 milliamps and for woman it is around 10 1/2 milliamps.

I stress here that I used the word minimum.

3-2
cf

Q Okay.

And, likewise, is there a range -- or is that you range for children there --

A Children --

Q -- Sorry. Go ahead.

A Children for obvious reasons children were not subjected to this test.

Therefore, it has been theorized based on body weights and size that at levels somewhere around 5 milliamps would be the level at which would be a safe level for children if they got involved with the possibility of grabbing an object and receiving a shock.

Above 5 milliamps they would have theoretically some difficulty in letting go.

Although, there even is a safety factor involved in that -- those particular calculations.

But, there are no actual measures on children. It is a theoretical calculation.

Q When you speak of a margin of safety, what margin do you believe exists with respect to children?

A If I can remember the study exactly, it is possibly there is not too much leeway in there. It is possible there. It is possible that depending on the child that it could go up to 6 to 7 to 8 milliamps

Q Thank you.

3-3

At page 6, you reach certain conclusions regarding the hazards of shock.

In particular, you conclude that the present design clearance as postulated by HL&P provide adequate protection from induced shock and further than in terms of indirect injuries the design of the lines is such they don't require any additional protection features.

Can you identify the principal basis you have for those conclusions regarding shock hazards?

A Basically, there is that particular question and answer segment is dealing with the 5 milliamps criteria.

The 5 milliamp criteria is basically designed as part of the National Electric Safety Code to give clearances at the lowest part of the sag of the line to establish certain clearances which will in fact result in a situation where theoretically a shock would not be received that would exceed the threshhold level of 5 milliamps.

The, in this case, these lines it is my understanding will, in fact, be designed that means essentially the clearances over roadways, over farmlands will be designed so that in no case will an object be able to develop a current in excess of 5 milliamps.

Based on that I accept that that is a very

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adequate, prudent safety design; and based on that I feel that the shock hazards will not exist.

Q You feel that there is a safety margin remaining even after the 5 milliamp field is described.

A Certainly for men and women there is a large safety issued involved here.

I'm not sure if I can say what the margin is for children, but I can certainly say as I said before that the average level for a male adult is 16 milliamps and we're talking about design for 5. For women, it is somehwere around ten, so we're talking about those safety margins.

The margins for children are, again, somewhat questionable.

But, the 5 milliamp criteria is definitely below that level which the majority of experts feel is an adequate safety.

That the threshhold for children would not -- certainly is not below 5 milliamps.

Q So, that you don't perceive a hazard to children from exposure to the 5 milliamp field. Is that correct?

A Right.

Q At page 9, you described a study by a group Soviet scientist in Footnote 11. Are you aware of the

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controls, if any, that were used by those researchers in their experimental work?

MR. DOHERTY: Mr. Newman, to which study do you refer?

MR. NEWMAN: I'm referring to the one in Footnote 11.

MR. DOHERTY: Number 11, thank you.

I'm sorry.

THE WITNESS: The published paper cited that this Reference 11 does not describe in any adequate detail any sort of control undertaken.

It was an essentially and epidemiological study which reported only effects.

It did not describe the environment in terms of electric fuel parameters.

It did not discuss possible other environmental problems that could be associated in an electrical environment in a substation.

So, essentially, we do not know the precise background for -- or the experimental conditions under which these things are described.

Q Is that a difficulty generally encountered in the Soviet research?

A It is my opinion, based on discussions on the Interagency Advisory Committee on Electric Fields,

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that published Russian data in this area often times does not have an adequate description of protocols and that we, in fact, with groups in the utility are in constant, until recently, constant communications with the Russian authors. And, that is one area where the Interagency Advisory Committee is trying to lend some sort of light.

We are actually trying to exchange scientist, putting -- bringing Russian scientist over here under the laboratory conditions and trying to have them reproduce their results and vice-versa, sending people in the American scientific community over there to, in fact, look at the way they are doing things.

If I may say one thing, this is one of the areas that we're talking about in terms of electric fields that the -- so far the results that have come up have been published are, in fact, very subtle. And, it involves a great care to make sure that all the facts are in the actual studies themselves and that even the question of measuring electrical fields is a very touchy subject in that depending on what sort of field measurement devices you use and how you use them. The field measurements can in fact be off by orders of magnitude.

Then, if you think you have a 25 kV per meter field in your laboratory measured on your instrumentation

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that perhaps it could be anywhere from 15 to 100 on somebody elses instrumentation.

So, part of our committee has been to develop a research area -- research program in the National Bureau of Standards to calibrate simple measurements.

And, so, one of the things that we require of all of our experimenters is that the field be first monitored with one similar calibrated instrument before the experiments are undertaken.

This is what we're trying to do with the Russians, too.

Q Then the experimental protocols are extremely important then in evaluating the work in this field.

Correct?

A Yes.

Q Is there developing a fairly uniform experimental protocol for this type of research in the United States? Is that part of the work or your Interagency --

A Certainly, there are auspices that the research that the Interagency Committee, and primarily through the Department of Energy that is one of their main criteria accepting any research program that protocol has established and agreed upon before it is

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undertaken.

Q At page 9a of your testimony, you report on a study by Dumanskiy, if I am pronouncing that properly.

Are you familiar with the controls and the protocol used by Dumanskiy?

A No. Again, this particular Citation and paper did not thoroughly address the issues of protocol. That, in fact, in our review there were some points which were of concern.

I do want to say in this particular work that the protocol, initially, appears to be better than other studies that we have seen from Russian authors.

But, again, the question of electric fields and measurements and exact fields that the animal were being subjected to is a questions that we don't know, because of the difference -- the Russian -- primarily the Russians have a measuring devise which has been tested by the National Bureau of Standards which from model to model is quite sensitive and even the way you hold it is extremely sensitive on the order of submagnitude. Diffenerence even in the way one extends one hand out versus bringing it close to the body. One can get a field from one kV per meter to 10 kV per meter, simply by doing that.

Q What types of -- Let me ask you this.

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Does the report by Dumanskiy identify the behavioral reactions that he observed in his experiment?

A. It's been about six months since I have reviewed that particular paper. I'm not sure if I can answer it.

I don't think I could answer that.

I could look it up, but I'm not sure what sort of behavior characteristics are.

Q. Do you recollect that Dumanskiy indicated that the experimental animals returned to normal conditions or reestablished homeostasis within a few months after the experiments?

A. I can't recall that for Dumanskiy.

Q. Mr. Gears, do you observe the same differentiation between effect and hazard that Dr. Michaelson observes?

You are familiar with Dr. Michaelson's paper--his direct testimony --

A. I read it yesterday for the first time --

Q. At page 8 he discusses the difference between effects and hazards.

Do you generally observe the same kind of differentiation in the work that you do?

A. If I may, may I read it once more?

Q. It's at -- for the benefit of everybody else

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it is at page 8, and it is approximately line 5 through line 13.

A Well, generally, the first paragraph talks about or is a description of effects in that -- my understanding of what he is saying is that effects do not necessarily -- to paraphrase it do not necessarily mean that they are hazardous.

Now, my general opinion is that, and I have said this in my testimony, that in general e in fact seeing some effects.

It is my opinion that at this time that the effects do not appear to be -- or to provide or cause a significant health problems in humans.

I am not sure if continuous study in this area in more chronic exposures would, in fact, prove in the long run -- I may have to revise my opinion and call to the fact that they may be detrimental to human health.

Q But, in any event the effects that you report at page 10 of your testimony based on studies that are cited in Footnotes 14 and 15, do not conclude that the effects noted are a hazard to the animals involved.

Is that correct?

A At this point they do not appear to be causing significant health problems in the test animals.

Q Do you recall whether the authors of that

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study, in fact, have said that they observe no hazard in the sense of upsetting the -- permanently upsetting the homeostasis condition of the laboratory animals?

A In the case of the Reference 15, on page 10, primarily Dr. Phillips' report, he is clear on the point that he calls the effects -- or classifies the effects to date that he is finding, perhaps, a description of what is called chronic stimulation.

That is his opinion of what possibly could be manifesting itself in some of these areas.

He does not use the word hazardous.

He does not use the word stress.

He uses the word chronic stimulation.

They are possibly manifestation of what an organism might be showing if you did biochemical parameters like they have done in this test of something in a constant state of stimulation.

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Q Is positive stimulation necessarily an adverse effect?

MR. DOHERTY: Objection, Your Honor.

Counsel has asked a question that's vague where he says positive stimulation. I think --

MR. NEWMAN: I thought that was the term used by the witness.chronic. I'm sorry. Chronic stimulation was what I meant.

MR. DOHERTY: Well, I withdraw the objection.

THE WITNESS: Would you repeat the --

BY MR. DOHERTY:

Q Yes.

Does the term chronic stimulation necessarily imply adverse effects on the health of the animals involved.

A In the general overall health of the animals, there is no evidence that chronic stimulation would be hazardous to the health of the animals.

Q Also, at page 10, in the first full answer, you describe some research -- I guess it is the Battelle research, again. Check that. It is the research, I guess, reported in Footnotes 14 and 15.

And, you said, "These effects were found at field strengths scaled to man of about 4 - 20 kilovolts per meter."

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How reliable are scaling efforts of that type? Do you have a high degree of certainty that they can be extrapolated directly to their effects on man?

A No.

This is one area, if I may explain, that needs additional research and is undergoing additional research.

The actual exposure rates to these animals are, in fact, on the order of 100 kilovolts per meter to 130 kilovolts per meter.

But, in fact, because fields are perturbed by these objects that go in them and because the shape of rats versus the shape of man are substantially different. When one does actual measurements when animals or when man or seales of man are in a particular environment, one finds that the direct correlation between the exposure system for a rat at a 100 kV has to somehow be correlated to the man exposure rate.

That, in fact, a rat being exposed to 100 kV per meter may in fact be equivalent to a man only being exposed to a much lower field. Of somewhere around the 4 to 20 kV per meter.

I provide that range because there is a great disparity at this point as far as what is the actual

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accurate scaling.

So, that, in fact, there is a great uncertainty of whether four is an adequate number that may be entirely too low; or that 20, in fact, may be entirely too high.

There is at this point no real agreement on the issue.

Q Thank you.

Mr. Gears, are you aware of the work that has been done in this field by Marino?

A I'm generally aware of it.

In fact, Dr. Marino is now being fronted by the Interagency Advisory Committee on Electric Ill-Effects.

Q And, has Marino's work established that there are hazardous effect associated with the types of electro-magnetic fields that one might see normally in a 345 kV line?

A Dr. Marino has reported findings which he purports to say that they establish.

The question is, again, on protocol on the actual experiments and how they were conducted.

Four or five years ago he came out with some research -- actually was some of the first research in the area reporting, in fact, muli-generational studies several generations of studies were showing indications

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of changes for example in body weight among second generation rats and mice.

This has been reported in the investigations of -- that he undertook. And, the way he undertook it has come under criticism.

Our particular committee is, in fact, now funding him to repeat the experiments but under a stricter protocol.

Q I see.

To your knowledge today, has Marino been able to replicate his results under approved experimental protocol?

A Well, he has not -- he is in the process of undertaking it as of this year. That he has not published any results, or has not reported any results under the improved protocol procedures.

Q Okay.

And, just, I guess, one final question.

In all of the work that you have done for your Interagency Committee, and literature you have examined and scientist with whom you've spoken, has anybody observed a known instance of biological hazard to human beings from exposure to the fields under 345 kV lines?

A No.

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MR. NEWMAN: That's all the questions I have, Mr. Chairman.

JUDGE WOLFE: All right.

Despite the procedures suggested by Mr. Scott yesterday which would be more restrictive upon Intervenors, we will follow our previous practice.

That is, after Applicant or Staff has cross-examined, we will then ask the Intervenors and we do so now, as to whether they have agreed to their sequence for cross-examination.

Mr. Doherty?

MR. DOHERTY: We have, Your Honor.

JUDGE WOLFE: Yes?

MR. DOHERTY: Mr. Rentfro's lead party will be the first; I will be the second, I guess.

JUDGE WOLFE: All right.

Cross-examine, Mr. Rentfro.

CROSS-EXAMINATION

BY MR. RENTFRO:

Q Mr. Gears, what is your understanding of the theoretical field strenth of this line?

A The theoretical maximum field strength I have stated in my testimony to be 6 kV per meter.

Q I would like to further expand on the

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definition of the field strength.

I would also like to include the kilovolts per meter and the gauss values that you understand to be the designing factor.

Are you aware of those?

MR. NEWMAN: Is there a question pending?

MR. RENTFRO: Yes, there is a question pending?

I wanted to know what his understanding was of the kilovolts per meter values and the gauss values of this line under consideration.

THE WITNESS: I made my calculations, if I understood the question, based on a standard 345 kV line. The standard was based on the acceptance of the 5 milliamp criteria, which in fact adjusts the clearance and based on the clearance -- maximum clearance between ground and the sag you can therefore calculate the field strength.

Now, let me tell you one thing, I am not talking about a worse case condition.

That, in fact, may shift the values up one or two kV's per meter.

I am talking about the more normal operation.

The 5 milliamp criteria which adjusts the clearances is based on worse case conditions of outside

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temperatures exceeding 100 degrees -- 120 degrees Fahrenheit. It, in fact, adjusts the -- a line to a standard which does not normally happen or routinely happen.

My figures are based on what would routinely be experienced beneath the line.

In fact, there are certain times of the year that one would get a field slightly higher than the maximums of 6 kV per meter.

Somewhere on the order of 7 or 8 kV per meter.

Q It sounds like your values fit well within those in Dr. Michaelson's testimony of 8kV per meter, 5 milliamps and 1 gauss.

A Yes.

I believe that I didn't use 1 gauss.

I used less than 1 gauss, .6 gauss to 1 gauss.

Q Are these calculations based on the corridor containing more than one possibly, up to three 345 kV lines?

A My calculations were based on a single line paramenter.

Q Have you any knowledge of additional lines proposed for this corridor?

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A. I have knowledge based on sitting in the hearing yesterday is that I now understand that their, I believe, proposed additional lines along the corridors.

Q. Are you aware -- Let me rephrase this.

Are there valid engineering calculations that could give us the value of the values of the kilovolt per meter, milliamps and gauss under two or three lines in the same corridor?

A. Yes.

There are certainly ways to calculate those.

Q. Would you feel those values would be increased by the addition of the other lines?

A. Well, I'll give you two possible answers to that, because it depends on the way the lines are placed.

If in fact they are double circuit towers where the lines are exactly stacked one on top of the other. There is a good chance that you will get a slight increase in the maximum electric field.

We have recently done calculations on a 500 kV line where the change was, again, on the order of one to two kilovolts per meter maximum.

It is interesting to note that the edge of the right-of-way the change is must less, you know, than one or two. It is the order of tenths of kilovolts difference.

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If, in fact, the lines were not stacked one on top of the other, but were spread or set side by side, the maximum field would not probably be increased at all.

The areas where the maximum increase, the actual area beneath the line would, in fact, be extended.

Right now when we talk about a maximum yield of 6 kV per meter for a single circuit line, we are talking about extremely small areas outside the outside face of the conductor on the order of very -- matter of square feet.

As soon as you get outside that area, it drops off substantially.

So, what I am saying is that if you place one line next to one line next to one line you would get concentric circles of maximum field strength separated by space. Probably you would get three of those, although again, there is going to be interference of conductor to conductor where, in fact, they do offset each other.

I have never seen a computer profile of three side by side conductors.

So, I'm not sure of the profile of the middle parameters, the middle -- In fact, I have a belief that they would in fact probably cancel out each other And, only the two outside phases would in fact have a higher than -- have a maximum electric fuel.

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Q Would it be appropriate for me to say then that the area would be -- effected area would be increased but the actual strength within that area would probably be -- approximate that under the one transmission line?

A I think that is probably a fair summation.

Q What is your estimate of the mean distance for conductor to ground clearance to come up with these values?

A I believe the figure would be somewhere between 28 and 30 feet. That is at the sag point.

I don't have that calculation right on hand.

But, that is the usual case for a standard 345 line. Designed for the 5 milliamp criteria. Somewhere around 28 to 30 feel at the lowest sag point.

And, that's what we're talking about for maximum electric field.

Q You mentioned ambient temperatures earlier, I believe you said 120 Fahrenheit.

Is this your value to calculate?

A That is the National Electric Safety Codes criteria for studying clearances.

That's the basis for how you determine what objects are going reach the 5 milliamp criteria -- determine what, in fact, the maximum sag in the line and, of course, it deals with several things. But, one of

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the things that would cause a line, a metallic conductor to sag would be, in fact, outside temperatures. Also, the amount of current going through that which, in fact, would be another conditions which would create heat, cause exparsion of the metallic conductor and, in fact, cause it to increase in size and therefore sag.

So, when I say 100 degrees Fahrenheit, I don't necessarily mean the ambient air temperature that is recorded in an airport somewhere.

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BY MR. RENTFRO:

Q Is this 100° Fahrenheit the temperature actually surrounding, or the temperature of the line itself?

A It's the actual air temperature surrounding the conductor.

Q On page three where you're talking about shock effects, how important -- or how significant is the spatial relationship of these objects that you mention?

A Well, if I understand your question correctly, the main component in figuring shock potential is the amount -- well, basically it is the strength of the electric field. As you, in fact, increase your distances away from the source, the potential for shock -- the potential for exceeding, say, five milliamps is decreased quite drastically.

So, in fact, the spatial concept is generally strong that as you get further away from the outside face conductor, there is less chance of accumulating or getting into circumstances where you have shock.

Q Does the spatial relationship, in the sense of how the object is oriented to the line have an effect?

A Yes. Generally, structures that are parallel to a line have the greater potential to build up the

4-2

current and, therefore, have a shock potential.

So things like fences, things like long roofs that are in fact parallel.

On the other hand, it isn't quite as easy as that because, in fact, if some of these structures are right beneath and right in that area of maximum electric field, but is oriented perpendicularly you could also develop shock potential.

Q On page four you go into grounding of the objects. How do you define effectively grounded?

A There are standard calculations. At least, our Agency has relied primarily on a group of calculations made for the Rural Electrification Administration which, in fact, tells you, based on the five milliamp criteria and the voltage class of the line, the length of fence, the square footage a foot of a building or roof metallic structure that one would have to ground.

For example, there are tables saying that for the class of a 345 kV line, if, indeed, you had a fence that was greater than, say, 200 feet that was on the edge of a right-of-way, that this fence was metallic, that in that case, in order to not exceed the five milli-amp criteria, you should ground that.

Now effectively grounding is a term that the National Electric Safety Code, in fact, spells out fairly

4-3

precisely what is adequate grounding techniques.

Q If it's effectively grounded, should there be no shock?

A There should be no shock in terms of a health hazard, in terms of a shock in excess of five milliamps. There are possibilities even on grounding structures -- structures or fences that have been grounded, that one could, in fact, receive a perceptible shock, but that it would not be hazardous.

Q But even though we exhausted all of our methods to effectively ground a structure ... fence or what have you, we still could experience the phenomenon that you're calling shock or arcing?

A Yes. I think that under certain situations that there is a possibility of receiving a slight spark discharge.

Q Are people normally effectively grounded in the electrical sense; say, someone just walking along the right-of-way?

A That's a very complex question; depending on what the person is wearing, for example, especially in terms of footwear, they may or may not.

But in most cases, there certainly would be some leakage in most cases for people walking along the right-of-way. That means, in fact, there would be some

4-4

grounding potential.

In other words, I'm assuming that a person isn't walking around in rubberized pants and rubberized boots; and that, in fact, he's not totally insulated. But, in fact, there is some leakage possible.

The question is hard to determine. Even on the type of person, as well as the size.

Q In the two studies that you have cited -- and let's call them Footnotes 3 and 4 -- are these -- Can these results be replicated time after time if someone followed essentially the same procedures?

A References 3 and 4 ... well, Reference 4 talks about the estimation of the threshold for children, 4.5 to 5.0 milliamp. Is that correct?

Q I was not sure that it was limited to children. If it's limited to children, then --

A Yes. As I said before, that is one calculation that has not received any clinical laboratory test because of protocol procedures ... experimenting with children is not looked upon as favorable.

Q How large a subject body was looked at to develop these results?

A How many subjects? I can't recall. I believe it was over a hundred, though.

Q Was there any attempt to replicate that study

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with an additional hundred people?

A I'm aware that these are the only studies that to date have been done in this area. I don't think there has been any replication, at least in this country, that I'm aware of.

Q What would be the probability of this five milliamp field being exceeded under the Applicant's proposed line?

I'm thinking in terms of, say, less than one percent, less than five percent.

A It's my opinion that it would never be exceeded.

Q Is there a standard or accepted instrumentation package that could be used to monitor the field strength under this line?

A As I mentioned before, there is now a program, an accepted instrumentation that will accurately measure the fields beneath the transmission line.

I do not believe that there is any -- We have not worked out any acceptable protocol for measurements underneath the lines, although there are some general guidelines for particular instrumentations -- or instruments that would -- that ... are clear that when using certain types of instruments, that there are certain things that you should not do in order that accurate

measurements should be taken.

But exactly protocol for taking or monitoring underneath the line, there isn't any -- we haven't developed any procedures.

I think it's needed. I think the instrumentations to date are accurate enough and can be used in such a way that fields can be adequately measured.

Q What I had in mind was that if I were interested in monitoring a field strength as part of -- say, one of your ongoing studies that you referred to earlier, would I submit a proposed package of instrumentation for your approval as part of the grant; or would you have one that you would prefer me to use?

A This gets into government funding. But simply if you had a proposed plan of -- or research area that you were interested, you would simply send in your proposal to the Department of Energy and outline what you wanted to do.

And then on our review we would ... you know, if there were problems with your protocol, your ways of monitoring, in fact ... we would highlight that certainly.

By the way, I would mention that there are already several studies ongoing to completely characterize operating 500 kV, and I believe a 765 kV line in the United States.

Q You seem to be placing a certain confidence in Mr. Bracken's study. What instrumentation did he use?

A The Bracken study -- the instrumentation that he used was a device that has currently been tested by the National Bureau of Standards.

There has been two or three devices in America for measuring field strength. All three of them have, in fact, shown fairly good agreement.

In fact, Mr. Bracken has -- used one of these particular instruments. Also he did a group of theoretical calculations to also get an idea of what the electrical field was.

In fact, there was very close agreement what the field measurements and the theoretical calculations were.

I don't know precisely the manufacturer that has devised those.

Q Are you aware of any plans by Applicant to monitor the performance of this line?

A No, I'm not.

Q In Footnote 5 you mentioned the National Electrical Code. Does it specify any detailed measurement procedures or development of the data that it uses as the Code?

4-8

A No, it doesn't. It only specifies the standard of five milliamps.

Q Is there any mechanism in their procedure for updating their standards or including new studies as we go along?

A Yes. All the time. They're always updating the National Electric Safety Code.

Q Have there been any changes that you're aware of -- say, for the last two or three years?

A No. 1977 was the major change in the National Electric Safety Code.

It was the first time that they did decide to regulate clearances based on potentials of shock hazard, and that's where they first decided to use five milliamps. That was a fairly major change in the National Electric Safety Code.

Q On page five where we're talking about direct permanent physical harm, the question was -- I'm reading from the testimony: "Can any precautions be taken by the applicant to reduce the potential for physical injury?"

Do you -- Is the direct physical harm from the shock itself or as a consequence of the tensual, involuntary reaction?

A I break that particular question into two

parts. But the direct permanent physical harm that I'm talking about there is in fact a lethal shock, something that would, in fact, exceed the let-go threshold and would possibly cause a lethal ... or at least some life-threatening consequence.

Below that, there are, as I mentioned before, other possibilities, not excluding the receiving of some sort of minor shock. That's when I'm talking about indirect.

The possibility of a person working beneath the line with moving equipment, touching a fence, receiving a shock, jerking back and somehow falling into that moving equipment, that's the secondary problem -- or the -- I call it indirect.

The cause of the injury was not the shock. The cause was due to startle reaction, a jerking motion, and possibly something happened as a result of that.

Q Do you believe that constant exposure to this potential of receiving a shock could have any ill effects on human health?

A I suspect that if a person were constantly exposed to repeated shocks over and over again, it certainly would be very annoying to anyone -- or to most people.

Beyond that, I don't know how an individual

4-10

person would react in a long-term. This is excluding the possibility of getting injured, say ... how one would react to that.

Q Will any of the grounding that you're referring to here be implemented by the Applicant, to your knowledge?

A It's my understanding that the Applicant has stated that they will ground those structures ... objects ... conducting objects that they calculate could receive or could produce a shock hazard in excess of five milliamps.

Q Do you know if this grounding is restricted to the right-of-way only?

A That is one area that I'm sure of. They have said that they will do it in the vicinity of the right-of-way.

To me that means not only on the right-of-way, but it also means off the right-of-way.

If, in fact, they calculate that there are objects that could in fact exceed the five milliamp criteria.

Q Would it be your understanding that they would do this at their expense?

MR. NEWMAN: I'm going to object to that question, Mr. Chairman. I don't believe that the question of who pays for what has anything to do with either the

testimony or the contention that Mr. Rentfro has introduced in the proceeding.

I object on grounds of relevance.

JUDGE WOLFE: Yes, Mr. Rentfro.

MR. RENTFRO: I believe it has relevance in that they should be required to assume responsibility for the effects of their line, be it financial, health or otherwise.

And if the people living along these lines cannot afford to do the grounding, then I think this definitely relates to the health hazard, if they are exposed to it.

MR. NEWMAN: The Applicant has already stated, as I indicated -- as the witness indicated, that he will ground things in the right-of-way and in the vicinity of the right-of-way.

That conclusion, or that statement having been made, it seems to me there's no health hazard to worry about further.

And that's the subject of this contention, not the question of who pays for what.

I see no purpose to be served by the answer to that question.

(Bench conference.)

JUDGE WOLFE: The objection is overruled. We

4-12

will hear the answer, Mr. Gears.

THE WITNESS: Well, it would be my understanding that if the Applicant, in fact, has agreed to ground those objects which would potentially produce a current in excess of five milliamps, that that would be done on his behalf and at his cost.

MR. BLACK: When you say "his cost," you are talking about that it would be the utility's, HL&P's cost?

THE WITNESS: Yes, the Applicant's cost.

BY MR. RENTFRO:

Q At page six near the middle of the page, you state: "Since the applicant has committed to design the 345 kV line for a 5.0 milliamp steady state limit, it is highly improbable that indirect injuries, caused by involuntary reaction to shocks will occur."

I thought I heard you say earlier that you -- when I asked a question about probability, that you didn't feel that there would be any. Is that -- How does that relate to "highly improbable" in thise case?

A That is based not only on the design parameters that we're talking about, but some actual calculations that were done, in terms of the 765 line.

Also, it's based on -- partly on my experience in the Interagency Advisory Committee that has looked into

4-13

the areas, especially of tractor and farm equipment that would be underneath the right-of-way, and investigations of those particular objects.

It appears that there are other safety issues involved that protects the operator himself that, in fact, we do not see in most equipment objects which, in fact, could cause serious injury.

That, in fact, because of other standards not at all relating to electrical fields, but general safety standards, that most equipment that was examined, in fact, had certain covers ... certain safety devices ... drive chains that were in fact covered.

The scenarios that were looked at that were considered to be the most probable were in fact ones that do not seem to be very likely. Even if an operator did receive a shock, the missing element appears to be that at least equipment that was operating that could cause some physical damage was not present ... that was safely designed for.

I'm sure we can sit here and figure out some other possible ways. But at least the ones -- the likely scenarios that we were thinking of at the time and had already been investigated by researchers, it's my belief that what makes my statement correct is I don't think there are very many conditions that one would be underneath a

4-14

transmission line; that you would get this secondary jerk response-type problem.

The missing factor there is that there isn't that equipment around that is that hazardous.

Q Have you considered the possibility of the -- I'd like to use an example here that is of some concern to me. And the question is have you looked at this possibility.

Let's say that you were training and riding horses in this area. And one of them inadvertently touches the fence and gets a shock.

I know there's not much research on large animals. But what would -- Have you looked at any possibilities of that happening in your scenarios that you have painted?

A No, I haven't.

I personally considered the scenario that you have just talked about. But we haven't really investigated it.

In other words ... description of an animal being startled, a rider being thrown, due to a small shock being received on a fence, for example.

We have not looked at that.

Q You mentioned at the end of that sentence, which seems to be sort of a conclusion: "Therefore,

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proposed transmission facilities do not require additional protection features."

What features are you excluding that would be additional, but are not required?

A Well, in the case of operating equipment -- for example, in the case of tractors or things like that, it is possible to reduce shock potential down even greater, for example, by using straps.

In other words, it's possible to design a line or to go ahead and ground below the five milliamp criteria. It's possible to do that to the one milliamp criteria, which is in fact -- I shouldn't say it's the one milliamp criteria. But one milliamp is a threshold about which most people would not even feel shock.

In other words, there would not even be the startle reaction involved.

So it essentially involves additional grounding, more grounding, more straps and sort of grounding every thousand feet or every 500 feet. It would be, say, every 200 feet; essentially more protective measures of the same kind.

For tractor vehicles it would mean straps, chains and things like that to ground.

Q Approaching it from the other direction, let's say that the use to which the right-of-way or adjacent

areas may be put -- Do you think you could justify the additional features on that basis, given the horse scenario or small children in the area? Could that be done engineering-wise?

MR. NEWMAN: Your Honor, I'm going to object to that question because I just think it's too vague for a responsive answer.

(Bench conference.)

MR. NEWMAN: I think he could try to rephrase it --

MR. RENTFRO: No, let me --

JUDGE WOLFE: Just a moment.

(Further Bench conference.)

JUDGE WOLFE: Go ahead. Would you like to respond?

MR. RENTFRO: Yes.

The point that I'm trying to examine is that there appear to be engineering methods by which we can further reduce the shock hazard that may not be justified along the entire line, but could very probably be justified in specific instances, if they were defined and brought to the attention of the Applicant.

MR. NEWMAN: Is that the question: Are there such measures that could be taken?

JUDGE WOLFE: Is that your question then,

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Mr. Rentfro?

MR. RENTFRO: I believe that question was actually answered by Mr. Gears. It may be that ... Well, I think ... yes, I think it's answered --

JUDGE CHEATUM: If you're not satisfied, ask the question again to satisfy yourself whether it was answered in fact.

MR. RENTFRO: Well, I was also interested in the -- Okay. Let me rephrase one more time.

BY MR. RENTFRO:

Q You're saying: "Therefore, these proposed transmission facilities do not require additional protection features."

My question, Mr. Gears, would be: Have you considered any specific areas that could qualify for these additional protective features; and might they be required if circumstances were verified?

A I haven't -- I do not know, nor have I stated in my testimony that I believe at this point that there are areas that would require additional protective features.

Q I think that's reasonable, based on your overall knowledge of the line temperature. It's very general. Thank you.

On page six also you mention the ... "(s)ome

4-18

type of public educational program about these hazards may be warranted."

Are you familiar with any such public education programs in a general sense, perhaps that other utilities are implementing or ...

A I know that in the case of the New York State Rochester Gas and Electric and Power Authority of the State of New York that based on the particular hearings that were undertaken there in front of the Public Utility Commission, one of the conditions for them to build and operate the line was that they were going to have to develop some sort of public awareness program.

I have no idea if that has yet been implemented. I do believe that that was part of the order.

I do have, in my experience with the NRC for seven years, that I have talked with other utilities -- some utilities and, in fact, some utilities upon energizing a particular line will, in fact, make an effort to contact those people living in close proximity to the line, asking them if they have -- if they experience any sort of problem to please contact a particular individual and they will come out and address the issue, not only in terms of shock, but in terms of other areas, like radio and television interference and similar things.

Q This then appears to be -- Would you describe

it as a reactive-type program, as opposed to a conscious effort to make people aware of any effects that the line may have?

A Certainly the second description of the utility that I discussed was reactive.

I'm not sure if the New York State hearing -- I'm not sure exactly what programs they're developing, whether they will be purely reactive or, in fact, they will endeavor to educate people as to possible things to avoid.

My understanding is that the utilities have been asked to provide people in New York State who live along the line some sort of information of potential problems and to give warnings ... sort of a safety lecture type situation.

Q The research program that you are sponsoring or any that you are aware of ... are they contributing anything to this effort? I think maybe it shouldn't be a total responsibility of the utility.

A I hesitated for a second, because the Bonneville Power Administration which, in fact, is now a federal agency has produced a publication describing a variety of issues and a variety of programs that in the case of Bonneville are undertaken to promote safety.

And so in that case there is at least available

4-20

to the public a document ... a manual of what to expect under high voltage lines.

Q Would you feel strongly enough about this public education issue to recommend that it be made a requirement in ... let's say, permitting these lines?

MR. NEWMAN: I'm going to object to that question, Mr. Chairman.

It's exceedingly vague. It doesn't indicate what lines or eschew what the voltage of the lines would be. And it seems to me beyond that to call for just pure speculation on the part of the witness.

MR. RENTFRO: I am given to understand that the witness is an expert in his field. And if he considers it speculation, he may state so.

But I would clarify my question -- or let's say give it more specificity, that we limit it to the Applicant's 345 kV line, and the possibility of the second and third lines.

JUDGE WOLFE: With that clarification --

MR. NEWMAN: With that clarification, that it applies only to the 345 kV line, I withdraw the objection.

THE WITNESS: I think, as I state in my testimony, I don't believe that at this time it warrants a public education program for the Allens Creek 345 kV

4-21

lines.

JUDGE WOLFE: Mr. Rentfro, I think we'll have a ten-minute recess.

(A short recess was taken.)

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JUDGE WOLFE: All right, Mr. Rentfro.

BY MR. RENTFRO:

Q I would like to continue on with the public education idea.

I understood you to say that you would not be in favor of making any such program a requirement for licensing. Do I understand that correctly?

A For the Allens Creek plant.

Q Right.

Would you feel that it might be a recommendation as a voluntary program?

A Excuse me. A recommendation on my part?

Q As a part of the overall -- Well, let me re-ask that question.

Do you feel that the public education idea that you've brought up here is of sufficient merit that it ought to be in some fashion addressed by the hearings as part of the line itself?

I understand -- I'm looking for perhaps a value judgment. But I ... use the expert witness who did mention it. I would like to get your opinion on that.

MR. NEWMAN: Mr. Chairman, with some sense of hesitation, I'm going to object to that question. It really does call for speculation.

The witness has stated clearly what his

5-2

reaction would be to the need for an educational program with respect to the Allens Creek lines.

And the question, beyond it having been asked and answered, is also extremely vague. The question as put: Is this the sort of thing that ought to be addressed in these hearings?

I don't know what that means. And I think it is both vague and previously answered.

MR. RENTFRO: I'd like to withdraw that question.

JUDGE WOLFE: All right.

BY MR. RENTFRO:

Q Let's just very simply say: Would you be in favor of a voluntary program of public education by whoever undertook it?

MR. NEWMAN: Mr. Chairman, I'm going to object again to that question. I don't know what the expression "by whomever undertook it" means.

And again, the witness' testimony is on the record with respect to the absence of a need for an educational program.

MR. RENTFRO: I disagree. In fact, his statement had to do with the absence of a need to require it as a condition of licensing.

My question is really: How does he feel about

it as a voluntary program for HL&P, in regard to this particular line.

(Bench conference.)

JUDGE WOLFE: The objection is overruled.

The witness has in his written testimony already addressed this. But he may respond again.

THE WITNESS: As I stated before, certainly I'm not recommending that a public educational program be undertaken by the Applicant.

I have no strong feelings any way about whether something is done in a voluntary situation by the Applicant--or whoever.

I stated before simply that some utilities do find it prudent and beneficial to undertake some sort of public -- I wouldn't call it an education program -- but some sort of public reaction program to the utility. And some utilities don't.

I have no idea what benefits one could gain from that type of program. So I really can't ... I don't have any strong feelings at this point of voluntarily -- of anybody undertaking a voluntary program.

I certainly would not -- I don't have a strong desire to have the utility do it at this point.

BY MR. RENTFRO:

Q You mentioned, "If additional data from research

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and other sources determine the necessary of additional protection against indirect injury" -- that's just prior to the mention of the public education possibility -- could you give us any examples of data that might be significant in this area?

MR. BLACK: Objection. I believe that's highly speculative at this point. It's talking about something that may be done.

(Bench conference.)

MR. RENTFRO: Well, the witness is the one who --

JUDGE WOLFE: Just a moment.

Would you repeat your objection, Mr. Black?

MR. BLACK: He's asking what kind of data or research may indicate that additional protection may be necessary in the future. And I believe that's ... since the data and research has not been conducted, that's something that's highly speculative.

JUDGE WOLFE: Yes, Mr. Rentfro.

MR. RENTFRO: Well, I'm following the witness' testimony; if we go by Mr. Black's analysis, then perhaps that should be stricken from the testimony because he says, "If additional data from research and other sources," without any specific identification of such data and research as ... you know ... the necessity, then I feel

5-5

it's within the interest of the -- within my interest to get an idea of what additional data or research that we could look at that might justify additional protection.

I'm personally very interested in this issue and perceive a fairly direct impact upon myself, as well as others, and would like to know what some of the criteria are that we're looking at.

JUDGE WOLFE: Yes, Mr. Rentfro.

The objection is overruled. The witness did bring this subject matter up. Therefore, as an expert, he will be able to tell us about this, and it's not speculative.

Yes.

THE WITNESS: That statement is in direct relation to my working as part of the Interagency Advisory Committee which is made up of a group of people. Some people represent agencies in that group who have a clearer path, I guess, in this area as far as regulations -- primarily OSHA and primarily EPA.

The additional data would, in fact, be reviewed by the Committee itself and each independent agency. My meaning in that statement is essentially that based on if in the future data did show some problems and after discussions, the Interagency Advisory Committee or independent agencies like OSHA or EPA, decided that some

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sort of protection is needed -- extra protection, that is when I essentially was trying to give the Board some possible directions that I thought would be helpful for a line that maybe is already built or already designed for; that even if something does come down the line in the future, in terms of data, that we as a Committee and/or independent agencies decide warrant some additional protection measures, there are other options that we could go ahead besides, say, knocking down the line or not allowing the line to be energized.

MR. RENTFRO: I think that clarifies it. I believe your notion of ongoing -- the sponsoring of ongoing research is certainly evidence of that effort.

BY MR. RENTFRO:

Q In your studies and review of the literature in this area, are you aware of any litigation or cases where a utility has actually been held responsible for health -- let's say damage to health by any individual?

MR. BLACK: Are you talking -- I'm going to object. That's a very vague question because I don't know if he's referring to a transmission line health effect or some other effect that that utility would be responsible for.

MR. RENTFRO: Let me be a little more specific. I had in mind the specific case of Mr. Winfred

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Higgins in New York.

Also, I think this had to do with the New York Public -- I can't remember all of the name in total.

BY MR. RENTFRO:

Q Are you familiar with that particular case?

A The only familiarity with that particular case was in reading, I believe, a deposition that you had stated; and there was reference to a Mr. Higgins. I think it was in Pennsylvania.

I tried to find -- within the time period that I saw that -- anything more specific about the case, but I was not able to ascertain any data besides just that there supposedly was a hearing on the issue of the health effects.

Q All right.

On page seven you mention, "(e)lectromagnetic fields may result in other potential biological effects of humans," which I assume is "on humans." Is that correct?

A Yes.

Q What are these potential biological effects that you had in mind?

MR. BLACK: I object. That's asked and answered on page seven.

"There are two other potential sources of

5-8

biological effects" -- Oh, excuse me. I'm reading this wrong.

No, go ahead. I withdraw my objection.

THE WITNESS: I'll have to go back and see what ...

Generally ... actually the following sentence does explain it a little bit better.

Besides the shock hazard which I discussed in my testimony prior to that, the other effect -- the other prime effect -- or potential effect would be long term chronic exposure.

And some of the experiments which I then discuss in terms of recent animal studies would show that there possibly could be some effects being shown in animals to field levels equivalent to transmission line electric field gradients.

The other effects would be, as I mention there, the ozone -- the generation of ozone. And that is another -- ozone ... generation of ozone. And there is definitely a definitive literature on hazardous human health problems associated with levels of ozone exceeding a specific level.

EPA has a particular primary health standard on that, which is 120 parts per million.

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BY MR. RENTFRO:

Q I accept your answer more as information about the sources rather than the biological effects, much as one might say if you were asked -- well, is the analogy that I --

The only one I can think of ... let's say that you're asking about fish -- Well, the ocean is a source of fish, but it is not a fish. And the source of the biological effect may be ozone or electric fields, but I don't believe it's an effect.

MR. BLACK: I'm going to object. I knew that the biological effects were somewhere in this testimony. It's listed on page ten.

It's in specific response to the question: "What are the biological effects to humans ...?"

It's listed in that answer. So I object as asked and answered.

MR. NEWMAN: I just might add to that that the witness is -- Contrary to what Mr. Rentfro said, the witness just referred to the testimony that is, in fact, on page ten, the first full answer talks about the statistically significant effects.

And he has just mentioned that some of them have been observed in fields similar to those fields which exist under transmission lines.

5-10

So it has clearly been asked and answered.

MR. RENTFRO: I read on page ten --

JUDGE WOLFE: That was the substance of Mr. Black's comment, Mr. Newman.

MR. RENTFRO: Well, I read --

JUDGE WOLFE: No, just a moment.

MR. NEWMAN: No, my comment really ... was partially addressed to asked and answered.

The other part of my comment was addressed to Mr. Rentfro's assertion that the effects had not been discussed in the answer that was given to his question, when, in fact, those effects had been described by the witness.

JUDGE WOLFE: Yes, Mr. Rentfro.

MR. RENTFRO: Well, let's back up a minute.

On page ten you're referring to, as I read it from the record and the testimony, "Current research has produced statistically significant effects in the areas of neonatal development, endrocrinology, hematology, neurophysiology, neurochemistry, urine volume and chemistry, sympathetic nervous system, and behavior in tests on mice and rats."

And the other ... on page seven we're talking about other potential biological effects. And if he wants to limit it to those that are mentioned on page ten, that is acceptable to me. But I don't think it meets

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the definition of "other."

(Bench conference.)

MR. RENTFRO: Could I say one more thing?

JUDGE WOLFE: All right.

MR. RENTFRO: It might clarify it a little more. What I'm looking at here is on page ten, I am reading it to say that these are areas that have been looked at and produced statistically significant effects.

And back on page seven, I see that we're talking about "may result in other potential biological effects."

I differentiate between things that we've already done statistical research on and other potential biological effects specifically.

JUDGE LINENBERGER: I think things are getting intertwined in a difficult way to separate here.

In the first place, one has to talk about whether we're dealing with effects resulting from the kinds of field gradients and currents that will be experienced around and under a transmission line, versus the kinds of things that are talked about on page ten where much of the -- or a significant portion of the research seems to have been done at field gradients higher than would have been -- than would be counted beneath a transmission line.

Why don't we keep those separate for the moment.

5-12

Let's stick with page seven. That's a suggestion to you, sir. You can do what you want obviously.

But why don't we stick with page seven for the moment, if you're not satisfied about the ozone consideration ... deal with that and then ... because there is ozone generated around a transmission line. Or maybe you have no problems there, I don't know.

But --

MR. RENTFRO: I guess where I'm having the problem is that we're talking about biological effects -- other potential biological effects. And I see those differently ... as the source, such as the ozone or the electromagnetic field.

The fact that you're in an electromagnetic field ... the effect is ... well, you're in an electromagnetic field. I think there are other -- there's a difference.

As I said, the effect is ... to me -- the only thing I could mention ... trying to determine source from effect --

MR. BLACK: Well, I --

MR. RENTFRO: -- Fish comes from the ocean, but the ocean isn't a fish.

MR. BLACK: Judge Linenberger clarified things in my mind. And I would only point out that the other

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potential biological effects from these fields that we're looking at underneath the transmission line and what ... obviously Mr. Rentfro was correct that one of the other sources was the corona effect.

But the actual biological or health effects is responded to on page eight ... the top of page eight.

And so I would object to that as being asked and answered.

The sources there, and he says the biological effect is insignificant or nondetectable.

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MR. RENTFRO: What's insignificant or non-detectable?

MR. NEWMAN: Is that a question now pending?

MR. RENTFRO: Well, he wants to know --

JUDGE WOLFE: We're still on the previous question and the previous objection to it.

The previous objection, as I understood it, was from Mr. Black that the question posed had been answered at page ten, I thought you said.

MR. BLACK: No, I'm withdrawing that objection. I think his specific question --

JUDGE WOLFE: You're withdrawing that objection -

MR. BLACK: Right.

But we have a rephrased question is my understanding, which I believe he's asking now, what are the biological effects from corona discharge and the generation of ozone.

If that is his rephrased question, I believe that's asked and answered on page eight.

MR. RENTFRO: That was not my question, or my rephrased question.

My question was, he was asked -- in an answer --

My question was: Are there any other possible harmful effects to humans, other than shock hazards or

5-15

electromagnetic fields.

And the answer was: "Yes, electromagnetic fields may result in other potential biological effects" -- "of" corrected to read "on humans."

And my question was: Can you identify any of the other potential biological effects herein mentioned, not as separate from their sources.

MR. NEWMAN: Mr. Chairman, this is getting -- I'm going to object to that.

This is totally out of hand now. I don't believe Mr. Rentfro understands the sequence of testimony. The testimony asked the question: Are there electromagnetic effects -- or health effects resulting from electromagnetic discharges.

Then the question was: What are are the source of those discharges? And the two sources are identified.

And quite specifically, between pages seven and ten, the biological effects of each of the principal sources are discussed.

And that's the scope of the testimony. I don't know of any other biological effects that are discussed by this witness. Any other biological effects, to the best of my knowledge would be outside the scope of this testimony.

MR. RENTFRO: That's all very interesting.

5-16

But it still does not in any way address what the witness has said on page seven that, "Yes, electromagnetic fields may result in other potential biological effects on humans."

I'm very aware that there are many sources. Dr. Michaelson went to great detail to enumerate all of the sources that can cause stress, headache, nausea ... all of the things that were mentioned.

And those are -- to me you're talking about corona and the field itself, yes, I agree one hundred percent that those are possible sources that contribute or possibly are responsible for the effects.

But I do not understand how they can be effects.

Ozone is not a health effect. Ozone is an identifiable chemical --

MR. NEWMAN: Mr. Chairman, that happens to be a good case in point.

That exact question is answered at the top of page eight.

"Thus, if ozone is produced, it should not result in any significant or detectable health effect."

Okay. Now is that the answer to the question on ozone, or is there some other question relating to ozone?

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MR. RENTFRO: No, you're simply stating that ozone is not responsible for any effect. I haven't said that it was or it wasn't. I just was reading from the witness' testimony that there may be other potential biological effects.

I was curious as to what their identity was. That has nothing to do with ozone, corona effect or the other physical happenings around the line.

These are effects that I believe to be in the -- within the person or operating on the function of the person, not the ozone itself, or not the electromagnetic field itself.

JUDGE LINENBERGER: All right, sir; but the effects have to do with many things. The transmission line produces ozone which, in turn, has an effect on people; and that is the first of these other effects the witness seems to be addressing in his testimony -- the effect of ozone on people.

He looks at that and comes to the conclusion that with respect to a real world transmission line, there's not going to be enough ozone to have an effect on people.

And then he goes on to talk about other kinds of effects. Let's get them out of the way one at a time.

Are you satisfied with his conclusion about

5-18

ozone not having an effect on people?

And if you're not, then ask him about it.

Ozone produces effects. Electromagnetic fields produce effects.

MR. RENTFRO: I agree one hundred percent.

JUDGE LINENBERGER: So let's go through them.

The first one he picked to discuss was the effect of ozone. He didn't call ozone an effect. He said it is a cause, and then he proceeds to treat it.

And then he goes on to others ... getting around to page ten where he talks about still more.

But the first one was ozone. Now do you have a problem with his treatment of ozone and its effect on people?

MR. RENTFRO: I have no problem with the idea of ozone as a source that can -- of an effect. All I'm saying is that --

JUDGE LINENBERGER: Now wait a minute. Excuse me.

You're not answering my question. I said, "Do you have a problem with his conclusion that ozone as a causal agent does not produce important effects in people?"

MR. RENTFRO: Yes, I do.

JUDGE LINENBERGER: Then ask him about that,

5-19

and let's get ozone out of the way so we can go on to some of the others, because he discusses others ... sources of these other effects that you're talking about.

JUDGE CHEATUM: May I try to "intuit" Mr. Rentfro's problem.

I think that Mr. Rentfro is not satisfied with the conventional definition of "effect," such as can be described as endrocrinal, hormonal, pathalogical -- that can be measured; but, rather, going beyond that ... effects which have some subtleties in upsetting the sympathetic nervous system in ways which may affect the psyche of the individuals, but which may not be measured in ordinary medical terms or ... Is that right, Mr. Rentfro?

Because I think I understood this sort of concern of yours, when you brought up your cross-examination of Dr. Michaelson.

Isn't that true?

MR. RENTFRO: You're correct in that assumption, sir.

The point that I was trying to bring out here, and I have a very ... you know, significant concern about it is that, yes, there are measurable effects; that they apparently have been demonstrated statistically; and there are other effects which are often referred to

as a functional type effect.

And I was curious to know if in other potential biological effects, these perhaps were considered. And apparently, Staff and Applicant would like to believe that he limits "other" to being synonymous with those on page ten, and perhaps they're right.

But I think we need to clarify that.

MR. BLACK: I have no objection now to the witness responding to that. Many times -- it's bad that this has to happen.

But many times objections are taken because of a certain way the question is phrased. But I understand what your concerns are now, and I believe the witness should respond to those.

THE WITNESS: I'm not sure if I understand.

I was trying to understand what Mr. Rentfro wanted.

And I'm not sure if this is going to be responsive; so please tell me.

In discussing ozone, I may have made a mistake by the assumption that the well-established clinical pathology dealing with ozone was known by everyone. And I did not discuss that, which means exactly -- I did not describe the types of clinical parameters one would expect under high exposures or any type of exposures to ozone.

5-21

But certainly what I meant to say is that the other potential biological effects would be, if I had enumerated the ozone biological, pathological parameters that should have been in there -- and that's what I meant as one type of potential biological effect, that the ozone results in certain classical symptoms of pathologies to biological humans.

I'm not sure if -- and it is not in my testimony. I was assuming -- or I did assume that because the Primary and Secondary National Air Quality Standards cover in detail the symptomologies of ozone illnesses, that I did not include it here.

I guess I assumed that in fact the word "ozone" would generate some sort of train of thought. And, therefore, I just discussed, in fact, the source; and that the source in itself ...

My feeling is that the transmission line will not add anything to the ambient background source of ozone.

Is that being responsive?

MR. RENTFRO: I believe that you ... you know, what yo[illegible] saying is really what you understood.

I was reading it in a different light. I have read the question in a much more general sense, especially, you know -- are there any possible harmful effects to

humans other than shock hazards of electromagnetic fields.

And I think you have narrowed the scope of that to -- of electromagnetic fields -- to the corona effect and the production of ozone.

THE WITNESS: It is one theory and then on page ten, I also describe the other area which is sort of the ... again as a source. We start out as a source.

-- the long-term or chronic exposures to electric fields themselves, which is discussed in page ten.

The answer in page seven says "may result in other potential biological effects on humans," as corrected.

Page ten says what are the biological effects to humans as a result of exposure to electric fields.

That's to differentiate the discussion on ozone.

If you read the answer though, that question does not imply that I'm saying that there are definite effects to humans; that, in fact, my opinion is that at this age there are not any biological effects of significant health hazards.

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5-23

BY MR. RENTFRO:

Q Okay.

I also agree with Dr. Michaelson's differentiation of effects versus hazard. There are some known benefits that are -- let's say, some known effects -- in some of Dr. Marino's work that were deemed to be quite positive in dealing with the processes in a controlled environment.

I really wasn't asking you to say that -- to make a judgment on the health effect. I was just curious about some of the other effects that you thought were potentially there other than those enumerated on ten.

If you know of no others --

A At this stage I know of no others.

Q I see.

Well, let's talk about the corona effect a little bit. Could you give us your -- or could you give me a definition or -- how does the corona effect create ozone in the engineering sense?

A Well, not being an engineer, I'm going to be a little bit vague on this. But my understanding is that the corona itself is essentially a resultant of a breakdown of air -- of ions in the air.

This is caused primarily due to imperfections along the conductor or the wire. It happens on all

transmission lines.

My understanding in an engineering sense is that it's one of the prime areas for designing a line, which I never really realized before, that a line like a 345 kV line can in fact be energized above that particular level; that, theoretically one could energize a line significantly higher than the voltage class.

The reason it isn't done is because of corona, that you increase the corona based on the size class of the lines substantially as you go over that line.

An increase in corona, spark discharges ... will cause a decrease in insulation and just cause generally an increase in flashovers and the reliability of the line is therefore decreased.

Corona, therefore, is present in all lines. It can be caused again by imperfections in the line. It can be caused by, as was discussed, I believe, yesterday about bird droppings.

It can be caused by a variety of factors. But when you have corona, then you will get a variety of other associated problems that are associated with the production of corona, such as ozone production.

Q You mentioned -- you described it as a breakdown of the air around it. Do you get any other elements during this breakdown process that we might look at? Or

5-25

have you looked at any of the other elements as a --

A That is my definition of what corona is. Because you have corona and you have the generation of sparking and arcing, you will get not only the production of ozone; but you could possibly get production of noise because of the sparking/arcing conditions of the line.

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Q Are you familiar with a paper called Environmental Problems in Extra-High Voltage Transmission" by Louise B. Young?

A I have not read that paper.

Q I would like to read just an exerpt out of it.

It is basically the chemical products of corona discharge.

And I would like to know if this agrees with your understanding.

"All EHV transmission lines create varying degrees of corona discharge. The amount depending upon design of the lines, voltage surface of the conductors and weather conditions. Electrical breakdown of air causes a variety of chemical changes which lead to the production of reactive chemicals such as ozone, nitrogen oxides, hydroxal radicals, single oxygen.

"Of these ozone is thought to be the most important product.

"Over the past few years a number of field investigations of ozone levels under 765 kV lines have been made which have shown no appreciable increase over ambient ozone levels."

To me that indicates there are -- there is ozone that is not perceived as a big problem.

Is that your understanding as the current

6-2
cf

state of thinking?

A It is my understanding through having worked on this issue for like 6 or 7 years now, that as we go down the road in terms of further research, that the actual ozone measurements versus theoretical calculations, but the actual measurements beneath the line are, in fact, insignificant.

Q I would like to go on and read from another paper from Louise B. Young, that seems fairly objective based on that.

This one is called "ON Effects of Extremely High Voltage Transmission Line."

MR. BLACK: Can you identify that document for the record? Where is it from? Where was it published, what year?

MR. RENTFRO: Let's see.

It says the article was published in response to the request of the Environmental Protection Agency for information on on environmental effects of extremely high voltage transmission lines as published in the Federal Register, March 18, 1975.

I am forwarding a copy of an article from the Bulletin of the Atomic Scientist of which I was co-author.

It does not give a date.

6-3
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MR. BLACK: May I ask, is the witness aware of that document?

THE WITNESS: I haven't read this specific document.

BY MR. RENTFRO:

Q The part of it that I would like your comment on is --

MR. BLACK: Mr. Chairman, I'm going to object to the question even before it is -- it comes out. The witness has indicated that he is not familiar with the document. A matter is now being extracted without any knowledge of the context in which it exists and the opinion or the response to the question can't possibly be of meaningful value to the record.

MR. RENTFRO: As I said before, that is very interesting, but I don't see how you could say that until, at least all I am doing is asking his opinion of the validity of the comment.

I'm not asking that he verify it or that he put out any supporting data or research.

JUDGE WOLFE: I'm just not certain.

Has the authenticity of the commentator even been established at this point is my concern.

I'm trying to follow your description there. All that I know is that what you proposed to read from is

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from some comment made by someone attached to what -- an article or whatever of some other person.

I'm just not certain that this is the proper way of going about it.

Would you describe in detail more of what you are reading from at this point, or would like to read from, Mr. Rentfro.

MR. RENTFRO: An article entitled On Effects of Extremely High Voltage Transmission by Louise B. Young.

JUDGE WOLFE: You wish to read directly from her article, then? Is that correct?

MR. RENTFRO: Yes.

And, he asked, you know, about where it was published and the date. I presume that is what Mr. Black wanted, you know, for identifying information.

The best I could do was that it was published in the Bulletin of Atomic Scientist.

JUDGE CHEATUM: Mr. Rentfro, is that actually the publication you have in hand or have you just --

MR. RENTFRO: No. Just a copy of the article. Not the Bulletin of the Atomic Scientist.

That apparently is a scientific publication that this article was published in.

(Bench Conference)

6-5

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JUDGE WOLFE: Mr. Gears, you said that you had not read this article at any time?

THE WITNESS: No. I haven't.

MR. BLACK: Judge Wolfe, that does appear to present a problem. I think we allowed it the first time around, but it is a problem if they are reading an extract from a paper that a witness has no familiarity with and asked to comment on a particular extract.

If the witness has no familiarity with either the author or the document itself, it would be very difficult to offer a comment on a specific extract without reading the whole document and placing that extract in context.

So, really, Mr. Gears' comment on a specific extract from a paper really has no weight and is probably just a futile effort at this point.

Not unless that specific extract is just a one sentence statement and the witness is asked whether he agrees or disagrees with that statement --

JUDGE WOLFE: Well, we still don't know what the question is going to be.

It may be just a single sentence question.

MR. BLACK: I have a feeling that the extract is very long.

(Laughter)

6-6
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That's why I'm very --

MR. RENTFRO: If you are worried about the physical length of time, it is ten lines.

MR. NEWMAN: How long is this article that you are reading from?

MR. RENTFRO: The article itself is about 14 pages.

This has -- The article covers other things but it has a section specifically addressing corona effect and it -- I just read an article from -- her previous article before and I am not so much interested in this as an adversary-type proceeding.

I'm interested in getting some information and furthering my own knowledge.

I perceive that this could be of help to me in the future and, if this gentlement is an expert witness, then I intend to try to avail myself of his expertise.

MR. NEWMAN: Mr. Chairman, I think that there is, indeed, a legitimate objective in finding -- in educating oneself on a matter of concern to oneself, but that isn't done in the context of an adversary trial proceeding on specific issues.

He can consult with the witness at any time during a break, during any time the witness is around

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here and get all the information that he wants without the constraints of the legal process or the objections of other lawyers.

I think he can get more information, frankly, if that is what he is looking for, just in direct conversation with the witness.

MR. DOHERTY: Your Honor?

JUDGE WOLFE: Yes.

MR. DOHERTY: I think Mr. Rentfro has by filing you know, established himself as an adversarial party to this. I think that he probably just stated maybe was, perhaps, a misstatement on his part.

That, actually, he does want to get to the bottom of this, and he wants the Board to get to the bottom of this and help him as a private citizen who sees himself living near power lines.

I, also, think since because of the previous rule he has no participation in this hearing except just this one issue. That, if there is doubt with regard to this that ought to weigh in his favor slightly.

That all things considered, it ought to go. So, he ought to be able to do this.

JUDGE WOLFE: Do you know the author of this publication -- of this article?

MR. RENTFRO: I know of Louise Young, and I

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actually have the Citation for this particular document, if that helps.

But, again, I have the Environmental Protection Agency's compulation of all of these documents. And, their interpretation; but I don't have the original sources. But, I do have the article Citation that he is talking about. I have the page numbers, the dates and things. If that does help --

JUDGE WOLFE: Yes. Thank you --

MR. RENTFRO: -- I know Louise B. Young --

JUDGE WOLFE: -- yes.

The authenticity and the established, the recognized expertise of the writer of this article has been established through the witness.

I think I am going to allow the question.

Read your question -- read the portion that you wish the witness to comment upon, Mr. Rentfro.

BY MR. RENTFRO:

Q Talking about the generation of the corona effect and the comment is that, "It is apparent from purely theoretical considerations, that the maximum levels are not likely to occur directly under the line but quite a distance downwind. The ozone being hot when formed, rises and then is blown by the wind reaching ground level at some distance from the line. Even in the

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lightest of winds." And then in parenthesis (about 2 miles per hour.)

"Maximum concentration would occur about 300 feet from the line. Only when the wind blows parallel to the line would it be possible to expect higher levels under the line itself. When the wind is transversed to the line, the maximum concentration is inversely proportional to wind speed. Temperature conversions and very light winds provide most favorable conditions for elevated ozone levels."

JUDGE WOLFE: Now, Mr Rentfro, would you hand that document to the witness and point out to him the exact words that you read off into the transcript so that he will have visual concept rather than auditory accounts as to what was read off.

(Document handed to the witness.)

THE WITNESS: Should I respond now?

JUDGE WOLFE If you are ready. Yes.

THE WITNESS: I think what I had said previous to this was that in connection with ozone, we had been dealing approximately five or six years ago with theoretical calculations, modeling which presented some scenarios that said perhaps upwards to 20 parts per billion ozone concentrations could be achieved.

That in many cases is within what you would

6-10
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find in the ambient atmosphere around the line in a rural area. Sometimes, lines going through urban areas are much in excess of that.

However, when we have done now field measurements to test the theoretical calculations which I believe is what Ms. Young is talking about. In those areas that she is talking about based on wind speed the actual field measurement at ground level, no matter where it is measured, actually, are so minuscule that in many cases they are not detectable.

The detection are approximately one part per billion.

So, in that sense I would disagree with that statement today because of the field experiments that we have had conducted in this area. That field experiments do not contradict the theoretical calculations.

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JUDGE CHEATUM: Do not contradict?

THE WITNESS: They contradict, excuse me.

They contradict the theoretical calculations.

BY MR. RENTFRO:

Q Could you cite any of those field measurement experiences that are the study or way to identify the process of just the study?

A I believe on page 7 of my testimony, essentially, at References 8 and 9 summarize the work of these individuals.

I, also, have each individual report but in for convenience in this testimony I have cited documents that cite the original works.

There are approximately six field tests so far that have been undertaken.

Also, some are undergoing today some further testing in this same area.

But the tests that we had so far show that there is not any significant, or let's say there is negligible impacts or measurements of ozone often times undetectable.

JUDGE LINENBERGER: Mr. Rentfro, I'd like to follow up on that just a moment if you'll permit me, sir. Without in any sense challenging what you have just said, Mr. Gears, is there any reason for challenging the

6-12
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statement of the author that Mr. Rentfro quoted, to the effect that under the circumstances of a wind blowing transversely to a transmission line you would expect to find the maximum of concentration of ozone produced by that line not underneath the line but downwind from the line?

Is there a basis for challenging or disbelieving that aspect of the excerpt?

THE WITNESS: No. Not the premise of the calculations of where one should look. Where the maximum concentrations would be.

JUDGE LINENBERGER: So, nothing that you are familiar with respect to field measurements contradicts that feature of this quotation. Is that correct?

THE WITNESS: I'm not sure if the field measurements actually, in fact, do not contradict that, because it's hard to say.

In several of the experiments no matter -- based on theoretical calculations, monitoring stations were set up and since they did not reach any detectable level it is really hard to say whether the theoretical calculations were, in fact, accurate or not.

JUDGE LINENBERGER: So, would you characterize the field results as neither confirmatory nor contradictory with respect to the downwind maximum

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concentration?

THE WITNESS: I would say the only thing we have seen theoretically that -- that the field measurements have substantiated the theoreticaly considerations, have been, in fact, that the theoretical considerations also say that the closer you are to the source, the higher the levels are.

The closer you are to the conductor, the higher the levels are. In fact, they have shown that. I don't think there is much else that the field measurements have really shown.

They actually were undertaken to not only see what actual field conditions were, but to fine-tune the modeling efforts.

And, in that sense they have failed because the levels haven't been adequate enough to get even any data points of significance.

JUDGE LINENBERGER: Thank you.

BY MR. RENTFRO:

Q Would the field measurements have taken into account that, as far as health effects goes we're talking about people at say one to three meters above the ground or in that spatial plane; and, yes, the ozone concentrations are as I understand it nearest the line. But, do they -- did the field measurements go out any distance or did

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they go under the line or at the line. I don't understand.

A They went -- They were basically ground -- well, they were all sorts of heights.

As I mentioned some of them were actually done at conductor heights.

But, most of them were done at levels that would be associated with an individual or man, say one to three meters in height. And, not only along the right-of-way, beneath the right-of-way, outside the right-of-way. Controls certainly were done outside of the right-of-way.

And, also, in those areas where one, again, the theoretical calculations were predicted to, you know, to give the maximum concentrations.

And, these were not just spot checked field surveys, they were ongoing 24-hour measurements and correlated with wind-speed data, rain data, things like that.

Q Could you tell me the technique used to measure -- to determine, I'm thinking in terms of an instrument, to determine that there is no detectable ozone or there is detectable. Is it a chemical process? How do they analyze this in their metering arrangement?

A The only thing I can say is it is not a

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collection sample, but it is an instantaneous field measurement devise.

Offhand, I can't recall exactly what the basis of the measurement is.

What I am saying is it is not a complex chemical ionizing type of situation, but it is some fairly portable instrumentation equipment. I'm not sure what the principle is for the measurements of ozone.

Q I'm familiar with instruments that measure in parts per million, such as chlorine and other commonly measured chemicals, but they usually use a sampling technique and I'm curious --

A Yes. That's what I was trying to answer your question.

I believe that these measurements are in fact done by instrumentations that are portable, not laboratory bound; and, in fact, do have really -- fairly good specifications at various levels on the order of about one part per billion, I guess, is the detection level.

Now, the air level may be greater than that obviously, you know, five parts per billion I understand.

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BY MR. RENTFRO:

Q In these six field tests, it sounds like you're defining the repeatability as the fact that none of them measured any ozone. Is that correct?

A On page seven ... well, actually on page eight, I do mention that they did measure small amounts of ozone at approximately the height of the transmission line. But at ground level ... they were on the border of detection. I'm not going to say that they were definitely below one part per billion.

But they were within the range of detectability, but certainly it appears from my recall that they were below the ten parts per billion and the five parts per billion.

Q That sounds like a valid criteria for repeatability. I was just curious to know if that was the only one you were using, or if there might be others.

JUDGE WOLFE: Mr. Rentfro, did you have a question out?

MR. RENTFRO: Let me -- Maybe I do.

I was looking to the idea of repeatability, which I understood as the fact that at ground level none of the instruments or the tests detected any significant or measurable or distinguishable amounts of ozone.

Was this, in fact, the only criteria for

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repeatability that was supplied?

In other words, were the instruments different in some of the tests? Were the line voltages different? Were the weather conditions --

THE WITNESS: There were a lot of -- I don't think the six tests should be meant to mean that they all had the same protocol, they all had the same weather conditions or even the instrumentation.

In fact, there were five ... five or six of the tests were fairly different, in terms of voltage classes, weather conditions.

And even in terms of extent, the length of period that actual measurements were done. There was a variety of conditions that were ....

But all I'm saying is that in no case, no matter how the things were done, they still came out with pretty much the same answer. At least the measurements at this time say -- some of those would be on a much higher voltage classification lines than the Allens Creek.

We're talking about 765 lines. Even in those cases, we didn't find -- they didn't find any detectable levels at ground level.

JUDGE WOLFE: Mr. Rentfro, do you have much more cross-examination? We'll recess for lunch if you

7-3

have.

MR. RENTFRO: I do have more, sir.

MR. NEWMAN: Mr. Chairman, before we recess for lunch, we have a number of witnesses who are standing by -- three witnesses who are standing by, two of whom are from out of town.

We would appreciate your consideration perhaps in establishing a shorter lunch period today than normal; perhaps getting back here by 1:30 or so.

And if possible, your consideration in going into later -- early evening, perhaps to 6:30 or 7:00, in order to get these people on and off from out of town.

JUDGE WOLFE: Well, certainly, we'll accommodate you as much as we can.

We will recess then until 1:30.

Insofar as the -- you say there are two witnesses or three?

MR. NEWMAN: Three witnesses, two of whom are from out of town. They're all standing by to testify.

JUDGE WOLFE: Well, we'll make every effort to accommodate them with overtime sessions.

But we'll just have to see how we proceed this afternoon.

That's the best I can indicate to you at this point.

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Who are these two witnesses from out of town?

MR. NEWMAN: It's Mr. Finley and Mr. Schoenberger. Mr. Schoenberger, I believe, has come in from California.

JUDGE LINENBERGER: Were you planning on having Mr. VanSickle this afternoon?

MR. NEWMAN: Yes.

JUDGE LINENBERGER: But Finley and Schoenberger are the particular ones --

MR. NEWMAN: Right. They're from out of town.

JUDGE LINENBERGER: Thank you.

JUDGE WOLFE: We had understood earlier that Messrs. Finley and VanSickle would be the first witnesses --

MR. NEWMAN: I believe it's VanSickle going first, then Finley and then Schoenberger.

JUDGE WOLFE: Yes, Mr. Doherty. Anything?

MR. DOHERTY: I'm just looking alert, sir. I have nothing to say.

(Laughter.)

JUDGE WOLFE: All right.

We'll wait until later this afternoon.

All right. We'll be in recess until 1:30.

(Whereupon, at 12:35 p.m. the hearing was recessed, to reconvene at 1:30 p.m. of the same day.)

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AFTERNOON SESSION

1:32 p.m.

JUDGE WOLFE: The hearing is resumed.

It's now 1:32.

In attendance are Mr. Newman for Applicant; Mr. Black for Staff; Mr. Doherty and Mr. Rentfro.

I have an initial question. My office has advised that I have received a letter from Ms. Hinderstein of some recent date. I don't have a copy of that letter.

MR. NEWMAN: I think we can round one up for you. I think I know the letter that you're referring to. It outlines what her court schedules are during March.

I'll get a copy for you.

JUDGE WOLFE: Secondly, the Board has been conferring over the luncheon hour. And it's our recollection that yesterday, Mr. Newman, you advised that there would be two witnesses taking the stand today, Messrs. Finley -- or Mr. VanSickle first and Mr. Finley second. No mention was made of Mr. Schoenberger.

Therefore, while we do attempt to accommodate out-of-state witnesses, we feel that Mr. Schoenberger, not having been mentioned yesterday as coming in today, that we will not hear him today.

As I say, we try to accommodate out-of-town witnesses, but we have to be advised early enough -- as

well as the other Intervenors -- as well as the Intervenors, as to what the schedule is going to be.

So if we proceed to finish with those two witnesses this afternoon, we'll just recess and begin tomorrow morning with Mr. Schoenberger.

All right.

We'll now resume -- I might point out that in the past we've accommodated out-of-town witnesses where they're on the stand, and they do wish to leave that day. We accommodate them by going into evening session.

This is not the case here.

All right. You may resume your cross-examination, Mr. Rentfro.

MR. RENTFRO: Thank you, Chairman Wolfe.

BY MR. RENTFRO:

Q On page eight where we're talking about the passage of electric current through an unshielded conductor, does the human body approximate an unshielded conductor, in your opinion, Mr. Gears?

A I don't think I can answer that specifically.

Q Would these currents that -- both electric and magnetic -- Well, let's back up a minute.

"The passage of an electric current through any unshielded conductor produces both electric and magnetic fields in the surrounding medium."

7-7

Of course, in the air I think it's obvious. But it's obvious that in a fence or conductor-type object -- metallic especially, there are also fields set up. And my question is: Can we reasonably believe that any currents might be set up in a person?

A Certainly if a person were subjected to an electric field, there's a potential for current to be induced within a person. But it's dependent on the size of the field ... you know, the strength of the field.

Q Yes, sir, I'm sure that would be the case.

You mentioned the effect of electric fields on humans has been and presently still is being studied extensively throughout the world.

We've looked at several of these studies, and my impression was that the majority was ... they were being conducted on small animals, some on rhesus monkeys; and the data ... you know, was transferred through some formula to apply to humans.

Could you elaborate on any studies you're aware of where the direct effect -- or, say, the humans are participating in the study or experiment as subjects?

A To my knowledge there has been no experimentation ... long-term, directly in laboratory conditions on humans. In relating the question to long-term chronic effects, my meaning there was primarily the epidemiological

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studies -- studies involving people who, perhaps because of job-related field conditions were exposed to electric field higher than the normal environment.

We had mentioned before -- given testimony before about the Russian study.

That's one of these particular studies which involve not laboratory conditions, but an epidemiological study.

Q Are any of these studies what -- the exposure -- at an exposure rate that could be called chronic exposure or significantly --

I'm thinking in terms of both time of the day and over a period of time ... a month, say.

A Certainly the Russian study involves a chronic exposure, in terms of long-term ... probably minimally eight hours a day exposure. Long-term may mean up to three months.

Q Continuing on: "For an overhead AC transmission line, the three separate phases create an interference pattern so that the strongest field exists in the area below the outer phases, approximately 20 to 60 feet from the centerline."

Then: "The field drops off moderately as one moves closer to the centerline, and falls off rapidly as one moves further away from the facility."

7-9

Then skipping a couple of lines: "(t)he field drops off to about 1.6 kV/m at the edge of right-of-way."

What width right-of-way did you envision in that case?

A That was my standard 345 kV design, which had a right-of-way of 150 feet.

Q 150-foot right-of-way.

A Total width.

Q And presuming the line would be essentially in the center?

A Yes.

Q "The maximum calculated magnetic profile at 1.5 m above the ground is about .6 G (gauss)."

What would you estimate that it would be -- using the same calculation at, say, three or five meters above the ground?

A Perhaps a gauss, one gauss.

Q At the bottom of the page the question is basically: "Are any harmful biological effects expected from magnetic fields under transmission lines?"

A "no" is essentially your answer.

Are there any effects, period? If we don't have to judge them as being harmful, neutral or otherwise.

7-10

A I believe the following sentence says that there are some safety standards that talk about -- around the 200 to 300 gauss level.

Those are based on biological harmful effects.

Q Would -- Going to --

JUDGE WOLFE: Excuse me, Mr. Rentfro.

I would advise for the record that Mr. Scott has made his appearance at 1:42 p.m.

All right, Mr. Rentfro.

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BY MR. RENTFRO:

Q When you speak of the biological effects at the much higher level, would those be essentially the ones that we looked at on page ten earlier; or would there be any others?

A Page ten deals primarily with electric fields, and page nine deals primarily with magnetic fields.

And magnetic fields, if I recall, there are different effects. I'm not sure offhand precisely what type of clinical effects have been established, but I would answer that question that there are possible different effects between the magnetic fields and electric fields.

Q I suppose -- Well, I hate to belabor the point. But then can we say at this point that we really don't know the precise biological effects associated with magnetic fields?

A No, I think at this point we can be fairly certain that there are in fact at the levels beneath the transmission line, that we will not see any measureable, detectable, perceivable effects.

Q I'm looking for a definition of "effects." I would find it hard to develop a criteria for measurement of that -- any particular effect until I have -- I understood what effect I was looking for.

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A Well, in terms of the magnetic field, there's a fair amount of literature and data in this area. And that safety guideline that we're talking about is considerably below the threshold of any minute detectable clinical symptoms that have been found.

What I'm saying is that, in fact, of all the evidence we have to date with magnetic fields, nothing has been detected at the 200 to 300 gauss level.

In fact, the detections are much higher. And then the level of detection is again -- the effects appear to be fairly miniscule.

With the transmission line we're talking about less than one gauss. So it's my opinion that we will not see any effects whatsoever from the 345 kV line from magnetic fields.

Q I noticed on this you referred to long periods of time. Would the three-month period that you expressed earlier be appropriate in that context?

A I believe in the magnetic literature ... data ... that there are many experiments that deal in terms of years, instead of months.

Q Are you aware of any specific study that could better define, you know, the period of exposure for magnetic field at these levels?

A Any particular reference besides the one I

7-13

cited or --

Q Is the -- Am I understanding correctly that the one that you're citing is the Russian experiment?

A No. The citation I give includes a massive amount of literature research on the fields ... of magnetic fields and it's not just the Russian data.

In fact, it incorporates most of what is called the Seafare Studies, which were done on a variety of magnetic fields.

It incorporates vast literature on this area.

Q At this point we go into your comments on the Russian study. I believe in Footnote 12 you make reference to one Russian study.

Do you feel that there is any measurable validity to the Russian research or safety standards as published?

MR. BLACK: Objection. I believe that was asked and answered in response to Mr. Newman's question. He talked generally about the Russian studies and the protocol and what would be done in the future through the Interagency Task Force.

MR. NEWMAN: That is correct.

(Bench conference.)

JUDGE WOLFE: The question is worded differently

7-1

than from prior questions. The witness may answer.

Objection overruled.

THE WITNESS: I'm going to have to ask for the question, or if you can ...

BY MR. RENTFRO:

Q The question basically was -- and I'll go into a little more detail --

Mr. Newman, I believe, discussed lack of control and what have you ... other things that he felt were of significant impact on the experiments.

But we all, I think, are aware of those -- I'm asking you do you feel that in light of ... you know, with all of this considered, that there is still validity to the Russian research or safety standards?

A The particular research that we're talking about in eleven in the safety standards ... at least the research I have serious doubts about the validity. I can't question the validity of the standards. They are in fact standards.

I mean they do in fact exist.

By the way, they exist for substation workers. They don't exist for the general population. They're not standards meant for the general population ... agricultural workers, people like that.

Q Well, how do these standards compare to the

7-15

U. S. standards for similar circumstances?

A Well, first of all, the U. S. doesn't have any standards. That's the major area.

The Russian standards are based on limiting field strengths. And the United States at this point does not have any limits on -- precise guidelines for field strengths.

We're talking about kilovolts per meter. But generally, the limitations on field strengths for the Russians are essentially the same as what we have beneath our lines today.

In other words, none of our lines in the United States would in fact exceed any of their standards. In fact, they're below the standards.

Q The part that I thought was significant about the standards was the limitation on the exposure rates to the U. S. standards --

A No, they don't. Those time-dependent limitations on exposures are there in the Russian standards for substation workers and people working in a professional -- an occupational environment.

They do have separate standards for the general population.

Q I noticed in your professional qualifications that you had Bachelor of Arts and Sciences in German and

Russian from Villanova University.

Have you ever read any of these studies, uninterpreted versions?

A Not in Russian, no.

Q In reference to the paper by -- I believe it's Dumanskiy, D-u-m-a-n-s-k-i-y -- "(s)cates that laboratory test animals (albino rats) undergo changes in behavioral reactions when subjected to fields in the range of only 1 to 5 kV/meter."

This sounds like it could be a more -- there could be more opportunity to protocol or structure, since it appears to be a laboratory situation.

Do the Russian standards, or lack of standards, go into this area? I mean, are they lacking in this area also?

A I guess I don't understand your question.

Q All right.

The previous Russian data appears to be subject to being discredited because of lack of protocol, ways that they expressed themselves. I think Dr. Michaelson indicated their -- I can't remember the exact wording that he used -- but idiosyncratic vocabulary, mixing of empirical observations with other data.

And my understanding was that that especially -- he thought was especially true in the study

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concerning the workers in the power plant environment.

I am -- My question is: If you're in a laboratory situation here, do the U. S. experts hold that their laboratory criterion and protocol are also invalid?

A. I believe I answered this morning ... I think I generally stated that it's the opinion, at least that this study, had much better protocol; but there was still a fair amount of uncertainty.

And this is one of the areas that is being pursued to try to get an equivalent American counterpart to work with Dumanskiy at his laboratory to monitor this particular experiment.

Q. This experiment appears quite similar to Dr. Marino's experiment, and I believe the one that he's going to redo under the -- your auspices. Is that correct? Or is there --

A. I think you could generally characterize it as that, yes.

Q. If we applied the standard translation ... you know, where we scale them to man on page ten, what kind of a value would we expect to see in that area? I'm just thinking in terms of the scaling, not whether it's valid or invalid.

A. What were the scaling factors used?

Q Not -- Well, apparently, there is mention on page ten ... it says, "These effects were found at field strengths scaled to man of about 4-20 kV/m."

And if we scaled this one to five-kilovolt per meter on the albino rats to man, what value would you estimate?

A Well, just off the top of my head, it would certainly be less than one kV per meter. You know, scaling factors are anywhere from five to one to 12 to 1, so a quarter of a kilovolt per meter ... you know, to a kilovolt ... one kilovolt per meter.

All of the values would be - in fact -- if this were accurate data, would be in fact one kV per meter or below.

Q In the current research that is being funded, and apparently underway -- I'm speaking of this where you refer to the Federal Interagency Advisory Committee -- do you have any feel for when the study that would approximate this Dumanskiy study might be available?

A Not the particular Dumanskiy replication. But if we assume that the Marino experiment is equivalent or close to it, I do have a schedule -- approximate schedule for Dr. Marino's research. I mean, at least it's underway now.

And preliminary findings are scheduled within

7-19

a year.

Q I'm still curious about the scaling technique to get us from animal research to making -- drawing some conclusion about effects on man.

Could you attempt to explain that to me or what ... how that would go about?

A Well, it's basically a laboratory technique that one attempts to -- There's a variety of ways of doing it.

One of the attempts is to make actual clay models of a man versus clay models of the actual laboratory animal.

The Southwest Research Institute, for example, is doing a baboon study where they're doing a clay model of the baboon in different configurations and a clay model of the man, putting these models within a test chamber for various fields.

And then they have a micro -- a mini-probe electric field measurement device, and then doing it at various spots -- various spots throughout the body, to calculate the actual field measurements, the actual perturbation.

And that's still being undertaken.

The original calculations were based on theoretical calculations. And now we have a little bit

better definitive calculations.

Q It is a modeling technique then?

A It's a clay modeling technique, yes.

Q Right.

"Current research has produced statistically significant effects in the areas"--and then we get into the biological effects that are obviously measurable.

I guess I keep coming -- Is Dr. Marino's study ... the primary thrust -- of looking at any other potential effects?

A I think the current research that I'm talking about not only expands on Dr. Marino's study, but is much more inclusive, much more extensive and, in fact, his research has shown that there are some statistically significant effects after several replications of the same experiment; in fact, two years in a row, to make sure.

They are still coming up with some areas that have statistically significant effects.

I think -- My opinion is that this research is much more extensive ... much more rigorous than Dr. Marino, much more inclusive of all parameters.

Q Okay.

On the research by R. D. Philips, is this generally replicated in other studies? Have there been a series of this type?

7-21

A. This experiment -- These groups of experiments have not been replicated on the same laboratory test animals. The cost of this experiment is extremely expensive, in the millions and millions of dollars.

And DOE is funding this. What has happened is that another group of experiments have been done, looking at the same type of parameters, but on a different animal -- in this case, baboon.

Those are being undertaken at Southwest Research Institute, again looking at pretty much the same parameters, but on a different laboratory animal.

Q. You mention the 4 to 20 kilovolt per meter field strength is typical of the maximum values measured near the ground under 345-745 kV transmission lines.

Could we limit -- Could you give us a feel for the 345? I presume it would be -- that would cut out some of the top end of the range. Is that correct?

A. I discussed that this morning. The value is somewhere between six and eight kilovolts per meter.

Q. On page 11 you were talking about the New York State Public Service Commission hearings. Are you familiar with the testimony of Dr. R. O. Becker?

A. I've read, I think, all of the testimony given at that hearing at one time. And I think -- I certainly have read Dr. Becker's testimony.

7-22

Q Are you familiar with any of the more than 70 scientific papers published by Dr. Becker referenced in his testimony?

A I did see the reference, and I did attempt to read those particular studies that I thought were directly related to electric fields underneath the transmission lines.

I believe there were actually none.

Q In your opinion, would Dr. Becker's position as director of the orthopedic biophysics lab at Syracuse VA Hospital in upstate New York ... Medical Center indicate a knowledge of acceptable, scientific test procedures and parameters for evaluating or assigning -- not assigning -- but, let's say, commenting on laboratory experiments?

MR. NEWMAN: Your Honor, I would object to that question.

It's too vague to have a meaningful response for the record.

MR. RENTFRO: Let me rephrase it.

BY MR. RENTFRO:

Q I'm looking for an indication that Dr. R. O. Becker may in fact know -- have a working knowledge of laboratory procedures and the parameters that constitute valid experimental procedures or collection of data.

7-23

JUDGE LINENBERGER: Excuse me, Mr. Rentfro. I thought I just heard you make a statement. But I don't think I heard a question.

MR. RENTFRO: The question, I thought, was objected to by Applicant's counsel.

JUDGE LINENBERGER: Then you said you would rephrase it. And after saying you would rephrase it, you made a statement. But I have not heard a rephrased question.

If you did rephrase it, I'm sorry, I just didn't hear it.

MR. RENTFRO: No, I don't think I did.

BY MR. RENTFRO:

Q My question is: Do you -- Would the professional experience of Dr. Becker indicate that he is generally as qualified -- is generally qualified to conduct or evaluate experiments in the field of biological effects related to magnetic or electric fields?

A Yes.

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8-1

BY MR. RENTFRO:

Q I have here a copy of Dr. Becker's testimony before the State of New York Public Service Commission, Cases 26-529 and 26-559.

On page -- Are you familiar with that document?

A I'm familiar with the document. I have not read the -- There was 14,000 pages of testimony in this hearing.

And as I say, I think I once attempted to go through everything.

And all I can say is I probably read it once ... many years ago.

Q To refresh your memory I would like to read from page nine: "To sum up from the viewpoint of possible medical significance, the literature reports represent a solid body of data indicating that living organisms are influenced by the ELF fields and that such effects are likely to occur in the areas of growth, both cellular and of the total organism, and in the function of the central nervous system and the cardiovascular system. Obviously, to answer a specific question such as the effects of various field strengths of 60 hertz upon the variable human population will require specific laboratory experimentation. These answers are not available at this

8-2

time."

Do you agree with that supposition?

A I think it's clear from my testimony that I generally agree that we do in fact have some ways to go still in this area, and that the ongoing research is not definitive one way or the other.

Q Do you believe that -- This is again from Dr. Becker's testimony. And it has to do with the case as referenced.

And the question posed to him was: Would it be unsafe to permit people to occupy residences within 329 feet of the centerline of the proposed lines if the electric field within the residence was less than 1.5 volts per centimeter.

We should remember there that is a larger line; that's 750, I guess.

His answer was: "We cannot answer this question at this time, not knowing the effects of chronic exposure to fields lower than we have employed in our experiments to date."

Is there any possibility of 1.5 volts per centimeter -- I don't understand --

Well, in your opinion, does 1.5 volts per centimeter over a long term, or chronic exposure, represent a hazard?

8-3

A. Based on the review -- on the data that I've seen and the current research, 1.5 volts per centimeter, which is equivalent, I guess, to 1.5 kV per meter, would not pose any significant health effects on humans.

Q. On page 11 again of your testimony, you say: "Based on the foregoing facts" -- which, I presume -- this was right after the comments of the New York State Public Service Commission hearings -- "it is my opinion that there is no evidence at this time that the operation of 345 kV power lines will have a significant effect on the health of humans."

I guess -- Could you tell me if, in your opinion, there is any credible evidence available at this time which might give any effects at all, disregarding the level of significance you assign?

MR. BLACK: That question, at least to me, was vague. He said "give any effects at all." Above a significance level?

Well, I'll permit the witness to respond, if he understands.

MR. RENTFRO: I'll rephrase --

JUDGE WOLFE: You mean you won't object?

MR. BLACK: I won't [illegible].

JUDGE CHEATUM: [illegible] the witness probably understood your question.

8-4

THE WITNESS: I think I stated essentially the answer to that on page ten where I'm saying that at least in terms of the animal health studies that we have to date, which are being used to model possible or potential effects for humans, that, yes, there are some significantly-- statistically significant effects.

My point is that at this point there's no clear indication that they would pose significant health effects.

But there are some statistical effects being seen.

BY MR. RENTFRO:

Q You further state: "If ongoing research were to conclude that protective measures were warranted, a variety of actions could be considered including, but not limited to: increasing the width of right-of-way to limit the field strengths to which the public would be exposed ... specific warnings of possible risks ... shield wires ...." There's a whole list of them here.

What would you consider a necessary result from ongoing research to trigger consideration of using some of these, apparently protective measures?

A I think I generally discussed that this morning.

I think that the way I, as an individual -- or

8-5

at least my responsibility on the Interagency Advisory Committee would in fact be in consultation with the other federal agencies, especially those who at this time I believe would have the responsibility to set levels, primarily EPA or OSHA. - Based on their findings and their recommendations, the NRC would then, in fact -- I guess -- look at the recommendations and take some sort of action if we felt it was required.

I'm only saying that at this point my response would be as part of the Interagency Advisory Committee and a group concensus.

JUDGE CHEATUM: Mr. Gears, I don't believe you answered his question.

THE WITNESS: Okay. Maybe I misunderstood --

JUDGE CHEATUM: Because you didn't indicate what kind of results might trigger these protective measures.

In other words, what kind of data might come from the research which is ongoing, which might trigger the implementation of greater protective measures?

THE WITNESS: Well, certainly the most obvious one would be anything that dealt with lethal doses or death of animals in a statistically significant fact.

I guess that is really what I wasn't thinking and addressing. It's not clear in my mind, because of the

8-6

way these experiments are going that subtle effects -- how we are going to react to a continuation of subtle effects and what sort of reaction will be taken.

It's certainly clear to me that if we had -- if we were talking about mortality or lethal doses, that was a very clear perception that we would take some sort of action as a group. And that's the type of data one prescribed, easy, simple method of handling that problem.

Lethal doses ... toxicities and threshold levels -- prescribed threshold levels.

I hope I'm responsive to that.

BY MR. RENTFRO:

Q You aren't getting quite what I want. I really think it's probably unanswerable. I think the data that as it develops, you almost are going to have to evaluate the potential for harm of the data as a part of the -- but I accept your answer.

One question that I have: We often are exposed to news about what certain government agencies do as protective or preventive measures, like the FDA monitors foods and drugs ... this type of thing.

They have a standard normally that they use of perceived or potential harm that might come. Is there anything at all in the mechanism that we are using to

8-7

look at the nuclear power industry that would approximate the ... let's call it the prudent, reasonable thing? Or maybe that's the whole purpose of this hearing.

They do have specified standards.

A Well, I can discuss some of the FDA standards, say, in terms of toxicity, or at least carcinogens. There's various models that they use for that.

At least they are targeted to something specific. For example, carcinogens. And they have a variety of specific tests. For example, rates of cellular mutagen rates in various organisms.

And based on that if a particular toxic substance were to cause a rate that was above normal, then that would be a trigger for some sort of prescribed action. And then they determine, based on that, what level to set.

And usually the level right now is one-hundredth of the threshold dose that they see.

In the field of electric fields, we have gotten up to some pretty high levels with animals and have not shown -- besides electrocution we have not shown a lethal dose yet.

In fact, there has been some difficulty in experiments with some ... say, fruitflies where the field has been so high that we could not carry out the

8-8

experiments because the fruitflies were -- actually being carried in, pulled into the current at the poles and just being essentially destroyed.

There is at this point -- I'm almost positive there has not been a threshold for lethal doses yet established, besides that of electrocution from shock. I'm talking about what we were talking about here, the long-term chronic electric field exposure.

Q Thank you.

Going on to page 12: "Although the staff does not believe that additional protective measures are warranted at this time, we are keeping abreast of these studies and will take any new information into consideration during our review of transmission line operation at the operating stage."

Is there an actual group or someone on the Staff who after we -- say, the line is in the operating stage, still monitors performance or the studies, and -- Is there a continuing input from the Staff in a real sense as we progress?

There are a lot of lines operating. Are you doing that on any of them?

A Well, that's really not what that statement is implying.

But, first of all, to clarify: What you're

8-9

saying is that at this stage we do not monitor operating effects -- electric field operating effects after an applicant has received his operating license.

The meaning of this statement is that we have a second review of the transmission lines during an NRC proceeding; and that's the operating licensing stage, which is usually several years down the road, in which we have the opportunity to look -- The Staff has the opportunity to take a second look at operational effects of transmission lines and operational effects of the power plant.

In the case of Allens Creek, therefore, we will have -- at least routinely we will have another -- we will do another impact statement considering the operational impacts of the Allens Creek transmission line.

They will not be operating at that point. Don't misunderstand me.

There will be an operating license stage proceeding before they're allowed to go ahead and operate.

Q Still on page 12, we're into the area of the effects of electromagnetic fields on plants and animals.

With -- Well, I found it a little confusing.

8-10

You said you did not address it, but there is information in here that I would like to go ahead and ask about.

The first question is: With regard to large animals, were you considering domestic or wild animals or both?

A. I was primarily in this issue considering wild life.

Q. I think your statement concerning the territorial range would be valid there. I question the validity on domestic animals, such as horses, that would be basically ... you know, confined to the right-of-way area.

Would you feel that that type of chronic exposure would be something that would give us an effect?

A. Well, we do have research on that. I don't have it cited here.

But Bonneville Power Administration has a test facility. It has essentially energized at something like 1100 to 1200 kV per meter.

Beneath that test facility they have used cattle -- a group of cattle beneath the lines as a control ... and watched for behavioral characteristics, and also for --

I'll back off and not say cattle. I'll make sure I say cows.

-- and looked at milk production rates and have found no significant difference between the control and the animals exposed beneath those lines -- 1100 kV lines.

Q You go on to talk about smaller animals and the fact that they are shielded by grass, shrubs, et cetera ... "and therefore would not receive a high cumulative exposure dose."

Could you tell me about the cumulative effect or exposure dose? I'm not familiar with that. I've heard it expressed in other papers, but I'm not sure I understand it.

A Well, essentially what we're saying -- the gist of that particular sentence is that although the small animals may in fact live directly beneath the power lines and, therefore, possibly could receive the maximum field and, therefore, for them a high dose.

Over time what in fact happens is that because of the way rights-of-way are maintained, there's always a fair amount of vegetation along rights-of-way, or at least animals tend to use cover.

If one were to measure a field below the one meter standard, the field drops off in a fantastic manner.

In other words, a shrub, for example, will

essentially stop most of the field.

If you had a measurement instrument and you took a measurement at one meter above a vegetated area and then dropped it down to six inches, it would be practically zero.

All I'm saying in that statement is that since most of these smaller animals in fact use vegetation for purposes of shelter and hiding, that although the field as measured above the grass levels would be -- or could be fairly high -- "high" meaning, say, it was a maximum field of six kV that they theoretically could receive a 6 kV per meter dose.

Since they're below and then shielded, they receive probably practically nothing ... or probably zero over any long period of time.

And so essentially that's what is meant by "high cumulative," "cumulative" meaning receiving a dose over a long 24-hour/48-hour -- habitually receiving a continuous dose or continuous exposure.

The whole point is they don't receive a continuous exposure. They probably receive at most most of these animals that I'm talking about -- in many cases are burrowing animals or animals that will be essentially shielded from the field and in fact probably receive no exposure whatsoever.

8-13

Q Then if I'm understanding your explanation correctly, maybe that would be a reduced -- maybe a lack of -- Could we say that they're simply, because of their size and where they are, that they're receiving a smaller dose?

That's what I thought I heard you saying, but I'm not sure I -- I still don't feel I understand the meaning of "cumulative."

A It may be a bad use of words in this case. I guess that what I would try to say again is that theoretically if an animal -- a small animal was living beneath the right-of-way, exactly at the point where the maximum predicted field existed, and that its range was only within that field, that it had such a small range that within the very small parameter of the maximum predicted field, say, it only ranged within three or five or ten feet of this particular area and, therefore, constantly was subjected to the maximum field, then you could say that it got -- at least for this particular line -- if the maximum predicted field was six or eight kV per meter, you could say that theoretically that animal would receive chronically eight kV per meter per 24-hour period. Chronically. All the time.

Now all I'm saying is that in fact that is not the case, because, number one, the vegetation significantly

8-14

shields and reduces the field gradient so in fact it does not receive anywhere near this 8 kV per meter all the time.

Now I can't say how much of the time it does and how much of the time it doesn't. But all I'm saying is that it's not conceivable that that animal is sitting right ... you know ... that the shielding --

What I'm trying to say is that the vegetation does a significant job in reducing the field gradients below one meter.

Q Let me make sure that I understand what it's not; and maybe that will answer my question a little bit better.

We're familiar with the build up -- when we're thinking of ... say, radioactive-type poisoning. There is a dosimeter -- a cumulative dosage rate where you can totalize it, et cetera.

This is not what you're -- You're not saying there's no phenomenon that would approximate that in the sense of the word "cumulative"?

MR. NEWMAN: I'll object to that. I don't think there's a meaningful question in that.

It's vague.

JUDGE LINENBERGER: Well, before you rule on the objection, Judge Wolfe, I think there's some semantic

8-15

difficulties here.

In the first place, radiologically speaking, a distinction is made between exposure and dose. I think I heard Mr. Gears use those two words synonymously.

THE WITNESS: I probably did, because I said "exposure dose" here.

JUDGE LINENBERGER: Do you look on them as equivalent words in the context of electromagnetic --

THE WITNESS: I would like to say that the word "dose" at least is not the accurate word. I would like to use at least "exposure" meaning actual exposure to a particular electric field.

JUDGE LINENBERGER: Secondly, there's another consideration that comes in ... in radiography, in radioactivity considerations and possibly here also -- I'll leave that to you, sir.

The concept of reciprocity. It is not always true that in terms of radiation a high dose for a short period of time has the same equivalence as a low dose for a long period of time.

But in terms of the kinds of phenomena you're talking about, is it true that a high exposure for a short period of time is equivalent to a low exposure for a long period of time, if the product of field strength and times are the same for both?

8-16

THE WITNESS: That has not been answered. That has not been looked into.

One would think that at least in this area we might get the same type of potential results as in the field of radiation, ionizing radiation.

But the question of long-term -- Well, as I said before, it's not clear to me even at maximum - what levels of maximum exposure, if we talk about hundreds of kV's per meter, whether we have really established any lethal threshcolds.

Theoretically ... you know I'm saying theoretical, because we get into other problems of shock, which in this question we're talking about long-term electric fields, and not the shock issue.

And it's hard to make an experiment where, when you adjust the high electric fields, that you don't get into the danger of [illegible]sing a lethal shock current.

JUDGE LINENBERGER: All right, sir. Fine.

Now a third kind of thing, Mr. Rentfro, that I think might be bothering you -- and it has not come out from this discussion whether it comes into play here -- with radiation exposure, given a constant radiation field, the damage that that radiation does goes on building up in the body if the body continues to stay in that radiation field for longer and longer times. There is an

8-17

accumulation of damage. One has a cumulative effect.

Now it is not clear from what you've said, Mr. Gears, whether there are cumulative effects on the body that go on building up as one stays longer and longer in the same electric fields -- the same intensity electric field.

And that may be the sort of thing that -- Well, Mr. Rentfro indicates that is the kind of thing he is bothered about.

Now then, Mr. Chairman, if I may say so, having pinned down that that's the kind of thing that's bothering Mr. Rentfro, I would suggest that he rephrase his question to overcome the objection that has been raised to the previous question, so I can get out of this.

(Laughter.)

MR. RENTFRO: I'll attempt to rephrase the question.

BY MR. RENTFRO:

Q Do you -- Are you aware of any cumulative effects that would be a function of the field strength that you're exposed to and the length of time of the exposure?

A I wish I could say no. I want to say something about circadium rhythms in that area that is just possibly being -- we are now investigating it.

8-18

Generally, all of the experimentation so far indicates that once the organism is removed, there's a fairly quick reversion back to normal characteristics. That it's not a long ... once it's -- It's not a chronic condition, once the organism is removed.

However, there is some evidence that says that electric fields could possibly disturb circadium rhythm.

And if that is the case, then there are people who are knowledgeable in this area who say that that could in fact be a longer term, more chronic and perhaps more cumulative effect, that once the circadium rhythm is substantially disturbed, this could cause fairly prolonged periods of disturbance.

And, therefore, even though the organism is outside the field, you can still get a long-term effect.

Obviously, you can see from my answer that I'm not certain. I have given you both sides of where the issue is at this stage.

Q I only found one piece of literature that even addressed that, and that was the "Electromagnetic Fields and Life" by A. S. Pressman, who is ... Department of Biophysics, Moscow University, Moscow USSR, and translated from Russian by Sinclair, edited by Frank A. Brown, Jr., Professor of Biology, Northwestern University.

8-19

Are you aware of that particular paper?

A No, I'm not.

Q I am not sure exactly what it means, but I would like to read what I think is the pertinent paragraph from it. Would you like to see it before I read it or ...

JUDGE WOLFE: Well, if there's no objection, read that part. Then show to the witness that part which you've read.

MR. RENTFRO: It says: "It has been found that in some cases the reactions of living organisms to EMF's occur only at certain optimum intensities. In other cases, the effects increase when the intensity of acting EMF is reduced. And in other cases, the reactions of low and high intensities are of opposite nature. Cumulative biological effects produced by repeated exposure to EMF's well below the effective threshold for a single exposure have also been observed. Finally, the concept of energetic interaction is contradicted by the fact that for the same average EMF, energy absorbed in the tissues of organisms, the nature of the reaction depends considerably on the modulation of the EMF, on the directions of the electric and magnetic vectors of the EMF relative to the animal's body axis, on the localization of the exposure" and so on.

That -- the way I understand it -- tends to

8-20

leave me confused. But it also supports your answer ... I see.

MR. NEWMAN: Is there a question in that or is that a statement for the record?

If it's a statement for the record, I ask that it be struck.

MR. RENTFRO: Let's pose it as a question then.

Does this --

JUDGE WOLFE: Well, there's a motion to strike your comment.

(Bench conference.)

JUDGE WOLFE: All right. Proceed with your questioning then.

BY MR. RENTFRO:

Q You mentioned in your testimony at page 12, "Smaller animals which exhibit a more limited range would most likely be shielded extensively from electric field gradients at ground level by surrounding shrubs, grasses, etc., and therefore would not receive a high cumulative exposure dose."

My question is: How do they go about receiving this -- or not receiving this high cumulative exposure dose. And I did not -- Do you feel that the information from Mr. Pressman's paper is of any validity at all?

8-21

MR. BLACK: I'm going to object. The sentence that you read on page 12 of Mr. Gears' testimony has nothing to do with the cumulative biological effect that you asked him to comment about on that document that you hold in your hand.

To me you haven't connected it up yet. To me it was just -- I thought you were going to ask him -- and I would have no objection -- whether he agrees or disagrees with the statement that you read from the Moscow paper.

But if you try to tie it into what he said in his testimony, I think that's objectionable.

Maybe we could simplify this thing -- Why don't you just ask him -- and I would have no objection -- if he agrees or disagrees with the statement that you read.

MR. RENTFRO: That's fine with me.

BY MR. RENTFRO:

Q Mr. Gears, do you agree or disagree with the statement that I just read?

MR. NEWMAN: Mr. Chairman, I would object to that question because the statement that was read perhaps has eight or nine significant points of fact in it.

And I don't know that a single answer --

agree or disagree -- can conceivably cover all the points in that statement.

The question, therefore, is impermissibly vague.

JUDGE CHEATUM: I'd like to make one comment. For this Board member it would mean nothing to me.

First of all, I don't even know what animals are involved in the experiment.

You talk about the action on tissues ... or organisms or systems. I don't even know what animals are involved.

Are they ants? Or are they mice? Or what? Or did you tell us?

I'm asking you.

MR. RENTFRO: According to the paper he is addressing animals --

JUDGE CHEATUM: Ants are animals.

MR. RENTFRO: Yes, animals.

JUDGE CHEATUM: Ants are animals.

Did you say "ants" or "animals"? I mean, when you say animal , that also includes human beings. Whether you admit it or not.

(Pause.)

MR. RENTFRO: No, he is addressing man in this case, and specifically tissue.

(Bench conference.)

9-1
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(Bench Conference)

JUDGE WOLFE: The question is much too vague. It is a multifaceted question. Therefore, we will sustain the objection.

You may ask point-by-point questions, however, if you so desire.

BY MR. RENTFRO:

Q Does the statement that you have made indicate that a cumulative exposure dose is possible, although not high in this case?

MR. NEWMAN: I object to the question, again. I don't know what case we're talking about; and my record of that question says, "Does the statement you have made. . " and I don't know what statement that is.

JUDGE WOLFE: Try again, Mr. Rentfro.

Objection sustained.

BY MR. RENTFRO:

Q The case that we're about is Before the Matter of Houston Lighting & Power, Allens Creek Nuclear Generating Station, Unit I, NRC Supplemental Testimony of Gerald E. Gears, on page 12, he states, as we have read two or three times now, that there appears to be, that the smaller animals under the line would "not receive the high cumulative exposure dose."

And, my question is that is there any

9-2
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exposure or accumulation of the exposure dose?

Is it high or medium or low or whatever place you would like to make it in between.

MR. BLACK: Objection.

I think he has gone into this, I'm fairly certain he has asked-and-answered exactly what he means by the term "high accumulative exposure dose"; and any other line of questioning I believe is clearly repetitious.

MR. RENTFRO: Well, the line of questioning has become repetitious, in my opinion also, Mr. Black. But, certainly not any more vague than the statement that we're questioning.

MR. NEWMAN: I think with the acknowledgment that the questioning has now become repetitive, I'm going to ask for a termination of cross-examination on this point and ask the interrogator to go on to another point.

MR. RENTFRO: Could I make one further comment?

JUDGE WOLFE: All right.

MR. RENTFRO: I have basically accepted and agreed with the cumulative, the definition of cumulative. I think with Judge Linenberger's help I was pretty satisifed with that. I think the question that we really

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got back to, my understanding was I read out of this Pressman Study and there was an objection to "Hey is it a statement or a question." I was trying to make a question out of it.

I think that's where we really were.

JUDGE WOLFE: Yes. But, you didn't refer to this study in your last question.

So, you abandon, apparently, any question derived from the study.

So, the Board is rather confused as to what you are up to.

JUDGE LINENBERGER: Why don't you go back to that Moscow Paper which lists a variety of reactions to electro-magnetic field exposures.

And it says that, "In some cases the higher the exposure the smaller the reaction. And, in some cases other things."

Why don't you take them one by one, break them down into a half a dozen separate questions, and put each one to the witness and ask him if he agrees with that one particular fact.

The problem before was there were just too many things in that ball of wax to pull together as one question.

So, can you do that?

MR. RENTFRO: Yes, sir.

That is a valid observation.

BY MR. RENTFRO:

Q Would you agree with the Pressman Study that cumulative biological effects produced by repeated exposure to EMF's well below the effective threshold for a single exposure might pose a biological -- or might be a biological effect?

MR. NEWMAN: May I see the Pressman article? Does it have reference to the term biological effect in it?

(Document handed to counsel.)

JUDGE WOLFE: Certainly you may see the article.

MR. NEWMAN: Just from reading the paper that has been shown to me now, that was not a direct quotation.

I think as a result one cannot ask whether the witness agrees or disagrees with the Pressman statement. It is not based on the basis of the question just asked.

And so I object to the question.

JUDGE WOLFE: Do you withdraw?

MR. RENTFRO: The point I was --

JUDGE WOLFE: Do you withdraw?

Do you withdraw the question in light of

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Mr. Newman's objection, or do you wish to comment on the objection?

MR. RENTFRO: I would like to comment on the objection.

JUDGE WOLFE: All right.

MR. RENTFRO: I believe the objection was that it was not a direct quote, and the article is -- the article itself, in my understanding, although it is a translation, is directly from the original and is that the basis -- is he questioning?

MR. NEWMAN: If I can just concisely restate the objection.

The witness is unaware of the statement that is being used as the basis for the examination. He is being asked, however, whether he agrees or disagrees with the statements in the document, which by the way is not identified for the record. Nor is any part of the record.

And, the interrogator is then proceeding to interpret the document and asking whether his interpretation of the document is right or wrong.

And, so the question is not really whether the witness agrees with the author's characterization but rather whether he agrees or disagrees with

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Mr. Rentfro's characterization.

I think the entire premise for the examination, therefore, is without any foundation. And, if he can restate that series of questions in a manner asked by Judge Linenberger, then maybe we've got something.

But, as it stands now there's not a specific enough question on the record.

MR. RENTFRO: I will try to restate, as per -- in a more appropriate manner.

BY MR. RENTFRO:

Q Reading this -- I'm going to read the statement.

Then the question will be "Do you agree or disagree?"

And, the statement is, "Cumulative Biological Effects Produced by Repeated Exposure to EMF, Well Below the Effective Threshhold for a Single Exposure have also been observed."

Do you agree or disagree with that?

MR. NEWMAN: I don't believe the witness can really respond to that question.

Now that I hear it.

There's no indication of the animal involved, the subject of the experiment, and it is just totally without any basis for the witness to make an

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adequate response to.

MR. RENTFRO: The witness made a statement along those lines in his direct testimony without reference to any particular study or data.

How do you explain that?

MR. NEWMAN: The difference, Mr. Chairman, of course, is that the witness is here to be cross-examined. The author of that paper is not here to be cross-examined.

MR. RENTFRO: Have their been any authors of any of the other papers here to be cross-examined?

JUDGE CHEATUM: Mr. Rentfro, I'm looking out for the record here, usefulness of the record in this case.

And, on this question no good could be served by extracting a quotation out of a paper, a translation from the Russian or any other language or even in the English language, which has to be addressed by all parties in this case, is out of context because we do not know the total of the paper. And, the paragraph which is drawn is without the total context of the paper.

We don't know what went before. We don't know what followed.

I would be unwilling, and I'm sure the Board would be unwilling to accept a single isolated paragraph

9-8
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like this without the presence of the author to be cross-examined on the total paper as any value.

So, therefore, the Board would be really, and all parties really, would be up against it in trying to make anything out of it.

(Bench Conference)

JUDGE CHEATUM: To further clarify the record, Mr. Rentfro, the Board has discussed this and trying to look at this from your point of view, and also from the witness' point of view, if the witness had, indeed, studied this paper you are referring to in its entirety, he would be in a position to answer your specific question as to whether he agreed or disagreed or whether he thought some statement was weak or unjustified.

But, having not seen or studied the total testimony or the total paper that you are extracting, you see, you are putting him into a situation which really his testimony I wouldn't value it very much, no matter what he said.

Now, he has studied other papers. And, he has looked at research findings and he has read many of these papers. And, he draws conclusions from reading all of these papers.

But, he has first-hand knowledge of what is in these papers. He has no first-hand knowledge about the

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paper that you are talking about.

So, therefore, cross-examining on quotations from that paper to me seem to be fruitless, and have little value.

JUDGE WOLFE: I'll sustain Mr. Newman's objection.

(Pause)

MR. RENTFRO: May I, just for my own understanding ask the Board a question here?

On the -- We have presented a lot of papers and referenced a lot of them and footnotes --

JUDGE WOLFE: Yes, but I think I know where you're going with that question of the Board.

References were made in written testimony to various studies, papers, articles.

But, the opposing parties were given time within which to look at those referenced studies, articles, whatever.

This is perfectly proper, and the person who has cited them in their testimony have read and relied on those studies or articles.

In this case, you are asking the witness for the first time who's not aware of the article or study at all to focus in on one sentence or two or three sentences out of this entire study and asking him a

comment.

Do you agree or disagree.

And, this is unfair and unreasonable.

The witness has not read the entire article.

Secondly, there's really plucked out of context questions directed -- I should say questions are directed to the article to sentences taken out of context to the entire study.

And, once again, this is unfair and unreasonable; and further it doesn't serve to enlighten the Board at all by virtue of whatever the witness might say because as Judge Cheatum has pointed out, we don't know other than what you tell us that the human animal is involved in this study.

So, I think I have answered where you were going.

MR. RENTFRO: I think I understand --

JUDGE WOLFE: Yes.

MR. RENTFRO: -- you know, what you're telling me and I was -- I have no problem at all with that.

I was interested in -- this was the second guy who knew, who had mentioned cumulative and that's the -- I was curious about it. I'm not sure that I understand it now. At any rate, I withdraw.

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JUDGE WOLFE: All right.

How many more questions do you think you have, Mr. Newman -- Mr. Rentfro?

MR. RENTFRO: We're just about through --

JUDGE WOLFE: And, that goes for you, too, Mr. Newman.

(Laughter)

JUDGE WOLFE: Approximately how much time will you need?

MR. RENTFRO: I have --

JUDGE WOLFE: I'm just trying to determine whether we should have a recess now --

MR. RENTFRO: I have about a have a dozen questions, sir.

JUDGE WOLFE: Well, why don't we proceed then. Go ahead.

BY MR. RENTFRO:

Q On the bottom of page 12, we talk about, "Field tests and studies of biological ill effects of field gradients conducted on plants and animals have generally indicated that no significant effects are attributable to electric fields predicted to occur from the operation of 345 kV systems."

What biological ill effects were the subject of these field tests and studies? Could you be

9-12

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anymore definitive, Mr. Gears?

A Well, in terms of plants there has been -- there are studies -- have been studies conducted at Pennsylvania State University where it has been noticed that under approximately, I believe, 50 kV per meter, 25 to 50 kV per meter, that certain types of plants suffered leaf-tip burn. That they are so minuscule as to be almost indiscernible and the only way that you would tell that there was any effects at all were with a magnifying glass.

That was one effect. Generally, the health of the plants appeared not to suffer at all.

There has been -- the only other instance that I know is in the case of honeybees beneath the transmission line. I believe in this case it is the 1,100 kV line, where those bees exposed beneath the line did show some abnormal tendencies which was dependent on the type of hive that they were inhabiting.

It appears that a wooden hive held together by nails, the bees would in fact seal off their entrance. Seal themselves in. Whereas if they were in plastic or some sort of non-conducting material, there was absolutely no effect between the -- either colonies the control or the ones beneath the species.

Those are the two studies that I know that

9-13
cf

there were some, I guess, one would call -- I call them ill effects.

Q Thank you.

Would the bees be the only small animals that we really considered?

A There has been general studies beneath the 1,100 kV line at -- in Oregon that has looked at wildlife inhabiting that section and have found to date no discernible effects between the controls and the -- and those that would be underneath the line.

So, that would include a wide range of animals sizes.

Q Do you know of any studies where the people conducting the studies have actually gone into the, let's say, right-of-ways -- let's call it a median or on to the right-of-way to hold a test.

I realize we're talking about laboratory tests for the most part; but is that a feasible idea?

Conducting a test on the right-of-way?

Or is it --

A What type of test? It --

Q I'm thinking about the small animal test where you might --

A Small animals?

Q Right. On the right-of-way.

9-14
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It is my understanding that most of these tests are field, not -- laboratory, as opposed to --

A. As I mentioned before, there has been the -- there is an ongoing research published on the 1,100 kV line in Oregon which dealt with, as I said before, with cows and I don't believe that there were other animals; but I have just mentioned recently that they did, also, studies of wildlife at least the existing wildlife beneath the right-of-way. Those in a similar area not beneath the right-of-way, mainly they were looking for any particular avoidance type behavior, do small animals avoid transmission lines, in other words.

They found no significant difference.

Q. In these studies of, do we have enough of them at this time to address the question of replication in the field studies? Have there been enough to get the same results under the same or similar conditions that would satisfy that condition?

A. I think there is enough for me to be satisfied, but I will mention that they are still ongoing. They are still being taken in different areas, different transmission lines are doing similar studies again.

MR. RENTFRO: Chairman Wolfe, that completes my questioning.

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JUDGE WOLFE: All right.

We will recess until 3:30 p.m.

(Whereupon, a brief recess was taken.)

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JUDGE WOLFE: All right.

Mr. Doherty, cross-examine?

MR. SCOTT: Mr. Chairman?

JUDGE WOLFE: Yes.

MR. SCOTT: Can I raise a preliminary matter first, Mr. Chariman?

JUDGE WOLFE: Yes.

MR. SCOTT: I was asked by Mr. Copeland yesterday to check with my witness Clarence Johnson to discuss the feasibility of whether or not he should come this Friday or --

JUDGE WOLFE: Yes.

MR. SCOTT: -- wait, considering anticipated schedules.

I wanted to discuss that momentarily, if it is appropriate.

JUDGE WOLFE: All right.

MR. NEWMAN: Can we just hold on a second until I get Mr. Copeland up, because he is the one who had discussions with Mr. Scott. He will be up in just a second.

(Discussion off the record.)

JUDGE WOLFE: Mr. Scott wants to bring a matter up, Mr. Copeland, involving the proposed appearance of Clarence Johnson this Friday.

We are advised that you had some conversation with Mr. Newman. Now proceed.

10-2

MR. SCOTT: With Mr. Copeland.

JUDGE WOLFE: With Mr. Copeland. Right. Yes.

MR. SCOTT: He asked me to consider whether or not it would be appropriate to consider changing him from his present schedule appearance this Friday, March 6th, to some later time.

And, as we have previously discussed, and I mentioned to him, that that seemed appropriate and fine with me, if it was all right with Mr. Johnson.

Mr. Johnson had expressed some concerns about only being able to be here except on Fridays.

And, as I remember, Mr. Copeland's statement he says, "Well, maybe you can bring him down the next Friday. Well, at the time that seemed reasonable, and that is what I was going to propose.

After looking at it, I think we are off next Friday.

JUDGE WOLFE: That's right. Well, we won't be here next week.

MR. SCOTT: And the week after.

JUDGE WOLFE: We reconvene on March 16th through the 19th.

MR. SCOTT: Yes.

JUDGE WOLFE: And we will not be here the 20th, because the auditorium is not available.

MR. SCOTT: That's the problem that I have

10-3

discovered.

JUDGE WOLFE: Yes.

MR. SCOTT: I called Clarence Johnson and told him those facts.

He indicated, given his preference, he would come next week, the 13th, at which time we are not meeting.

The next preference would be the 20th, and we are not meeting.

Probably the next preference would be the -- well, considered pretty much a tie between this Friday the 6th, or Thursday the 19th.

We might look at present status and see if there is a likelehood that we are going to be running in the environmental phase of the hearing past the 19th. I haven't decided myself. If that was the case, then some -- If we go all the way to the 27th, that would be the best time.

But I don't have an answer.

JUDGE WOLFE: After March 19th, Mr. Scott, we do not plan to reconvene again until May 11th --

MR. SCOTT: Okay.

JUDGE WOLFE: -- for a two-week period.

MR. SCOTT: Now, at that May 11th time, it wasn't clear to me if that was going to be only safety issues, or it might include finishing up some environmental issues, if there were any to be finished.

10-4

JUDGE WOLFE: My understanding is that if we do not complete the environmental issues by March 19th, we will proceed to carry over into the new phase of the hearings beginning May 11th, and make an effort to complete those.

But I don't know that we are getting anywhere here, Mr. Scott. This is something you could work out, I would think, with Mr. Copeland and Mr. Newman, as to when it would be most convenient for you to have Mr. Johnson here.

MR. SCOTT: Well, --

JUDGE WOLFE: If he can only come on Friday, why, work it out with counsel, and the other parties. I don't see any problem.

MR. SCOTT: Well, I do foresee the problem that if he could not be here by the 20th, and we dismissed the environmental hearings then for some reason, and there was a claim made that you knew he had to be in here by then, and you didn't; therefore, you lost your chance --

JUDGE WOLFE: Well, now, you know differently.

MR. SCOTT: Yes, but I didn't before I brought it up to the Board.

JUDGE WOLFE: All right. Okay. Work that out with Applicant's counsel.

MR. SCOTT: I would like to also mention that there -- I don't know that there is problems, but there are other witnesses of TexPirg's besides Clarence Johnson we have

10-5

still somewhere in this hearing got to call Dr. Marrack for some more testimony, and there is also the recalling for the re -- I forget if it is redirect or rebuttal of Dr. Marrack based on his prior testimony.

At this point there is no scheduled specific date to do that.

MR. COPELAND: Your Honor, we can work this out off the record, it seems to me. But the obvious answer here is that we ought to plan on finishing those matters up when we reconvene in May.

You know, I can't imagine that in the next seven days of hearings we are going to complete all of the witnesses we have, or that the Staff has.

JUDGE WOLFE: Yes. There is going to have to be some adjustments made in that future hearing sessions.

So, the parties get together, representatives and counsel, and hopefully there will be no problem.

MR. SCOTT: Mr. Chairman, I would like to say one last thing.

Is it agreed, then, Mr. Copeland, that I can call Clarence Johnson tonight and say that he does not have to come here this Friday?

MR. COPELAND: Yes.

MR. SCOTT: Okay.

JUDGE WOLFE: All right.

10-6

MR. SCOTT: I would like to be excused for the rest of the afternoon. I have got to go get some xerox copies made of the testimony that we are going to be presenting.

JUDGE WOLFE: All right, Mr. Scott. You are excused.

All right, Mr. Doherty.

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10-7

CROSS-EXAMINATION

BY MR. DOHERTY:

Q Mr. Gears, I want you to turn for reference to Page 4 of your written direct testimony.

I kind of want to follow in the shadow of Mr. Newman's questions a little bit that he had this morning.

I believe you stated -- Well, is the body weight used as a variable for determining the let-go threshold?

A In reference to the statement I have here these let-go thresholds were determined on actual subjects.

Q Okay. And you state in there minimum let-go levels for men and women. I believe you stated, though, that the average for males was 16, and women something on the order of ten and a half milliamperes. Is that correct?

A Correct.

Q Okay.

Then I think you also said there was no average for children. Is that correct, too?

A I stated that they did not do this particular experiment on children, that they calculated it, theoretically deduced.

Q All right.

Now, in calculating it, do you use both the sex and body weight, or what do you use?

A Well, I don't recall exactly what was used in this

10-8

case.

I can say that I do not think that sex was the determinant.

Q I see. Now, that standard set forth in the National Electrical Safety Code, they don't say on what basis they used to arrive at a rate for children, or a measure for children?

A They do not even specify that it is a measure for children. They specify only what they consider to be a safe level.

Q For children?

A I don't believe that they specify that it is for children.

They specify that it is 5 milliamps. That if the line is designed for 5 milliamps it will not cause a health hazard.

Q Now, in order for this let-go threshold to be observed, do they have to use both hands?

A Well, --

Q Is that when the phenomenon occurs?

A I believe that they did. I believe that they tried to approach a condition where in fact both hands -- I can look that up, exactly what they did.

No. It is not necessary to have both hands used. It simply means that if a part of your body, primarily

10-9

one hand does in fact grab on to an object, and that there is sufficient current going through there that you are not able to let go. Then one hand would be sufficient for that test, versus two hands.

One hand, in fact, would be a sufficient test, if you could not let got with one hand. Therefore, current would constantly be going through, flowing through your body.

Q Okay.

Well, then, I don't understand how in the next sentence you say: "At some point above the let-go level, respiratory arrest and consequent suffocation may occur..."

I don't understand how -- I mean, wouldn't you just burn your hand, just one hand?

A No. The sample says that at 5 milliamps you are able to let go. Not that you can't let go, but that you can let go. That no matter what current is flowing through, at least at the 5 milliamp criteria it states that at 5 milliamps any individual being exposed to that particular current level will, in fact, be able to let go of the conducting object, and, therefore, would not be subjected to a dose that would -- an occurrence that would cause the following particular ramifications that I talk about, respiratory arrest, suffocation.

That, in fact, let go means that you can actually under those situations always let-go.

10-10

Q Right.

A And above those are some uncertainty at which point you might reach that you couldn't let-go. So, the standard is always below that level.

Q Well, if the experiment were done with just one hand, how -- Well, if any experiement were conducted with just one hand, and above this let-go level, how would a respiratory arrest be involved with that?

A If in fact -- Let's give an example a large tractor-trailer beneath the transmission line, if in fact the children, a child was to touch the handle of the door with one hand, and there was sufficiently stored current in that vehicle above the 5 milliamp, there is some possibility -- I say, again, above the 5 milliamp, there is some possibility that that person could not let go.

Now, to further explain, that doesn't solve -- Now, assuming that the transmission of which we are talking about under which the particular vehicle is there at a particular field level, but, again, the vehicle is capable of exceeding the 5 milliamps, the current is constantly going through the vehicle, and, therefore, it is constantly going through the person touching that.

Therefore, what happens if you are not able to break contact, and the fact the current is above there, there is a danger that you will -- the current will be constantly

10-11

going through the body, and, therefore, there is a possibility of suffocation, of breathing problems, respiratory arrest.

Q So then the same person will perhaps touch the door of the truck, current will pass through the hand, and out, or -- there has got to be another contact with that body.

A Yes. It is assuming --

Q Through the foot, or something like that?

A No. It assumes that the person is in fact ground -- you know, the current can flow through the body and acts as a ground.

But that the current level is high enough to not only cause a startle reaction, but to not allow the person to in fact let go.

Now, you know, it perhaps is like somebody grabbing any sort of electrical line that is fairly significant in strength, and you will get the same type of reaction where you cannot literally let go of that thing, and that is what essentially we are talking about.

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Q Okay. So the standard, that is what the standard code maker had in mind, that it would go through a hand and out some path, so it would traverse the central organs of the body; right?

A Yes. It is assuming that the current level goes through the person, and that the level that we are worried about we don't want to see beneath the transmission line is some level that you would not be able to let go in that the dose, the current that you are receiving in your body could in fact be lethal.

Q All right. Thank you.

Now, in the same sentence, which began at some point above the let-go level you'd have these consequences, and then you say it is finished by one condition. That's for a sufficient time.

Just above the let-go level what would be a sufficient time?

A I can't answer that precisely. I do have the chart that we can refer to that gives us some indications of, for example, that 160 milliamps will cause a definite cardiac arrest, a definite respiratory arrest and suffocation.

I am not sure if it tells,the particular table tells how long that takes to occur. But that in fact it does occur.

Below those levels, I don't think there

10-13

is -- Well, I'm not sure of any published data that tells you how long.

Q. Well, in theory from what you said about this below these levels there would be no sufficient time. Isn't that right? It just wouldn't happen?

A. Exactly. I won't happen. At 5 milliamps it will not happen. You will always be able to let-go.

Q. You will always be able to let-go, but above it then time apparently becomes a factor.

A. Yes.

Q. But you can't really alluminate that in terms of seconds for us?

A. No. I can't.

Q. Okay.

JUDGE LINENBERGER: Mr. Doherty, I need to get a clarification here, please sir, from the witness.

Mr. Gears, you are talking about the 5 milliamper range of currents for this let-go threshold, perhaps somewhat higher, understood, but you always have been talking about the electric fields gradient at about a meter to a meter and a half above the ground caused by a 345 kV transmission line, being something of the order of six or eight kilovolts per meter.

Now, let's assume that a person walks into this kind of field gradient of six or eight kilovolts per meter,

10-14

he is emersed in that field.

THE WITNESS: Yes.

JUDGE LINENBERGER: Is such a field gradient capable of producing a 5 milliamper current in his body?

THE WITNESS: In it by itself, no.

JUDGE LINENBERGER: So, the kind of results, comments, and effects that you have just been discussing with Mr. Doherty, while true with respect to the current levels you were talking about, would indeed not occur for a person in the kind of electric field gradient that we are talking about near ground level underneath a transmission line. Is that true?

THE WITNESS: That is true. I understand your point. Maybe it will confuse it more, but there are possibilities of moving objects beneath the line, say, a high tractor-trailer, that is fairly insulated, that would act almost like a capacitor to store a sufficient amount of electricity, that when someone touches it -- in other words, this is a different situation. The actual vehicle would be the one that would be receiving electrical field, and receiving the charge, would be storing the charge.

And the discharge mechanism would be the person touching it. And that this charge perhaps -- This is what we are worrying about. That type of shock that would be hazardous.

JUDGE LINENBERGER: Right. However, is it not

10-15

also true that under the circumstances you are just now talking about that the current experienced would not be a steady stream of current. It would be a discharge current, such as a capacity charging or discharging phenomenon, and that the duration of the current would be quite short. Is that a true statement?

THE WITNESS: That is not a true statement.

JUDGE LINENBERGER: It is not?

THE WITNESS: No. There's two aspects.

JUDGE LINENBERGER: Excuse me. I don't want to take away from Mr. Doherty's time here. I will come back to this on Board questions later.

Thank you.

BY MR. DOHERTY:

Q Turning to Page 3, back one page, please,, your second answer, speaking of transit currents, and when they are encountered.

Now, for all that to occur in that single sentence, must that person be grounded?

A In terms of -- I'm sorry. Transient currents as far as discharges?

Q That's the sentence, yes.

A Yes. It assumes that the person is grounded. It assumes, obviously, that the object that is -- the charge object is somehow insulated from ground. Therefore, it is charged.

Q All right. I want to ask a question that is

10-16

probably common observation, but is not something I am very familiar with.

Frequently you see fairly large vehicles going down the highway, rubber tires, of course, and they drag something, small like a wire, or something along that line.

Is that an effort to take this charge off that vehicle. Is that what that is for?

A. Well, I am not an expert in this area, but it would seem to me that that would be the object, to remove the charge from the vehicle so it will not store a charge, will not accumulate a charge.

Q. Yes.

A. And perhaps an accumulation of charge there could be a spark, and if the vehicle has some sort of flammable material it could be, you know, a hazard involved.

Q. Okay.

Now, there is another sentence on that page. "Once contact is established a continuous curren tflows through the body of a person who may be in contact with the charged object."

Now, is a spark necessarily a current flow in that situation?

A. Well, I am trying to take that the scenario here of approaching an object that is charged. As one approaches, let's say with a finger, the one thing that would probably be

10-17

most likely to happen would be a spark.

The second possibility is that once the spark is discharged there still could be sufficient stored energy within the object to cause a current in the flow through the object, say the person, to ground. That's the second type of potential hazard. That's, you know, a short circuit current.

The spark is sort of instantaneous, very short. I call it transient, whereas the other one of actually -- after the spark is discharged, you grab the handle, you still could be receiving a current through it. That is more of a steady state. That is more of a longer-term period, and this is what the 5 milliamp criteria addresses this possible long flow through of current from a charged object rhrough a person.

Q All right.

A So there is usually always two things happening in a charge. To go toward an object and touch it, you will probably get a shock, which in many cases will cause you to jump back.

But if you still perceive to grab the handle, then there is a possibility the current will flow through you to ground. And that is what is called the short-circuit, or, you know, this is the longer term, current flow.

In the 5 milliamper criteria, it is addressing that issue. You want to be able to let-go. If you feel something happening to you, you do not want to be immobilized, paralyzed.

10-18

And the 5 milliamp criteria, essentially, assures that, in my opinion.

Q Okay.

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11-1

BY MR. DOHERTY:

Q. Referring to the last sentence on Page 3, you discuss a host of factors that vary, or cause the induced charge to vary.

One of these you are speaking about transmission conductor-to-ground clearance, and as sort of a little rule there, the lower the clearance, the greater the charge.

Then you also speak about spatial relationships of the insulated conducting object to the transmission line conductors.

Okay. Never mind. I can see that now. I couldn't differentiate those at first.

Now, back on Page 4 again, perhaps you a re merely quoting the National Electrical Safety Code, but you speak about the largest vehicle expected beneath the transmission line.

For these trnasmission lines what would that vehicle be, sir, do you know?

A. Well, first of all, it is a quote.

Q. It is a quote.

A. Well, I did not quote the whole section, but beneath the largest anticipated vehicle beneath the transmission line essentially what the code says.

I would say that in some cases it would be

safe to say at Allens Creek that you would probably have a tractor-trailer or a school bus beneath some point of the line.

Q All right.

What would be in terms -- I think, personally, that a tractor-trailer is a good deal larger than a school bus. What would be the most conservative calculation?

A Tractor-trailer.

Q Tractor-trailer.

A Yes.

Q And have you used that? Has that been your thought?

A Well, I have not made any calculations. I am citing what the National Electrical Safety Code says, and I am citing that the Applicant has -- well, I am not sure if it is appropriate to say -- on record, but has told the NRC Staff that they will abide by the National Electrical Safety Code.

Q So then it would be your expectation that the Applicant use a tractor-trailer rig for this, to fulfill the code?

A Well, I can't answer that, because I am not that specifically versed in the lines. It would be a matter of the roads that are crossed by the lines.

I guess it would be safe to say that the line probably does cross a two-lane highway, and a two-lane highway probably will at some time have a tractor-trailer.

11-3

So I guess I would, you know, with that qualification I guess it would be safe to say that at least those crossings -- and that's the point to say, only those crossings, and only those areas where a particular vehicle would most likely be that you would get a line clearance that is higher than, say, along an agricultural area where no such vehicles would travel.

Q All right.

Now, then, in this 5 milliampers, in accordance with the code, would have to be at the highest point of the vehicle?

A No. The calculations are based on not only height of vehicle, and length, but also length of vehicles.

Q Say again.

A Height of vehicle, as well as length. And it assumes that the particular vehicle is in the maximum field, and also parallel to.

It is a worst-case calculations.

Q Okay.

A Also under maximum 120 degree Fahrenheit conditions, too. That is also part of the code under worst conditions, worst-weather conditions.

Q I see.

Now, at the foot of Page 7, the subject changed to ozone, and its generation.

1-4

You state at the very last of Page 7: "During foul weather, small amounts of ozone were measured..." and give some details on that, how much and all.

Now, this foul weather, would that include a thunder-and-lightning storm?

A. I don't think that any of those tests did measure during a thunder-and-lightning storm, per se. I'm not sure.

In fact, there may have been some conditions. It certainly -- Okay. Well, I don't think it -- I cannot say specifically that foul weather means only during thunder-and-lightning storms. Perhaps there was a thunder-and-lightning storm during those measurements.

Q. During your research in developing this part of your testimony did you come across any other sources of ozone generation in nature?

A. Any natural sources of ozone?

Q. Any other ways which ozone might be created in natural processes?

A. It's obviously in thunder storms, lightning storms. Also, it is a phenomenon of urban environments.

Q. Do you happen to know if it is a phenomenon in Houston, to urban environment?

A. I would say that ozone generation is a phenomena of any urban environment, or all urban environments that I know.

Q. Do you know if ozone is particularly heavy in the

1-5

City of Houston?

A That, I don't know.

Q All right.

Now, in reply to a question from Mr. Rentfro, you mentioned several products, we could call them, from generation of -- excuse me, from transmission lines, in addition to ozone.

One of these was singled oxygen, I think you said. Do you recall?

A I do recall that he mentioned singled oxygen.

Q What is singled oxygen, please?

A I'm not sure if I can recall his testimony. I believe he said ozone nitritic oxide, and singled oxygen. I'm not sure if -- Singled oxygen means to me "O", not "O_2".

Q Do you know anything about any health hazards of singled oxygen?

A None. I know of none reported for singled oxygen.

Q Now, was it your testimony that singled oxygen is produced?

A No.

Q Do you know of any EPA standard for this form of oxygen?

A I am aware of no EPA standards for singled oxygen.

Q Okay.

Now, there has been previous testimony that

11-6

the effect of electric fields on humans is not a source of concern. I believe the testimony was last Friday, if my memory serves me correctly.

You have a statement down here in the middle of the page, roughly: "The effect of electric fields on humans has been and presently still is being studied extensively throughout the world."

Do you think this is necessary? That is on Page 8, sir. I'm sorry.

A. I certainly think the statement is necessary, if that is what you mean.

Q. That wasn't what I was asking.

A. I think also that it is very prudent to continue research in this area.

Q. Do you think it is necessary to study the effects of electric fields from wires that carry more than 500 kilovolts at this point?

A. At this point I think, and actually what is occurring, is the research that I am involved with at least in some overviewing, does not limit at all the size or voltage of the lines.

Q. All right.

So would it be fair to say that you think continued research in electric fields produced by 345 kV lines is necessary?

11-7

A Yes.

Q Okay.

What do you think is the biggest weakness in our knowledge on this right now?

A Well, I think there is a variety of areas. We sort of got into it just before the break. It is not certain to me -- Well, we don't know any sort of dose response relationships.

We really don't know mechanisms of why so many effects are occurring.

There is not one. You asked me for a single. I don't think I can answer that in a single thing. I'm saying that I think there is three or four very important areas that need to be undertaken, looked at.

Q I would like to suggest one more, and get your comment.

What about genetic effect?

A We are looking at that. They are being looked at.

Q Is there any preliminary data that has come out of this research on genetic effects?

A First of all, let me address the animal laboratories, species --

Q Yes.

A -- and things like that.

11-8

There are some effects with some animals, at least in terms of mutation rate changes.

And slime molds. And in terms of fruit fly to soft leather there has been no -- it is my understanding to date there has been no change or anything significantly found.

These, by the way, are extremely fields, in terms of two or three hundred kV, four hundred kV per meter.

On the other hand, there is a recent epidemilogical study in Sweden that was published in the last month in terms of 600 substation workers who had indicated there was perhaps slight chromosome damage. Now, that is not exactly responsive to your question, but it did manifest itself in increased rates of deformed children, of wives on the order of three to four times.

And these levels are, again, at substation levels, for substation workers who ware exposed to something like 25 to 50 kV per meter more than eight hours a day.

That is not a transmission line environment, obviously.

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11-9

BY MR. DOHERTY:

Q Did the authors of that study take any -- do any quantitative -- any analysis of their data in terms of observed and expected,and come up with any meaningful figures? Observed versus expected deformities, let's say.

A I have not had a chance to review the whole study, itself, so I can't say exactly what. I can only report what has been reported to the interagency committee at this point.

That is a summary of what was found to date. So, I don't know exactly how it was determined, or what was done. It was, again, an epidemilogical study, and it did imply at least in summarization that they did some chromosome mapping.

Q Well, not that I am terribly sympathetic to their cause, but how did the slime molds make out in these studies?

A I am not sure, again, if I can precisely say that one, except that that is still undergoing on the way. There is not a definitive report. It's preliminary investigations, and it is generally classified under genetic effects, and that was one of the research items that we are funding, but I am not really clear in my mind exactly what they are investigating, or how they are investigating.

Q Okay.

I think, again, in an exchange with Mr. Newman, you got into a brief discussion about an effect being a chronic stimulation, in regard to animal studies and

.1-10

exposure to electric fields.

Now, did you state that chronic stimulation was not found to be detrimental to the experiemental animal?

A. No. I did not.

I only explained that some of the results that have been reported have -- in trying to tie them together, the particular experitmenter has asked, "Well, what does this mean?"

First of all, he was very careful to say that he wanted to go into further study of the whole issue, and that he is not sure whether there is any beneficial, or any detrimental problem involved here.

His only observ ation at this time, both printed and orally, is that from his professioanl opinion it may be that these particular parameters, showing some statistical significant effect, are indications of what he called chronic stimulation from the electrical field.

I think he was careful to counterpose that to the stress argument.

Q. What is the "stress argument" that you speak of?

A. The stress argument is an argument that these particular parameters that are being shown are in fact indicative of stress, indicative of stress of the organism.

Q. Now was that the study by W. T Kaune and Philips? Is that the one you are speaking of?

11-11

A. Actually, 13, 15, or the group of large studies out of Battelle Northwest. Dr. Philips is the one that is actually the project leader of the group, and he is the one who has termed that chronic stimulation.

Q. All right.

Did any of these studies attempt to correlate any of this observation with the presence, or the amount rather, the level of serum triglyceride in the organisms, do you recall?

A. Dr. Philips in his studies on large numbers of rat and mice did look at serum chemistry, which in fact looked at serum triglycerides, and found that there were no significant effects.

Q. Okay.

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BY MR. DOHERTY:

Q Now, turning to Page 11, you quoted an opinion of some commissioners up in New York State and the well discussed issues around PASNY wire.

Does this say that a 345 k line is as bad as a 765 kV line? Is that what that quote says?

A I don't think it implies that, or says that. It just says that the risks -- what the risks are for a 756 line. That it will be no greater than the current ones that are in New York State.

Q I have editorialized slightly, but I want -- I think we've got it down.

Now, moving down to your conclusions on Page 11: "If ongoing research were to conclude that protective measures were warranted, a variety of actions could be considered including,..." and then you list some.

And then you say: "...increasing the width of right-of-way to limit the field strength to which the public would be exposed at the edge of the right-of-way;..."

Wouldn't that also include some type of fencing in order to make that of any value, sir?

A I am not including fencing. Certainly that would be another way of going about it, is restricting access to the public by fencing.

Q Well, what good would it do to increase the width

11-13

of the right-of-way, as you suggest, unless you can enforce some way of forcing the public to observe that?

A. Well, the only intent that I had in terms of that, would be to reduce the constant exposure of somebody that would be living right -- whose back yard, essentially, was right on the edge of the right-of-way.

To reduce that chance, to separate that particular living, the house away from the right-of-way by increasing essentially the right-of-way.

Essentially what I am saying is that I am not saying that one would necessarily have to restrict public use of a right-of-way.

I'm just saying that there has to be -- could be a possible scenario where you would just want to make sure that people who are living near a right-of-way there is greater spacial distance.

Q. Well, that would just apply to residences then.

A. Yes, sir.

Q. I would ask you how would increasing the width of a right-of-way to limit the field strength to which the public would be exposed at the edge of the right-of-way -- I would ask you how would that help with -- how would that help as a protective measure for any other group but residences?

A. I wouldn't, probably.

Q. Okay. We described a minute ago -- we were gesturing

11-14

back and forth about hands on trucks, and things like that.

Now, I wanted to go back and touch on the school bus and child situation, since I am alarmed, frankly, but, you know, that's just my situation.

Would it be the same sort of scenario, the child having his hand on the bus while getting on or getting off and grounding somehow to the street? Is that how this sort of thing would apply analogously?

A. They are similar analogies. School buses don't usually have handles. They usually have open doors, so there may not be any initial hand contact. There may be foot contact.

But, also, the school bus is sufficiently smaller than the -- what we are talking about, large anticipated vehicle. That, plus the fact that the 5 milliamp criteria is being adhered to in this case, you would not get a current greater than 5 milliamps.

Q. Do you know of any school district which has posted prohibitions under or near these power lines, or under or near any power line, essentially warning bus drivers not to put children on and off?

A. No. I know of no incidences of that.

Q. Okay.

You spoke in your testimony a bit earlier about the effect of, I think we call it thermal expansion. I am not going to be able to give you the exact reference. I think

11-15

this came from your oral testimony. Thermal expansion on transmission wires, that that was responsible for some of the sug --

A. Yes.

Q. -- to put it loosely.

A. Yes.

Q. Well, what about stretching, is that responsible for any of that?

A. I can't answer that. I'm not sure -- I just don't know.

Do you mean because of the conductor, the steel involved, the aluminum, or whatever, involving conductor there is probably some sort of specification to make sure that they don't stress, or don't stretch beyond a certain measurement.

But I don't know -- I can't answer that.

Q. Okay.

Also there was something that got a little cloudy. We spoke about parallel structures, and how much they would be involved in the field.

Then I think you also said the perpendicular ones were getting just about the same amount; is that right? Is there no difference?

A. No. I didn't say that.

I said that there is a possibility that perpendicular, say, structures or fences, right beneath a

11-16

right-of-way at the maximum field, could, in fact, accumulate fair charge, versus a parallel line or structure off the right-of-way that's further removed.

Q. Okay.

A. Remember, the maximum electric field is a defined area that is very small, and there is a possibility that in that one small area you could have something perpendicular to that. It's conceivable that you could in comparison with something off the right-of-way have a greater charge.

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11-17

BY MR. DOHERTY:

Q. On that point, what is the approximate area of maximum charge from one of these wires?

A. Very small.

Q. Okay.

A. I don't know offhand. I can give you --

Somewhere in my testimony I believe I talk about 20 feet from inside and outside the conductor.

Q. Yes.

A. I believe that's right. I'm not sure, 40 to 60 feet, so it would be approximately 20 feet wide.

The length would be not very long, because it is really at the maximum sag points where it is found. So at the most it could be 100 feet.

That I think would safely include -- that may be conservative, but that would safely include that the maximum field would be somewhere contained in this 100 feet long by 20 foot wide area, circular elliptical area.

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12-1

BY MR. DOHERTY:

Q Okay.

Do you know of any -- There has been quite a lot of talk about public education programs and whether they should be required or voluntary or what. Do you know of any public ed programs by any utility with regard to transmission lines?

MR. NEWMAN: Asked and answered. I object.

MR. DOHERTY: All right. Withdraw it.

BY MR. DOHERTY:

Q Now there has been a lot of discussion about various electric fields. I'll try to get specific here.

As in units of kilovolts per meter ... how uniformly distributed is that field over a meter, let's say? How does that seem?

A Well, vertically or horizontally?

Q Horizontally, please.

A Horizontally?

Q Yes.

A As we mentioned before, there are certain areas of very high fields.

You said horizontally, right --

Q Yes.

A -- as you go away from --

12-2

Q Let me see if I can make it a little clearer.

Suppose someone points to a wire and says, "The field under that is 6 kilovolts per meter."

Now thinking about a meter for a minute, would that mean if you took a device which would measure such a thing, would you get six, going from one end of that meter to another; or would you get some spikes and some dents; or what would you get?

A I've never seen an actual meter reading of how that ... in fact, the meters are calibrated kilovolts per meter. I'm not sure exactly what you would get.

I can give you a scenario where you would get a spike.

Q Would you?

A If you were in fact fairly close to an area of the maximum field, the defined small area that we've been talking about and you actually approached it fairly closely, moving the meter in ... say the one meter, perhaps would give you a conceivable jump of one or two kilovolts ... one kilovolt.

I don't think that there would be any spike greater than that type. It's fairly uniform, at least in the horizontal -- decreasing as you go away from the conductor and the source.

I don't think it involves over 39 inches a

12-3

group of spikes up and down.

Q All right.

A I don't think ... you know ...

Q And vertically then?

A Vertically is a more interesting case, because you in fact -- as I mentioned and testified before -- the convention is to use it approximately at one meter. And that's what everybody tries to do, to standardize the system.

If one were to move it within that one-meter space (one meter up, one meter down), especially moving down one could see a fantastic change.

It would mostly be a change to -- depending on the vegetation and shielding of vegetation, it could be a drastic change down to zero.

As I mentioned before in the testimony, as you approach the ground you get interference with vegetation along most rights-of-way.

As you increase, the change would be much more subtle in most cases, probably a meter higher ... on the meter -- a meter higher on the meter would in fact not show such a drastic change.

One meter ... from one meter to two meters would not show -- maybe would show on the average of 2 to 3 kV difference, read by the meter.

12-4

Q Okay, thank you. That was thorough, and I enjoyed that.

I have a few questions that Mr. Scott left me. No one can ask a question like Mr. Scott. So I'll do my best here. And some of these, I think, we've done, but ...

Now on page six, he wanted to know -- in the middle of the page there, your second answer, what is the relationship between the route mean square inducted current and the maximum current?

MR. NEWMAN: Objection. I don't understand that question. I believe it's vague. There is no relevance to any subject matter that has been previously testified to today.

MR. BLACK: I certainly would like to ask what the relevance is too. I --

MR. DOHERTY: Well, maybe I made a big mistake. I said it wasn't my question. I'll have a tougher time defending its relevance, and I hope the Board will keep that in mind.

What is it that you find vague? Is it the word "relation"? Is that the disturbing thing?

JUDGE WOLFE: That appears at page six. Therefore, it is derived from the witness' testimony. And you want clarification? Is that it?

12-5

MR. DOHERTY: Yes.

JUDGE WOLFE: Objection overruled. Answer the question.

THE WITNESS: If I understand the question, it is: What is the difference between the route mean square --

BY MR. DOHERTY:

Q No, the relation. It might be a difference, but it asks relation.

A Okay. The relationship between the route mean square of the field --

Q The inducted current ... the maximum inducted current.

You state in the answer on page six: "I believe that HL&P's present design clearances that maintain a maximum inducted current of 5.0 microamperes rms"--

JUDGE LINENBERGER: That's milliamperes.

THE WITNESS: Milliamperes. Right.

Okay. I'm going to say that in my poor biological training -- I am not going to be able to answer that satisfactorily.

Route mean square, in terms of 5 milliamps, I believe in this case it's not a significant difference, but that in engineering design, the five-milliamp criteria is quoted as five milliamps route mean square.

And they're always in most cases in terms of

12-6

route mean square, although sometimes the rms is not included and it's assumed in convention that that's what is meant.

All I can say is that it's a standard accepted way of evaluating that. In fact, there's other ways of calculating that don't involve route mean square, and that you would get a different answer.

But I cannot testify how significant that is.

BY MR. DOHERTY:

Q All right, thank you.

Staying on page six, what is the relationship between the steady state limit current and the maximum surge current?

A Page six ... let's see.

Can you point out where we are?

Q Yes. The steady state current limit is given by the National Electrical Code. That's at the top of page six.

A Yes.

Q And what is the relationship between that and the maximum surge current?

A I don't believe I used maximum surge current. Do I?

In fact, I can't find that in my testimony.

12-7

Q You didn't use that --

A They're both design parameters, but they both talk about different things entirely.

Q All right.

Now on page seven in measuring ozone concentrations, do you recall in those tests if they gave air stability classifications during the measurements?

A One of the tests used an air stability classification based on the nearest meteorological data source, which was an airport.

The other ones did not. None of them used air stability classes as defined in ... you know, at least no definition.

JUDGE LINENBERGER: Mr. Doherty, what is the significance of the air stability classification question here, please, sir?

MR. DOHERTY: Well, he mentioned six field tests which are in literature.

And weather conditions become a factor and determine the concentrations of ozone. Apparently, the question is to try to sharpen up on what these weather conditions were.

And there is an air stability classification system, according to Mr. Scott and according to the witness, apparently, which would further clarify what the

12-8

conditions were.

I think Mr. Scott was hoping all six of them had different classifications -- or perhaps the same classification ... but had the classification.

He has indicated that just one of them did.

JUDGE LINENBERGER: Well, was the concern about the diffusion rate of ozone once it forms?

MR. DOHERTY: It would seem to fit into factors of how weather diffused ozone into the environment.

BY MR. DOHERTY:

Q Now on page eight he wanted -- Well, where -- At the top of the page, where were these ozone detection devices placed in relation to the high voltage lines? Do you recall?

A I think I testified to that this morning, that the best I recall in all six of these experiments, at least in some of the experiments there were a variety of locations.

But I know definitely of the one experiment that tried to, in fact, correlate data generated by the theoretical models that we were talking about this morning, and there have actually been placed measuring detection devices in those areas.

So some of them were downwind several hundred

12-9

feet from the source and some were off the right-of-way, as I mentioned before, and some were at various locations within the right-of-way -- on the right-of-way.

Q All right. I only have a few more questions, so I hope you can bear with me.

One question is: Is there any locale in this transmission system where there will be parallel 345 kV lines?

MR. BLACK: Objection. Asked and answered, I believe, this morning.

(Bench conference.)

12-10

JUDGE WOLFE: I don't recall the previous question, so I'll overrule the objection.

THE WITNESS: I think Mr. Newman asked me this morning -- or someone asked me this morning if I was aware of a particular right-of-way having several parallel 345 kV lines.

And I stated at that point that I became aware that there would be other -- proposed other lines that would be next to the Allens Creek line that we are discussing.

I think that answers your question.

At least I think that there are proposed lines, lines to be built, that would be paralleling the line next to them at least.

BY MR. DOHERTY:

Q Now those lines are not part of this project, though, are they -- the Allens Creek project?

A I don't believe they are.

Q All right.

Now I believe you stated that the maximum effect would not be directly under the line, but rather to the side, something on the order of 50 feet, something like that.

Do you recall your testimony on that? Am I --

12-11

A Well, it's not necessarily directly under the line because if there's three circuits at different locations, it's -- What I'm saying it's not directly beneath a tower, but that it usually is located on the outside phase conductor, usually 20 feet to the outside of the outside conductor.

Q Did you say 20 feet to the ouside of the outside conductor --

A The maximum electric field is usually towards the outside conductor.

Q Would that mean hypothetically that if you had two such towers 40 feet from one another, side by side, that the fiels would coincide?

A I think I addressed this this morning. I don't know if 40 feet would in fact be the case. But they're certainly cancelling out, that in fact, that double circuit lines that are on top of each other will more than likely give you a greater field than two lines next to each other, because of the cancelling out effects that you would usually see.

That's why you do not see beneath the line right in the center of the right-of-way the maximum field, although you have perhaps three conductors. You would think that the two outside and the middle one, you would get a maximum field right in the middle of the conductors.

12-12

But in fact they cancel out each other, and the middle one cancels out the essential field on either one.

Therefore, you get the maximum field on the outside, not inside.

Q All right.

Well, I guess I see the cancelling out if you have a single tower. But if you have two towers side by side and start having some difficulty -- and I noticed you said very likely, how will there be a cancelling out, if it's two towers side by side?

A Well, I think I addressed this issue this morning. This is to me an unusual configuration. I haven't seen any real modeling of the field characteristics.

But it's my opinion that I don't think you would get an increase in the maximum field by putting two lines parallel next to each other.

What you would -- as I said this morning, you may get increases in the area of the maximum field.

Q All right.

Now let's change this to lines crossing one another instead of paralleling one another. Would you get a -- conceivably get an increase in the field at that point?

MR. NEWMAN: I'm going to object to that

12-13

question because there's no foundation in the record for it.

There's no foundation. There's no basis in the record for talking about lines that cross one another.

MR. DOHERTY: In the Environmental Report there is mention of crossing of some 345 kV lines at one point.

And I didn't come prepared for this, I'm afraid, but I know that there is a statement there, that there is one point in the system where that occurs.

(Bench conference.)

MR. NEWMAN: Do those involve the Allens Creek line, Mr. --

MR. DOHERTY: Yes, one set of them is the Allens Creek lines.

MR. NEWMAN: I'll tell you what, in the interest of getting on with this thing, let's see if the witness knows the answer to the question and get it over with.

JUDGE WOLFE: All right.

THE WITNESS: Yes.

I have never seen a configuration like that. I guess I would have to actually see the clearances, because I guess from experience I would think that there

12-14

would be some reliability problems doing that, and there may be a clearance between the two lines that is really extraordinary.

And so there's no way I could tell offhand, you know, how to ...

BY MR. DOHERTY:

Q Going to page ten on discussing biclogical effects to human of exposure to electric fields, the experiments by Philips cited on page ten, what were the measured unscaled electric field strengths for mice and rats in those studies? Do you recall?

A Yes. They were 60-hertz fields, up to 130 kV per meter for durations as long as four months. I believe they ranged from 100 to 130 kV per meter, unscaled.

Q All right.

Now on page 13 in the center of your large answer there about studies investigating electric field effects on small animals indicate that no major abnormalities ...

What were some of the non-major effects on small animals there?

MR. BLACK: I think that has been asked and answered. We got into the beehive, and I think he said that was the only one he was aware of.

(Bench conference.)

12-15

MR. DOHERTY: Okay, withdrawn.

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13-1 cf

Q Do these wires have a hum?

An audible sound?

A Well, these wires -- Will these lines, conductors produce a hum.

Yes, under certain conditions.

Q Is it a transient hum?

MR. NEWMAN: I'm going to object to that question, Mr. Chairman.

This witness hasn't testified as to any effects involving auditory sensations from the transmission lines; outside the scope of his cross-examination.

MR. DOHERTY: Well, the witness is supposed to present --

JUDGE WOLFE: The scope of his direct testimony --

MR. NEWMAN: Outside of his direct, excuse me.

MR. DOHERTY: I think the question is relevant to the witness presented on health effects of transmission lines.

I wish to ask him if there had ever been any cases of hearing loss due to residence being close to these lines.

I think that would be significant in the Board's determination.

13-2
cf

MR. NEWMAN: Why doesn't he put that direct question to the witness, and let's get on with that?

MR. DOHERTY: All right.

He's withdrawing the objection.

BY MR. DOHERTY:

Q Do you know of any studies or any reports of persons who have suffered hearing loss from living next to the transmission lines due to the hum of the them in use?

A No.

In all of the literature and studies that I have seen, there have been no mention or citations at all of any hearing loss.

MR. DOHERTY: That's good.

All right.

Thank you very much for your time with me, sir.

JUDGE WOLFE: Is there redirect, Mr. Black?

MR. BLACK: No questions.

JUDGE WOLFE: We will now have Board questions.

Judge Cheatum?

BOARD EXAMINATION

BY JUDGE CHEATUM:

Q I have a few small questions.

In answer to one of Mr. Newman's questions

13-3
cf

about the Marino reported studies.

You indicated something about questionable protocol; and in subsequent questions about research you used that term "protocol" on several occasions.

I'd like to know just what you mean by "protocol"?

I know of such things as autopsy protocols and things like that.

A. Well, at least, I can define what I mean in that context of what I am establishing as protocol.

One of the things that I have already mentioned to is the very important pre-test environment and measurement of that environment.

This is in terms of the electric fields in the -- in simple the adequacy of the measuring of the electrical fields, the adequacy of making sure that there are not some confounding problems going on once the field is energized.

In other words, testing the apparatus even before one is to induce the animals into that atmosphere to make sure that there are not any obvious defects. That is one.

Care and feeding of animals, maintenance of laboratory animals before, during and after test exposures.

13-4

cf

There is some doubt, it is not clear in the case of Dr. Marino, whether those were adequately undertaken.

There is a certain protocol that I understand that is disprudent in terms of validity of your final results, it is highly dependent on how you cared and treated for the animals prior to that.

Whether you brought the animals in for two weeks and immediately exposed them. Whether you brought them in for a long period of time, time to accustom to their surroundings, accustom them to their laboratory, you know, parameters that before you even turn on the field there is some doubt, in Dr. Marino's case, that this was done.

There is some doubt that the simple watering devise in this particular apparatus was not, in fact, giving off the shock.

It apppears that there may be some film evidence that the, again, the test facilities were not adequately grounded so, in fact, that there were shock, major shocks within the cage itself.

In fact, if you are looking for shock problems, that is one case; but if you are trying to look for electric field effects and exclude shock, which is what he was trying to do, then that confounds your

experiment.

That's generally the type of things that I am talking about in protocol.

That one looks at what one did in a test and has certain questions. Well, did you do this? How did you treat your animals? How was the field generated? How was the field within the cages tested, measured? Who did the measuring, how it was measured? Things like that.

Q Okay.

That defines the term pretty well for me.

In response to one of Mr. Rentfro's questions, you spoke about the National Electrical Safety Code Standard on kilovolt meters was changed in 1977 to five milliamps, amps -- yes, milliamps --

A Five milliamps.

Q Five milliamps.

What I would like to know is what was the maximum allowable before this 1977 change?

Do you remember?

A I don't believe I said to correct that, I don't believe I said it was changed.

I believe or I should have said that it was added in 1977.

Prior to that there were no standards.

Q Oh. I see.

Thank you.

Oh, yes. I'm curious about this phenomenon about the urban environment producing more ozone.

What is the affluent environment that produces more ozone?

A I believe the prime source are automobiles and exhausts from automobiles.

Q I see.

A And, the chemicals that come out of the automobile. A combination of light gives a reaction that produces ozone.

Q Okay.

In answer to one of Mr. Doherty's questions, he asked you about stress and what you mean by stress.

What is the stress phenomenon?

I don't believe you actually defined the word "stress" in your response.

I think you talked about stress, but you didn't define what you meant by stress.

A I think I tried to do that purposely, because no where in my testimony have I used the word stress.

I tried to characterize it that on this issue certain groups or certain people are saying that the data is indicative of classic symptomsof stress and then they

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go ahead and define that.

I'm not convinced nor do I even want to define or use their definition of stress.

I only mention the fact that where it has been used, it's a very --

Q Dr. Michaelson used it and I think he sort of defined it partly in terms of the study adaptation theory

A That may be a correct answer.

On the other hand, there are people who feel that stress is always a negative aspect; and that there are groups of people who believe that an organism is able to adapt to stress and that it could, in fact, be beneficial.

That's why I would like to stay away from it.

JUDGE CHEATUM: Thank you.

BY JUDGE LINENBERGER:

Q Sir, when you speak of a field intensity in terms of a certain number of kilovolts per meter, are you speaking explicitly of the electric field vector of an electro-magnetic field. You are speaking only of the electric field gradient that is part of the electro-magnetic field present?

A Yes.

That is a good observation that it is very

13-8

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confusing sometimes to say electro-magnetic field.

But, in fact, there is the electrical field component, and there is the magnetic field component.

Kilovolts per meter is talking about the electrical field versus the --

Q The electrical field component only.

I believe you indicated very early in your testimony today, with respect to the way you approach certain analyses that are involved starting with a five milliampere acceptable current and then proceeding, I thought I heard you say, from that to calculate a corresponding field strength.

Now, perhaps, I heard you incorrectly.

But, getting back to the question we were discussing a little earlier during Mr. Doherty's cross-examination.

It is my understanding that if a person, let's say walks barefooted or grounded into a 6 or 8 kilovolt per meter electric field gradient beneath a transmission tower that that field gradient is not sufficient to sustain in the person a 5 milliamp current.

Is that correct? Is that a correct statement?

A Yes.

Q In order to -- for the person to sustain

13-9
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a 5 milliamp -- or experience let's say, a 5 milliampere current, I would presume that the electric field gradient would have to be much, much higher than 6 or 8 kilovolts per meter.

Is that true?

A. Yes.

Q. Okay.

Now, let's put shoes on the person or ground him, isolate him from the ground even though he is standing on it.

And, let's place a large metal object next to him. I won't talk about a trailer truck because it is taller than the man.

I want to talk about a large metal object that stands no higher than the man, and it is also insulated from the ground.

Now, if an insulated man walks, a non-grounded man -- I mean a non-grounded man walks up and touches a large metal non-grounded object whose height is no taller than he is, will there be -- and these -- both of these, the person and the object beneath the transmission line, will there be a current passing between them?

Will there be a discharge one way or another man to object or object to man?

A. Well, there was one other parameter I guess I

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need besides the height.

What is the length?

Same size -- Is this metal object the same size, both height wise and width wise. Or is it longer?

That would make a fairly important --

Q Yes, it would and I was hoping you would think of that.

(Laughter)

If it is just a right circular cylinder whose diameter is equal to the height of the man, let's assume that.

A Who would discharge to who is the question?

(Laughter)

Q Well, yes. Let's not --

A Essentially.

I don't know. I mean I don't know the metal. I would say that the metal object has a possibility of passing a slight but, imperceptible -- I don't think, well, it certainly wouldn't be. It would be so imperceptible that you would not feel --

Q Yes. I wasn't trying to play tricks on you. I would assume that the metal object would have about the same voltage as the man; and, therefore, no charge would flow between them.

A Yes.

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Q Okay.

Now, let's go to the grounded man and the tractor, let's say, under the transmission line.

The tractor has built up a charge on it because its tires are non-conducting; the man in bare feet walks up to the tractor and touches it.

He is going to experience a surge of current through his body from tractor through him to ground, presumably.

A In that case, I don't think he will even experience it, I mean, in terms of perceiving it.

Q Well, that's what I was leading up to.

There will be a current flow, but are you -- I think you are saying that the current will be so small he will not be able to perceive it.

Is that --

A I would say the case that you are drawing with a 345 kV line certainly, that it would be less than one milliampere probably and considerably less in terms of -- If I could recall, there are a variety of these scenarios that we have discussed and there is data; but even with a 765 line, which is in my head right now that I am thinking about, I think it's well below the one milliamp.

And, the one milliamp current flow is

13-12

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something that's on the borderline of being preceivable.

Q Perceptable. Right.

Now, if I understand correctly, though, this would not be a steady-state current, in the sense of being constant with time.

It will be a discharge from the tractor through the man to the earth and will be a relatively rapidly quenched flow of current.

Is that correct?

A Well, it is in fact called a steady-state, the actual current flow is actually defined as a steady-state parameter that would in fact flow through -- a current would flow through the object.

I am not sure whether there is a sort of pulse of what is stored in the object that would -- and then as it is drained off, it would probably highly depend on the drain.

But I classify that as a steady state that it is constant. As long as the source of the electric field is flowing, therefore, the object that is the conducting object is there for absorbing that and as long as the person is in contact that current is constantly going through the person.

Q Current will be constant with time, you say?

A Yes.

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Is it -- Are transmission lines support towers normally grounded?

A. Yes.

Q. Does that mean, then, that as a safety measure, machinery or whatever in the vacinity of a tower, could throw a conducting chain or something from itself to the tower, and thereby effectively eliminate any source of annoyance to a person trying to use this or touch this piece of machinery?

A. Well, there are all sorts of engineering possibilities that a direct chain or chain attaching to a tower to ground it would be an effective way.

Q. You were discussing earlier this morning scaling factors with regard to effects -- extrapolating effects from animal studies to people, and you indicated the use of clay models; and microprobes to make measurements at various points in the clay models placed, I presume, in an electric or electro-magnetic field.

A. Yes, sir.

Q. I conceptually am curious here about the meaningfulness of the results one gets there because of the fact that conductivity patterns, current patterns in animals may be very different than current patterns in man. Whereas, in clay models man and animal to that extent may look very much alike. So, is there a problem here

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in deriving these scaling factors?

A Well, the scaling factors are solely meant not to measure internal current flow within an organism.

But, the external actual reaching of the skin.

And, that makes the difference of that. The perturbations are extremely interesting in that there is no such thing as a uniform field.

Q Is ozone normally produced fairly uniformly along the length of the conductor on a transmission tower. Is it produced more copiously in the vacinity of supporting insulators? Or, what can you say in that --

A Well, first of all because it is produced by corona and corona is not a uniform characteristic for lines at all in any sense of the imagination. That there is no uniform generating of ozone.

It is conceivable that near insulation strings, that there may be more generation, but I can't answer that.

I can definitely answer that there is not a uniform generation because corona discharges are not uniform.

Q Earlier when we were trying to sort out the extent of one of Mr. Rentfro's questions, we were -- I was making a contrast between a radiation field in which a person is placed and radiation effects may go on

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accumulating and damage may go on accumulating with time forgetting repair mechanisms for the moment; and ask you whether that kind of cumulative phenomenon takes place in an electro-magnetic field. At some point in discussing this you made the statement that one of the problems was establishing a threshhold for lethal doses. You used a term such as that.

Could you explain what you meant by that?

A. Well, the studies that I have looked at, and maybe it is my own ignorance, but I have never seen a definitive study going through any animal species looking for where a lethal dose was given.

Now, maybe it is already given in the literature or at certain level -- at a certain exposure for example.

First of all, an instantaneous exposure; and then a long term exposure. It is certainly the long term chronic exposures that have not shown any lethal relationships. The dose relationships are not established at this point.

Q. I'm afraid I didn't really define what -- completely what my question was about.

I presume you are talking about lethal effects so far as the size of an -- or the strength or grading of an external field that a person or form of

13-16
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of life is placed in.

Is that what you are talking about?

Not the amount of current flowing through that life form.

A. Right. That is exactly what I'm talking about. The external electric field. I think I made the point this morning that I wasn't talking about shock or electrocution, but in fact it is hard to establish that because once you get into higher field levels, if you are looking for a field effect in lethal, that you don't-- your instrumentation, your cages get to the point where it is hard to prevent the shock. Prevent shock from lethal doses. Or a shock that would cause a lethal dose.

JUDGE LINENBERGER: Thank you, sir.

I believe that's all I have.

BY JUDGE WOLFE:

Q. I understood you to say that the Staff is not considered wirefence shocks to animals causing them to shy. Is that correct?

The Staff has not considered that a problem?

A. I have not -- the particular scenario that was addressed by Mr. Rentfro, I have not personally considered, at least, in terms of a horse which is what the context was if I may explain myself, at which a horse would be startled into throwing off a child.

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I do recall after saying that that at least the Bonneville Experiment on the 1,100 kV line, the animals were in fact enclosed by a steel fence. Which I believe was left permanently, or unnecessarily or it was left ungrounded, so, in fact, it was able to build up a charge. And, that -- the general reports are that the animals did not, at least, under that test field show any aversion to that fence. But, I do not know if they in fact measured what sort of shock was being, you know, could be gotten from that fence.

Q I see.

All right.

JUDGE WOLFE: Is there any cross in light of Board questions?

Mr. Newman?

MR. NEWMAN: No, sir.

JUDGE WOLFE: Mr. Rentfro?

MR. RENTFRO: Yes, I have a couple of questions.

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RECROSS-EXAMINATION

BY MR. RENTFRO:

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Q On Dr. Cheatum's question concerning the protocol, we had quite a number of parameters of protocol, as I understood them. And it seemed to be revolving around Dr. Marino's study that he really had not observed enough of the standard protocol to have a valid experimentation.

My question is: On the other studies that were referenced, such as Philips and de Lorge, do we have definite evidence that they complied with all of these -- at least to the degree that we can assert or ascertain that Dr. Marino didn't?

Do you feel that there has been a fair evaluation of not only the lack of observation of the criteria on Dr. Marino's part, but perhaps also that these other people have -- that we're relying on for certain testimony --

Can we ascertain that they have followed all of the necessary protocol?

MR. NEWMAN: I'm going to object to that question, Mr. Chairman. I don't think that's fairly within the scope of Dr. Cheatum's question, which was aimed at getting a definition of protocol as used by the witness.

The witness did refer to Dr. Marino's studies.

14-2

But the purpose of the question was the definition of protocol.

And my concern is that this is not just one simple question. It involves an analysis of perhaps 10 or 15 studies that are reported in the witness' testimony.

I think we're departing now on a long road of questions that go way beyond where Dr. Cheatum intended to go.

(Bench conference.)

JUDGE WOLFE: Objection sustained.

Dr. Cheatum was just getting a definition really, Mr. Rentfro, for the use of the word "protocol," in general, and how it was used in the context of the witness' testimony.

MR. RENTFRO: The other question pertained to the question -- your question, Chairman Wolfe, concerning the reaction that animals might have.

My question is: Would Mr. Gears be familiar with just the standard commercial electric fences ... the reactions that animals have to that type of shock effect?

MR. NEWMAN: I'm going to object to that question, Mr. Chairman.

I think that that postulates a situation completely different from the one that was implicit in

14-3

your question.

I believe your question really related to the shock that might be experienced as a result of a fence being under a transmission line.

And this is some sort of an electrified fence, which I think would be ... that Mr. Rentfro is talking about.

JUDGE WOLFE: Isn't that so, Mr. Rentfro?

MR. RENTFRO: Yes, I think we are talking about ...

JUDGE WOLFE: All right. I sustain that objection too then.

Any other questions?

MR. RENTFRO: No.

JUDGE WOLFE: All right.

Mr. Doherty.

RECROSS-EXAMINATION

BY MR. DOHERTY:

Q I have a question on Dr. Cheatum's question. He inquired about a standard -- I think it was the one cited at the top of page six -- a moment ago. Is that right? Is that the one?

A I didn't hear the first part. The top of page six, a standard?

Q Yes.

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I think Dr. Cheatum inquired about it. Is that the one you had in mind when you answered his question?

A It has been a long day ...

Q Yes, it has.

A I guess I can't remember exactly what Dr. ... obviously.

Q Well, it was one you stated came into being in 1976 --

A Oh, yes, now I recall. Exactly. Yes.

Q Why was that added? What brought that about?

MR. BLACK: I object. That's certainly going beyond the scope of Dr. Cheatum's question. He just asked what the standard was prior to 1977, and this goes way beyond that, as to why it was developed after 1977.

MR. DOHERTY: Well, I would think it would be relevant to the question because he is actually inquiring into the history of standards for protection of people due to these wires.

And just the sudden appearance would add something to it.

MR. BLACK: And besides, it has been asked and answered.

I think that Mr. Gears has given a fairly long statement as to why the standards were developed and

14-5

the bases for those standards.

(Bench conference.)

JUDGE WOLFE: Sustained.

BY MR. DOHERTY:

Q Judge Linenberger asked you a moment ago about your definition of "steady state." Now thinking back over that long day, you used the term "steady state" with that definition in mind throughout the day?

MR. NEWMAN: I would object to that question, Mr. Chairman. I don't regard that as being related to any specific question that Dr. Linenberger addressed to this witness.

The question Dr. Linenberger addressed to this witness did not make reference to the way the term "steady state" was used throughout the testimony.

MR. DOHERTY: I believe Judge Linenberger inquired what he meant by "steady state" and how he defined it throughout the day, or how he defined it at all. Perhaps I'm mistaken.

JUDGE LINENBERGER: Excuse me, Mr. Doherty. I was asking whether under certain conditions there would be a steady state, rather than a transient current; "steady state" to me meaning constant in time.

And the witness answered there would be a current -- there would be a steady state meaning to him

14-6

constant in time.

So there was really no difference between us about the definition.

The only difference was that I was looking at a slightly different phenomenon than he was. But so far as definition, no, there was no difference.

MR. DOHERTY: Okay.

JUDGE WOLFE: The objection is sustained.

BY MR. DOHERTY:

Q From what source do you know that corona distribution is non-uniform?

A I didn't hear the last part of that question.

Q From what source do you know that ozone production is not -- or coronas rather, excuse me -- are non-uniformly situated on a wire?

MR. NEWMAN: That's asked and answered, Mr. Chairman, in the questions that Dr. Linenberger asked and the responses from the witness. He described how ozone was generated. There would be concentrations nearer insulators and produced more uniformly along the length of the conductors.

MR. DOHERTY: That's what he said, and I know he said that. But he didn't indicate from where he knew that, what studies or reports.

JUDGE WOLFE: Objection overruled.

14-7

THE WITNESS: Well, there's a variety of studies.

I guess the best source would be the -- what's called the "Transmission Line Handbook, 345 kV and Above," which I believe is published ... Well, anyway, it's a referenced textbook.

The main cause of corona, based on this article -- or this textbook and a variety of other articles ... the basic cause of corona are, in fact, defects in the line -- small gaps -- that are in fact usually standard imperfections along the line.

Therefore, my assumption is that based on that evidence, that you would not get a uniform distribution of defects; and, therefore, you would nct get a uniform distribution of ozone.

I believe Dr. Linenberger also suggested that it's possible that near insulators that you might get an increase in ozone. I'm not sure if I agree definitely with that.

I'd say it's a possibility, because there's a possibility of sometimes increased sparking and arcing near insulators, especially if they are damaged.

And, therefore, sparking and arc discharges are -- will produce corona, and corona will produce, in this case, ozone.

14-8

Q Thank you.

MR. DOHERTY: That was the last question.

JUDGE WOLFE: Any redirect, Mr. Black?

MR. BLACK: No questions.

JUDGE WOLFE: Is the witness to be excused permanently?

MR. BLACK: Yes, sir.

JUDGE WOLFE: The witness is excused permanently.

(The witness was excused.)

JUDGE WOLFE: Now as to tomorrow, I understand that we will have Applicant's witnesses presented individually, beginning with Mr. VanSickle, and then Mr. Finley --

MR. NEWMAN: And finally Mr. Schoenberger.

JUDGE WOLFE: All right.

MR. NEWMAN: Does that mean we're not going to be able to proceed any further this evening?

JUDGE WOLFE: Yes, that's right. It's getting late now. It's 5:25 now.

All right. We'll recess until 9:00 a.m.

(Whereupon, at 5:25 p.m. the hearing was recessed, to reconvene at 9:00 a.m., Wednesday, March 4, 1981 in the same place.)

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This is to certify that the attached proceedings before the

NUCLEAR REGULATORY COMMISSION

in the matter of: HOUSTON LIGHTING & POWER COMPANY

DATE of Proceedings: March 3, 1981

Docket Number: 50-466

Place of Proceedings: Houston, Texas

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

Mary L. Bagby
Official Reporter (Typed)

Mary L. Bagby
Official Reporter (Signature)