

PUBLIC UTILITY COMMISSION

ORIGINAL

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

Pages 1306 through 1367 Hearing Room No. 1
State Office Building
Broad and Spring Garden Streets
Philadelphia, Pennsylvania

Tuesday, December 17, 1991

Met, pursuant to adjournment, at 10:00 a.m.

BEFORE:

HERBERT SMOLEN, Administrative Law Judge

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C O N T E N T S

<u>WITNESSES</u>	<u>DIRECT</u>	<u>CROSS</u>	<u>REDIRECT</u>	<u>RECROSS</u>
James Michael Silva				
By Mr. Watson	1308	----	----	----
By Ms. McCloskey		1310	----	----
By Mr. Sugarman		1320	----	----

E X H I B I T S

<u>NUMBER</u>	<u>FOR IDENTIFICATION</u>	<u>IN EVIDENCE</u>
<u>Philadelphia Electric Company</u>		
✓ Rebuttal Statement No. 6 (Silva)	1309	1309

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P R O C E E D I N G S

1
2 JUDGE SMOLEN: We are ready to proceed this morning
3 with further evidentiary testimony?

4 MR. WATSON: Yes, Your Honor. I call James Michael
5 Silva.

6 Whereupon,

7 JAMES MICHAEL SILVA

8 having been duly sworn, testified as follows:

9 JUDGE SMOLEN: Keep your voice up. State your full
10 name and business address.

11 THE WITNESS: James Michael Silva, S-i-l-v-a,
12 ENERTECH Consultants, Campbell, California.

13 JUDGE SMOLEN: Counsel.

D I R E C T E X A M I N A T I O N

14 BY MR. WATSON:

15 Q. Mr. Silva, do you have before you a document
16 entitled Rebuttal Testimony of J. Michael Silva,
17 Philadelphia Electric Company Rebuttal Statement No. 6?

18 A. Yes.

19 Q. Do you have any additions or corrections to
20 that document?

21 A. Yes.

22 Q. Would you tell us what they are, please?

23 A. On page 15, line 18, there is a typographical
24 error. The first word on line 18, university
25

1 inadvertently has a "m" at the end. That should be
2 struck.

3 Q. All right. I know you have a cold and try as
4 best you can to keep your voice up. Feel free to let us
5 know if you need a drink of water or something.

6 Mr. Silva, if I were to ask you each of the
7 questions set forth in the document entitled Rebuttal
8 Testimony of J. Michael Silva while you were on the
9 witness stand under oath would your answers be as set
10 forth in this document?

11 A. Yes.

12 MR. WATSON: Your Honor, I move that the rebuttal
13 testimony and exhibits of Mr. Silva be admitted into
14 evidence subject to timely objection.

15 MS. McCLOSKEY: No objection, Your Honor.

16 MR. SUGARMAN: No objection, Your Honor.

17 JUDGE SMOLEN: They are received.

18 (Whereupon, the document was marked
19 as PECO Rebuttal Statement No. 6
20 for identification, and was
received in evidence.)

21 MR. WATSON: Thank you, Your Honor. I pass the
22 witness.

23 JUDGE SMOLEN: Ms. Burket.

24 MS. BURKET: No questions, Your Honor.

25 JUDGE SMOLEN: Mr. Dillon.

1 MR. DILLON: No questions, Your Honor.

2 JUDGE SMOLEN: Ms. McCloskey.

3 MS. McCLOSKEY: Thank you, Your Honor.

4 CROSS-EXAMINATION

5 BY MS. McCLOSKEY:

6 Q. Good morning, Mr. Silva. My name is Tanya
7 McCloskey and I represent the Office of Consumer
8 Advocate.

9 If I could turn first to your Exhibit JMS-2, where
10 you give us magnetic field environment for some domestic
11 appliances, what are the distances associated with these
12 levels of exposure that you have measured?

13 A. The distances vary depending upon normal use.
14 For example, on a can opener it would be at an arm's
15 length. These measurements were all made for the
16 appliances being operated at a distance that the
17 homeowner told us they used it. In some cases the
18 homeowner operated it or our people. For example, a can
19 opener was on the counter and it was used at an arm's
20 length away.

21 Q. Now, looking at page 16 of your testimony, on
22 line 28, you use the term similarity-based and you again
23 reference that on page 18, line seven of your testimony.
24 Am I correct that similarity-based essentially means
25 making magnetic field levels from new lines no larger

1 than those from existing lines?

2 A. Yes. Making them similar to existing lines,
3 yes.

4 Q. And when you use the term similar lines, how
5 would you describe similar? Let me give you an example.
6 Is it a 230 kV line compared to a 230 kV line? Is that
7 the definition of similar?

8 A. Yes. Lines and voltage classification.

9 Q. And would you agree that such a criterion does
10 not make any judgement on whether or not there is any
11 danger from existing lines?

12 A. Yes.

13 Q. And would you agree that such a standard is not
14 a health-based standard?

15 A. Yes.

16 Q. Now, for Pennsylvania, Mr. Silva, do you know
17 what the exposure levels are for the lines that would be
18 similar to the 230 kV line proposed by PECO in this case?

19 A. You mean for other 230 kV lines?

20 Q. Yes, in Pennsylvania.

21 A. Well, I would know only in a general sense. To
22 know in some kind of definitive sense one would have to
23 do a survey or perform calculations of all the 230 kV
24 lines. I am generally familiar with the 230 kV lines in
25 the state, having lived here for six years. And they

1 would be within the range, some lower and some higher
2 than the fields associated with this line.

3 Q. And the lines in Pennsylvania that would be the
4 similar lines to the PECO line, the PECO 230 kV line,
5 under a similarity-based approach, do you know when those
6 lines were designed or engineered?

7 A. I don't know when all of them would be. The
8 first 230 kV lines -- gee, I've forgotten the date they
9 were placed in service now. I was thinking it was in the
10 late '30's but I can't remember. Probably for close to
11 half a century some of the earliest ones have been in
12 service.

13 Q. Now, Mr. Silva, turning to the topic of your
14 walking tour of Langhorne, when you walked through
15 Langhorne, did you walk along the route of the proposed
16 transmission line?

17 A. No.

18 Q. And the equipment that you use in both your
19 walking tour of Langhorne and Philadelphia to measure the
20 E/MFs, does that capture any transients?

21 A. It would only capture transients if they were
22 coincident with the time the reading was taken, which is
23 every one-and-a-half seconds.

24 Q. So your equipment that you used was capable of
25 capturing the transient if it was coincident with the

1 reading times? Do I understand that?

2 A. If it was coincident with the reading time and
3 within the frequency spectrum of the meter it could
4 measure it.

5 Q. Now, turning to page 15 and your discussion of
6 prudent avoidance, I am going to ask you some general
7 questions concerning your discussion there.

8 When you are describing the concept of prudent
9 avoidance is it your opinion that prudent avoidance
10 should be -- at what point should prudent avoidance be
11 applied in the design, engineering and selection process
12 for the construction of a transmission line?

13 A. Well, prudent avoidance as it was described in
14 the Office of Technology Assessment paper originally does
15 not offer some time component or temporal component of
16 where --

17 JUDGE SMOLEN: I'm sorry. I didn't hear that. Can
18 you repeat that? I know you are having difficulty with
19 your voice.

20 THE WITNESS: The concept of prudent avoidance as
21 it was applied or explained in the Office of Technology
22 Assessment paper does not have a time or temporal
23 component. It is a loosely stated framework and it was
24 not specifically stated that it was to be applied in some
25 method or some fashion or some manner.

1 BY MS. McCLOSKEY:

2 Q. In your opinion, though, in working with the
3 concept of prudent avoidance and its application, at what
4 time in your opinion would you apply the concept of
5 prudent avoidance?

6 A. I mean, prudent avoidance could be applied
7 before or after a design. I mean, I am struggling a
8 little bit because we are trying to define something that
9 not much was written about. The author himself, who is a
10 friend of mine, specifically will tell you that he did
11 not mean for it to be --

12 MR. SUGARMAN: I'm objecting to this hearsay as to
13 what some other individual said.

14 MR. WATSON: Your Honor, this is an expert witness.
15 Experts are entitled to rely upon the information they
16 would normally rely upon in the practice of their
17 profession and particularly their expertise. And this
18 witness relies upon the statements of other colleagues in
19 the field in practicing and consequently it is not
20 subject to a hearsay objection.

21 MR. SUGARMAN: Your Honor, first of all, I would
22 point out that what is sauce for the goose is sauce for
23 the gander. I don't know how many times Mr. Watson
24 objected and was sustained to Dr. Liboff relying upon
25 information that he received from colleagues at meetings

1 much less in informal conversations. And the concept
2 that an expert can rely upon hearsay was one that I
3 asserted in response to those objections and was
4 overruled. That is one point. So I think there has to
5 be an equivalence as to the rulings on the use of oral
6 informal hearsay by experts.

7 Beyond that point, this is not -- does not even
8 rise to the level of a systematic investigation or
9 research effort but purports to describe generally what a
10 friend thinks and doesn't have the stature of even an
11 oral presentation at a conference.

12 JUDGE SMOLEN: Let's find out if it does or not.
13 What you were about to state, Mr. Silva, is that
14 presented in a paper? What you are relying upon.

15 THE WITNESS: Actually, what I was about to tell
16 was to relate what Dr. Morgan had said at an October
17 conference in San Jose when asked almost the exact same
18 question, and I was going to relate that.

19 JUDGE SMOLEN: At what type of a presentation was
20 it? At what function?

21 THE WITNESS: It was an EPRI conference in San Jose
22 in October and he was asked to speak on prudent
23 avoidance.

24 MR. SUGARMAN: And, Your Honor, again, I submit
25 that as Mr. Watson so eloquently stated in objecting to

1 Dr. Liboff quoting what colleagues had said at
2 conferences, we can't cross-examine about it and that
3 evidence was precluded.

4 JUDGE SMOLEN: Is it presented in a paper?

5 THE WITNESS: There are published proceedings with
6 his material in it, yes.

7 MR. SUGARMAN: But not with those comments, Your
8 Honor.

9 MR. WATSON: How would Mr. Sugarman know? He
10 wasn't there.

11 MR. SUGARMAN: Because I just heard the witness'
12 answers to the questions.

13 JUDGE SMOLEN: Let's find out from the witness.

14 THE WITNESS: I have not read what was published
15 for Granger.

16 JUDGE SMOLEN: I will sustain right now the
17 objection and ask you to proceed.

18 MS. McCLOSKEY: Thank you, Your Honor.

19 BY MS. McCLOSKEY:

20 Q. Now, looking at page 16 where you talk about
21 evaluating design features on lines six through 19, and
22 let's take a hypothetical example wherein a design was
23 selected and then after a design was selected additional
24 or optional design features were considered consistent
25 with the concept of prudent avoidance that showed other

1 designs may lower the electric and magnetic fields, in
2 your opinion, Mr. Silva, what would prudent avoidance
3 counsel in that situation?

4 MR. WATSON: Objection, Your Honor. It assumes
5 facts not in evidence. There is no showing there was any
6 design involved in this case that would produce lower
7 fields.

8 MS. McCLOSKEY: It's a hypothetical question.

9 MR. WATSON: Your Honor, hypotheticals have to have
10 some basis in fact in the record. Otherwise we are
11 engaging in speculation.

12 MS. McCLOSKEY: What we are trying to --

13 MR. WATSON: And there is no such information in
14 this record. I mean, it would also be -- we could ask
15 him assumptions about the transmission lines really don't
16 carry electricity. We could be discussing that. The
17 assumptions have to have a basis in the record, otherwise
18 your just engaging in speculation.

19 MS. McCLOSKEY: Your Honor, it is trying to test
20 the parameters of the concept of prudent avoidance and
21 its application. It is a hypothetical question in an
22 attempt to test those parameters.

23 JUDGE SMOLEN: I am going to sustain. Maybe you
24 can try to rephrase it and see if you can get what you
25 want on a different question.

1 BY MS. McCLOSKEY:

2 Q. If you could look at page 17, lines 12 through
3 15, the sentence ends with the clause "almost equal
4 cancellation of the balanced phase currents". Could you
5 please explain for us what is meant by the last part of
6 that sentence?

7 A. The balanced phase currents? That part?

8 Q. Yes. The almost equal cancellation of the
9 balanced phase currents.

10 A. The three phases of a transmission line have --
11 can have different types of resistance to the flow of
12 electricity because of their geometry and their position.
13 And some current can flow more in small amounts in some
14 phases rather than others so that the magnitude of the
15 current in the three different electrical phases may not
16 be the same.

17 My changing the positions of the wires in these
18 phase rolls it would be assured that the currents would
19 be equal, be almost equal, as the engineering in me --
20 engineers never make absolute statements. If that is the
21 case, that the currents are equal or almost equal, then
22 the cancellation of the fields with distance is very
23 effective.

24 Q. Let me try one last question, Mr. Silva. In
25 your opinion what is the usefulness of the concept of

1 prudent avoidance if it is applied after a line is
2 designed and construction has begun?

3 A. It accomplishes the same purpose that it was
4 intended for.

5 Q. What is that purpose that it accomplishes?

6 A. To alter field exposure.

7 Q. How does it alter field exposure if it is
8 applied after the line is designed and constructed?

9 A. Fields would be lower.

10 Q. After the line is designed and constructed.
11 How would it alter fields after construction is
12 completed?

13 A. The fields would be lower than if it was not
14 implemented.

15 Q. If prudent avoidance is implemented following
16 the design and construction of the line, afterwards, it
17 is a retrospective look, how does it alter the field
18 levels in any way?

19 A. When it is implimented, it does -- if I can
20 give an analogy from the OTA report itself, they suggest
21 that prudent avoidance might be buying an appliance if it
22 was available that had very low field levels. But the
23 prudent part of prudent avoidance, the OTA report goes on
24 to explain, would not indicate using that appliance until
25 your old one wore out.

1 A. I offer on page 15 --

2 Q. Well, you offer a whole paragraph that --

3 MR. WATSON: Objection, Your Honor. This is
4 argumentative. He at least ought to be entitled to
5 answer the question.

6 JUDGE SMOLEN: Let him answer.

7 MR. SUGARMAN: I thought he was finished.

8 BY MR. SUGARMAN:

9 Q. I'm sorry. With your cold you, slowed down,
10 and I didn't realize you had more to say.

11 A. That's okay. I am speaking a little slower.

12 At page 15, line 25, through page 16, line three, I
13 describe the framework that has been suggested in prudent
14 avoidance in some detail and the assumptions that have
15 been outlined in it. Above, on page 15, lines 17 through
16 20, I state where that came from. It came from its
17 initial introduction in the OTA brochure and also the
18 brochure that Carnegie-Mellon produced.

19 Q. Would you tell me where I would find your
20 definition of prudent avoidance?

21 MR. WATSON: Objection, Your Honor. Asked and
22 answered.

23 MR. SUGARMAN: Your Honor, there is no definition
24 in there. He didn't say there was.

25 MR. WATSON: That is argument. Put that in the

1 brief.

2 JUDGE SMOLEN: That is argument. I'm going to
3 sustain that. Try another question.

4 BY MR. SUGARMAN:

5 Q. How do you define prudent avoidance? Where is
6 the definition?

7 MR. WATSON: Objection, Your Honor. The same
8 objection.

9 MR. SUGARMAN: Your Honor, there is no definition
10 in there.

11 JUDGE SMOLEN: Well, that is argument.

12 MR. SUGARMAN: And he didn't say there was.

13 JUDGE SMOLEN: Then you're arguing.

14 MR. SUGARMAN: But he didn't say there was, Your
15 Honor. He didn't say there was. He didn't offer a
16 responsive answer to my question.

17 JUDGE SMOLEN: Ask it again.

18 BY MR. SUGARMAN:

19 Q. Where is the definition of prudent avoidance?

20 JUDGE SMOLEN: I will let him answer this time.

21 Do you want to answer? Go ahead, you answer the
22 question.

23 A. The source document and, if you will,
24 definition is in the OTA assessment. My explanation of
25 that in which I define the framework itself and the

1 assumptions and implement it are on page 15.

2 BY MR. SUGARMAN:

3 Q. But you agree with me that nowhere in your
4 testimony is there a definition of prudent avoidance?

5 MR. WATSON: Objection, Your Honor. It's asked and
6 answered now at least twice.

7 MR. SUGARMAN: Your Honor, I am entitled to a
8 direct answer.

9 MR. WATSON: That is purely argument. He can put
10 it in his brief.

11 JUDGE SMOLEN: The witness has, I believe, answered
12 that his definition of prudent avoidance is contained on
13 the bottom of page 15 and the top of page 16.

14 MR. SUGARMAN: Your Honor, he has not said that.
15 He won't say that.

16 JUDGE SMOLEN: I think he said it twice.

17 MR. SUGARMAN: It's not true and he won't say it
18 because he knows it's not true.

19 MR. WATSON: Your Honor --

20 MR. SUGARMAN: Your Honor, may I finish what I am
21 saying and then Mr. Watson can make all the speeches he
22 wants to?

23 JUDGE SMOLEN: Go ahead.

24 MR. SUGARMAN: If Your Honor will look at that
25 closely, the question -- it does not ask him to define

1 it. The question says would he please briefly describe
2 it. And what he offers is a statement that it's a
3 framework, and it's not a definition. And you go on and
4 read through that paragraph and nowhere in there is a
5 definition.

6 When I asked him the question three times he won't
7 say that is a definition because he knows it's not a
8 definition. And if Your Honor will listen back to the
9 transcript in each case he says it's a framework or he
10 says the definition appears in a source -- the last time
11 he said the definition appears in the source document.

12 JUDGE SMOLEN: All right.

13 MR. SUGARMAN: And I agree with that. The
14 definition does appear in the source document. But it's
15 nowhere in the witness' testimony.

16 JUDGE SMOLEN: Is the definition of prudent
17 avoidance as appears in the source document, does that
18 appear on page 15, the bottom and top of page 16?

19 THE WITNESS: I have only summarized part of what
20 is in the source document here, Your Honor, in my answer.
21 I would not say that in one paragraph I could restate all
22 these pages.

23 JUDGE SMOLEN: Very good.

24 BY MR. SUGARMAN:

25 Q. In PECO's brochure entitled E/MF, which is

1 Cross-Examination Exhibit 1 --

2 MR. WATSON: Could we have the witness look at the
3 document, please, Your Honor?

4 MR. SUGARMAN: Sure.

5 BY MR. SUGARMAN:

6 Q. PECO defined prudent avoidance as follows:

7 "Prudent avoidance is simply common sense reduction of
8 your exposure to electric and magnetic fields."

9 Would you agree that that is a definition of
10 prudent avoidance? Would you agree with PECO.

11 MR. WATSON: Let me see.

12 JUDGE SMOLEN: While the witness is looking at
13 that, I am going to ask Mr. Sugarman, don't those words
14 more or less appear on page 15, line 27?

15 MR. SUGARMAN: No, sir. I wish they did.

16 JUDGE SMOLEN: Lines 26 and 27 of the witness'
17 testimony?

18 MR. SUGARMAN: No, sir, they don't.

19 JUDGE SMOLEN: "And for considering actions that
20 might alter exposure to electric and magnetic fields."

21 MR. SUGARMAN: No. You will notice that the word
22 "alter" is substituted for "reduce". And if you go on in
23 that paragraph, he says you can balance increases on one
24 day with decreases on another day.

25 JUDGE SMOLEN: All right. Let's have the witness

1 answer.

2 MR. SUGARMAN: And the verb is consider instead of
3 reduce.

4 JUDGE SMOLEN: Let's have the witness answer your
5 question.

6 (Witness perusing document.)

7 BY MR. SUGARMAN:

8 Q. I was going to take it back from you when you
9 were done with it. But my question is do you agree with
10 PECO's one sentence definition of prudent avoidance?

11 A. Well, I am trying to get past being an engineer
12 here and I probably would say in general I would agree
13 with this statement. There would need to be some
14 qualifiers to have a more precise -- just as I had
15 answered a question before you asked me questions, I used
16 layman's terms to describe something and very generally
17 gave an answer. I would think this is a very general
18 layman's answer. If you are wanting to dissect one
19 sentence, then you might need more words to explain what
20 prudent means, what avoidance means and so forth.

21 Q. You would agree with me that your statement on
22 pages 15 and 16 of your testimony is much less direct.

23 MR. WATSON: Objection, Your Honor. That is
24 argumentative.

25 MR. SUGARMAN: I don't know how many hundreds of

1 questions --

2 JUDGE SMOLEN: I am going to sustain it. I don't
3 know what you mean by much less direct.

4 BY MR. SUGARMAN:

5 Q. You will agree with me that your statement on
6 pages 15 and 16 of your testimony is much more equivocal.

7 MR. WATSON: Objection, Your Honor.

8 JUDGE SMOLEN: Sustained.

9 BY MR. SUGARMAN:

10 Q. You will agree with me that your definition --
11 I'm sorry, Your Honor -- that your description of the
12 concept of prudent avoidance does not contain any
13 unqualified recommendation to reduce exposure and thereby
14 differs from PECO's definition.

15 MR. WATSON: Objection. Your Honor, it's
16 argumentative again.

17 JUDGE SMOLEN: The second part is.

18 MR. SUGARMAN: Your Honor, every cross-examination
19 question that Mr. Watson ever asked was argumentative if
20 that is argumentative.

21 JUDGE SMOLEN: The second portion, I believe, is.
22 There are two questions anyway. I am going to sustain as
23 to the second half of the question. Answer the first
24 half and then Mr. Sugarman can go on with the second half
25 if he wants to.

1 BY MR. SUGARMAN:

2 Q. You will agree with me that your description of
3 the concept of prudent avoidance does not contain any
4 recommendation to reduce exposure.

5 A. Actually, I do talk about lowering fields on
6 page 18.

7 Q. Page 18?

8 A. Yes.

9 Q. I was talking about your description of the
10 concept on pages 15 and 16.

11 A. I feel that my discussion has more information
12 than the one sentence thing that you gave me.

13 Q. I'm not talking about how much information it
14 has. I am talking about whether -- the fact that
15 something contains a lot more information does not
16 necessarily deal with the question I asked you.

17 The question I asked you is your discussion or your
18 description of the concept of prudent avoidance on pages
19 15 and 16, which is what you referred to when I asked you
20 where you defined the term, nowhere in it is there any
21 recommendation to reduce exposure, isn't that correct?

22 MR. WATSON: Objection, Your Honor. It is
23 argumentative. He can argue what he thinks the
24 statements includes and what it doesn't include. The
25 witness can't rule on what it includes or does not

1 include. It's written there.

2 JUDGE SMOLEN: Let me speak. I think the witness
3 answered the question the first time that although it may
4 or may not include it on 15 and 16, and he is entitled to
5 go on and explain, he has some recommendation on 18.

6 MR. SUGARMAN: But, Your Honor, the point is that
7 his whole analysis of prudent avoidance is based on a
8 concept which he describes differently from what the
9 company describes. And naturally his recommendations
10 will not have -- will not be the same as they would be if
11 he adopted the company's definition of prudent avoidance.

12 JUDGE SMOLEN: Well, you are arguing.

13 MR. WATSON: That is classic argument.

14 MR. SUGARMAN: What I am saying now --

15 JUDGE SMOLEN: Let him finish.

16 MR. SUGARMAN: Your Honor, this is incredible. If
17 you go through Mr. Watson's questions on
18 cross-examination every one of them could be defined as
19 argumentative. And argumentativeness cross-examination
20 is not only permissible, it is common. But my questions
21 aren't anymore argumentative than Mr. Watson's were. And
22 I think I am entitled to have the same standard applied
23 to my questions and he is not entitled to say something
24 is argumentative and therefore it's not allowed. There
25 is no such rule in cross-examination.

1 JUDGE SMOLEN: Lawyers are entitled to make
2 objections on whatever they believe is objectionable.

3 MR. SUGARMAN: I agree with that. But his
4 objections are --

5 JUDGE SMOLEN: We are just waiting record time.
6 You have a question outstanding to the witness. He can
7 answer the question with respect to pages 15 and 16.

8 MR. SUGARMAN: That is what I am asking him to do.

9 JUDGE SMOLEN: But he can also explain his answer
10 by other references to his testimony, and I believe that
11 is what he was trying to do. So instead of wasting
12 record time --

13 MR. SUGARMAN: But he hasn't answered it on pages
14 15 and 16.

15 JUDGE SMOLEN: Let's find out if he has. Ask it
16 again and we'll see.

17 BY MR. SUGARMAN:

18 Q. Isn't it true in your description of the
19 concept of prudent avoidance on pages 15 and 16, which
20 you referred to as containing your definition, you don't
21 make any recommendation to reduce exposure?

22 MR. WATSON: The same objection, Your Honor.

23 JUDGE SMOLEN: Overruled.

24 MR. WATSON: I had to make it anyway.

25 JUDGE SMOLEN: That's all right.

1 A. Prudent avoidance itself says that. On page 17
2 I say that. At page 17 lines 15 through 17, I say, for
3 example, "These design considerations result in lower
4 field levels at modest effort, and are consistent with
5 the concept of prudent avoidance." And on page 18 I make
6 a similar statement.

7 BY MR. SUGARMAN:

8 Q. Now, if you had applied that language, and you
9 are saying it is consistent -- when you say it's
10 consistent with the concept of prudent avoidance on page
11 17, do you mean that -- see, something can be consistent
12 whereas the opposite would not be inconsistent. Do you
13 understand that concept?

14 A. Well, I think I do.

15 Q. Okay. Now, when you say that it's consistent
16 with the concept of prudent avoidance to have lower field
17 levels at modest effort, are you saying that it would be
18 inconsistent with the concept of prudent avoidance not to
19 have lower field levels at modest effort?

20 A. Could you say that one more time to make sure I
21 understood?

22 Q. Again, let me start with the logical premise.
23 Something can be consistent with a concept and the
24 opposite of that something might not be inconsistent.
25 Isn't that true?

1 (Pause.)

2 Q. In other words, my being here today is
3 consistent with my being alive but if I weren't here
4 today that would not necessarily be inconsistent with my
5 being alive.

6 A. For that example, yes, I understand.

7 Q. What I am asking is when you say that the lower
8 field levels at modest effort is consistent with the
9 concept of prudent avoidance, I am asking you if not
10 having lower field levels at modest effort is
11 inconsistent with the concept of prudent avoidance, or is
12 that equally consistent?

13 A. Not having lower field levels at modest cost?
14 In other words, you spent modest cost and you did not
15 achieve lower field levels --

16 Q. No, you didn't spend any money. I am asking if
17 you don't spend modest effort to achieve lower field
18 levels, is that inconsistent with the concept of prudent
19 avoidance?

20 A. Well, the concept of prudent avoidance is
21 expending modest efforts in having lower exposure or
22 lower field levels.

23 Q. So therefore you would then say that not to do
24 so, that is, not to make modest effort to get lower field
25 levels, is inconsistent with the concept of prudent

1 avoidance?

2 A. That's not true if it turned out that it would
3 take large costs.

4 Q. No, no. Modest. I'm saying you are saying to
5 my and to the Commission that not to try to lower field
6 levels at modest effort is inconsistent with the concept
7 of prudent avoidance. Where you can do it at a modest
8 effort, then not to do it would be inconsistent with
9 prudent avoidance?

10 A. I think I understand what you are asking, and
11 the reason I was struggling is that that implies that the
12 decision has been made to apply prudent avoidance. I
13 guess you have to --

14 Q. That does make that assumption, that is
15 correct. Which you have made in your testimony, haven't
16 you?

17 A. If prudent avoidance, either in some manner,
18 either accidentally or on purpose has been applied, then it
19 should be done at modest cost and result in lower field
20 levels.

21 Q. You are not answering my question, sir. You
22 are answering a different question. The question I am
23 asking you is the concept of prudent avoidance, is it
24 inconsistent with that concept not to expend modest
25 effort to achieve lower field levels?

1 A. I guess I am struggling with the two negatives.
2 Not inconsistent --

3 Q. No, no, I didn't ask that. I said is it
4 inconsistent with the concept of prudent avoidance.

5 A. In other words, not prudent avoidance.

6 Q. To not make modest efforts.

7 A. It's not prudent avoidance to not make modest
8 efforts? Is that what you are saying?

9 Q. Right.

10 A. It's not prudent avoidance to not make...

11 (Pause.)

12 A. I'm still not sure. It's not prudent avoidance
13 if you don't make modest efforts? Is that what you are
14 saying?

15 Q. Right. I am asking if you agree with that
16 proposition.

17 A. Well, I don't think that prudent avoidance
18 requires that it has to be -- I think the result is lower
19 fields. That is what it leads to.

20 Q. Yes, at modest efforts. But I am asking you --
21 you see, the statement is made here by PECO prudent
22 avoidance is simply common sense reduction of your
23 exposure. And in your testimony you don't say -- I don't
24 find anywhere where you say that. You say that lower
25 exposure at modest efforts is consistent with the concept

1 of prudent avoidance. But the word consistent does not
2 imply that the opposite is inconsistent so I am trying to
3 find out whether you agree with that. Yea or nay? I'm
4 not trying to put words in your mouth. It could be that
5 you think that not making modest efforts is also
6 consistent with the concept of prudent avoidance.

7 MR. WATSON: I think we have somewhat of a
8 quadruple question here, Your Honor, at this point.

9 JUDGE SMOLEN: Well, I think the question is clear.
10 This is a sophisticated witness. I think the witness is
11 capable of understanding the question.

12 A. All I can say is that if the end result is in
13 lowering fields then that is prudent avoidance. And if
14 you have not lowered fields then it's not.

15 BY MR. SUGARMAN:

16 Q. I am asking you if I'm the utility, or if I am
17 an individual, and I make no efforts, I sleep right next
18 to my toaster and leave it on, I stand immediately
19 adjacent to my microwave oven at all times, I do those
20 things, is that inconsistent with the concept of prudent
21 avoidance?

22 A. It would be inconsistent with my understanding.

23 Q. Of prudent avoidance?

24 A. Yes.

25 Q. Okay. Thank you.

1 Now, did you --

2 A. I am struggling a little bit because prudent
3 avoidance as stated by Dr. Morgan is so loosely defined,
4 it's not very precise.

5 Q. I understand that. I just wanted to find out
6 whether you subscribe to that definition, and you have
7 answered my question. So I appreciate it.

8 Now, let me ask you this: under some circumstances
9 might prudent avoidance entail adding to the distance
10 that one thing is from another? For example, PECO says
11 don't stand close to your microwave oven, your dishwasher
12 or your television set while they are. Do you agree with
13 that concept, increasing distance?

14 MR. WATSON: Your Honor, could we have the document
15 shown to the witness?

16 JUDGE SMOLEN: Let the witness see that.

17 MR. SUGARMAN: Yes.

18 BY MR. SUGARMAN:

19 Q. Increasing distance. It's the next sentence
20 after the one that I read before. Some cases in point,
21 it says.

22 (Witness perusing document.)

23 A. I would agree with increasing distance as long
24 as it didn't do something outrageous like means that you
25 could no longer operate an appliance or something. That

1 would be consistent with what the authors state,
2 increasing distances.

3 Q. In fact haven't you said in your testimony that
4 E/MF does -- magnetic fields have the characteristics of
5 declining rapidly with distance?

6 A. Yes.

7 Q. Now, would you agree, then, with the concept of
8 wider corridors or rights-of-way to buffer homes and
9 playfields from transmission lines?

10 MR. WATSON: Objection, Your Honor. Lack of
11 foundation. There is no definition of wider than what.

12 MR. SUGARMAN: I don't need a definition any more
13 than that at this point. It's a concept, the same as it
14 was in the previous question.

15 JUDGE SMOLEN: Well, I am going to sustain because
16 if it's 20 miles wide, the basis of your question, and
17 then you say wider than 20 miles, it's not clear in the
18 record as to what you mean. Wider than what?

19 BY MR. SUGARMAN:

20 Q. Would you agree that transmission line
21 corridors of 150 feet are preferable to transmission line
22 corridors of 75 feet in terms of buffering from homes and
23 playfields?

24 A. It may or may not be preferable.

25 Q. Are you saying that there are conditions where

1 75 feet would be better than 150 feet? Or are you saying
2 that there may be no difference between the two?

3 A. There may be no difference; one may be better
4 than the other.

5 Q. You say one may be better than the other. Are
6 you saying there are cases where 75 foot -- all other
7 factors being equal. Maybe I didn't include that in my
8 question. All other factors being equal, the voltage,
9 the phasing, the delta configuration or whatever, are you
10 saying that there could be cases where a narrower
11 corridor could be preferable -- a 75 foot corridor could
12 be preferable to a 150 foot corridor?

13 A. Yes.

14 Q. From an E/MF point of view?

15 A. Yes.

16 Q. What would that situation be?

17 A. As the OTA document reports, if it's discovered
18 at some later date by researchers that there is a health
19 impact from electric and magnetic fields, one of the
20 things that is unknown is dose, what characteristic or
21 aspect of the field is significant. One of the things
22 discussed extensively in the OTA report is the concept of
23 windows and that some field levels have an effect and
24 others don't. Specifically, a high field level may not
25 have an effect but a low field level would. If by

1 widening something and causing people to be in one field
2 instead of another, you actually could have a situation
3 where it would be better to have a smaller corridor and
4 people closer than farther away.

5 And that specifically is mentioned -- not that
6 specifically. That problem is mentioned in applying --
7 that is why prudent avoidance is recommended, because we
8 don't know for sure what aspect of the field if any is
9 causing an effect, and this concept of windows is
10 something that leaves you to grapple with the problem not
11 not knowing how to change exposures for sure. So
12 therefore prudent avoidance counsels only modest expenses
13 until we know for sure which way to change things, if at
14 all.

15 Q. I thought that you agreed a moment ago that
16 proximity was something to prudently avoid. That is to
17 say that within the concept of not knowing and accepting
18 the range of uncertainty that you expressed that --

19 A. You see --

20 Q. Wait. I thought you agreed a moment ago with
21 PECO's statement that you are better than off further
22 away from your microwave oven, your dishwasher or your
23 television set. And what I heard in your answer just now
24 was that you might be better off if you stood closer to
25 it.

1 A. Could be.

2 Q. Which is your position?

3 A. A number of times in the OTA report they say
4 specifically that we do not know if more is worse. In
5 general --

6 Q. I understand they are saying they don't know.

7 MR. WATSON: Your Honor, I would like for the
8 witness to be able to finish his answer.

9 JUDGE SMOLEN: Yes. Let the witness answer.

10 MR. SUGARMAN: I'm sorry. I thought you were
11 finished. Go ahead.

12 MR. WATSON: You can tell if he keeps talking.

13 MR. SUGARMAN: I'm sorry to cut you off.

14 A. That's okay.

15 In general, the OTA report and I have stated and
16 you are telling me that PECO has stated that moving
17 things away are actions that people take. I would agree
18 with that in a general way. But on page 15 I bring up
19 this thing about dose and that it's not clear that we
20 know what dose is.

21 This whole concept of knowing whether more is worse
22 or not is important. If it turns out at some later date
23 that we learn for sure there is a health problem, we
24 don't want to take actions that will turn out to be
25 either not useful or to place people in situations that

1 could have a bad effect. That is why prudent avoidance
2 suggests doing things.

3 To me, the idea of buying a low field appliance but
4 then not using it until your other one wears out provides
5 a context for understanding how far overboard you should
6 go on appliances and all these things until we have more
7 information.

8 BY MR. SUGARMAN:

9 Q. But why not buy a higher E/MF appliance and use
10 it until the old one wears out?

11 A. You could.

12 Q. Your testimony a moment ago was by the concept
13 of windows and dosage more E/MF might be healthy for you.

14 MR. WATSON: I think that is a mischaracterization
15 of Mr. Silva's testimony.

16 BY MR. SUGARMAN:

17 Q. Please correct my misunderstanding of your
18 previous testimony.

19 A. I told you what the OTA report said. It said
20 that we don't know that more is worse.

21 Q. But you said that in response to my question
22 about your opinion, because it's your opinion that is
23 here today. If you don't share the OTA opinion please
24 say so, or what you are attributing to OTA as an area of
25 uncertainty. You see, I feel like I'm not getting the

1 whole thing here so I am trying to get the whole thing.

2 Let me start again. Are you saying that you are
3 unable to express a preference between having more E/MF
4 exposure and less E/MF exposure?

5 A. Well, I can answer the question by saying that
6 in general the guidelines are to lower E/MF exposure.

7 Q. And do you agree with that?

8 A. However -- let me finish -- you have to be
9 careful in applying absolute statements or just lifting
10 that one thing out without reading all of the things that
11 the OTA report warns and cautions about. Basically you
12 are dealing with something in which the measure of dose
13 is not understood or known and therefore they counsel
14 doing simple things that might lower exposure that don't
15 cost a lot, realizing that it may be a wasted effort in
16 the long run.

17 Q. I realize that. But why don't you advise
18 higher dosage at low cost, realizing you that may be
19 wasting your money in the long run? If you are saying --
20 if you are putting equal -- coming back to my question
21 about the width of the transmission line corridor, that
22 is how we started this and that is the thing that is
23 relevant to this proceeding, are you saying that in your
24 opinion it could be equally -- it could have equal
25 potential for benefit to humans to narrow -- to get

1 closer to the transmission line than to get further away
2 from it within the -- again, the distance being 75 versus
3 150 feet? That it's equally possible that people will be
4 better off at 75 feet by getting closer to it than at 150
5 feet?

6 MR. WATSON: Your Honor, I have to object on the
7 grounds that it's a very compound question. I mean,
8 there are at least four or five runs at it.

9 JUDGE SMOLEN: I think I have to agree with
10 Counsel? Why don't you try to simplify the question.

11 MR. SUGARMAN: I will try to rephrase it.

12 BY MR. SUGARMAN:

13 Q. Are you saying that in your opinion there is no
14 preference as between the a 75 foot corridor and a 150
15 foot corridor?

16 A. I said in general things that would lower the
17 field level are consistent with the concept of prudent
18 avoidance. So if you had a wider corridor and resulted
19 in lower field levels that would be an application of
20 prudent avoidance.

21 However, you should understand that that may not be
22 a benefit overall because of this problem with dose. And
23 I want to be careful not to interpret the OTA report that
24 states what prudent avoidance is. You can read it for
25 yourself and reach your own conclusions on this thing

1 about dose. But it says and it warns you in several
2 places, in the policy implications section, for example,
3 that we don't know that more is worse and that you should
4 guide you in making these kinds of decisions.

5 Q. Guide you in what way? Should it guide you to
6 regard more as having equal possibility of being good for
7 you as having less?

8 A. You would probably have to ask the authors that
9 one, but that's implied when they say we don't know what
10 dose is.

11 Q. You think it's implied?

12 A. It says we don't know that more is worse. It
13 says that windows are legitimate concern in defining dose
14 in which there may be an effect at a low level but not at
15 a high level.

16 Q. But isn't it true that although the possibility
17 that more may be better exists, the probability is that
18 less is better according to OTA?

19 A. I don't know that one. I don't think they say
20 -- I mean I would not use the word probability. I would
21 say that in general I would agree with the statement
22 things at lower field levels are consistent with prudent
23 avoidance. And I think that that is a fair
24 characterization of prudent avoidance.

25 I am just trying to qualify it so that it's not

1 misunderstood that these people did not write a precise
2 definition. They are warning you we don't know what dose
3 is, don't get carried away with this. If you can buy an
4 electric blanket that has zero field, go ahead and buy
5 it, but we would not recommend that you do that until
6 your old one wore out.

7 That means that lower is better but to me it
8 provides a qualitative factor that lower may be better
9 but maybe not a whole lot, we're not sure, so why don't
10 you wait four or five years until your old one wears out.
11 That is an exact example out of the OTA report and to me
12 it provides a definition of that. If lower is better
13 then I think it would say buy a low field blanket and use
14 it immediately. Rather, they say wait until your old one
15 wears out.

16 Q. But it's interesting, they don't tell you to
17 buy a higher field blanket.

18 A. I don't know why they didn't put in there. I
19 don't know if you can go out and make a higher field
20 blanket.

21 Q. Well, it's very simple. I mean, just take the
22 case where the person has bought the nice new model that
23 has the lower field and the ones that have -- the old
24 ones, the standard ones that have the higher field, are
25 still on sale, aren't they?

1 A. If they cost less for all I know Granger might
2 think you should go and buy one that costs less. You
3 should read his report.

4 Q. Would you agree with me that -- to avoid the
5 word probability which I had in my question a moment ago
6 -- that the OTA report reflects the conclusion of the
7 authors that while there is a possibility that more E/MF
8 could be beneficial in some circumstances, there is a
9 higher possibility that less E/MF is beneficial?

10 MR. WATSON: Excuse me, Your Honor. I don't
11 believe there has been testimony that the OTA report says
12 that more is beneficial. In fact, I think the testimony
13 was to the contrary, that it didn't say that.

14 MR. SUGARMAN: His testimony has been -- not
15 necessarily the OTA report, but his testimony in
16 describing the report is that OTA says that under certain
17 circumstances more exposure could be beneficial.

18 MR. WATSON: No, I think he said more is not
19 necessarily worse. That's what he said.

20 JUDGE SMOLEN: Let's ask the witness.

21 MR. SUGARMAN: Yes, let's ask the witness.

22 THE WITNESS: I never said the word beneficial.
23 OTA doesn't say the word beneficial.

24 BY MR. SUGARMAN:

25 Q. Then without regard to what you did say, and

1 the record will have that, what do you mean -- how do you
2 characterize the OTA report with respect to the concept
3 of windows and dosage and what we don't know? Would you
4 repeat or clarify your characterization of the OTA report
5 in that regard?

6 A. The OTA report says that we don't know if more
7 is worse. The OTA report says that there may be windows,
8 levels or intensities at which effects may occur and
9 other levels and intensities at which effects don't
10 occur, higher or lower, we don't know. Given that, we
11 can try to for modest cost do things that would lower
12 field exposure levels with the understanding that we may
13 not be making things any different or any better.
14 Therefore, we will only expend modest efforts to do this.

15 Q. So to pick up --

16 A. That is in a nutshell what they are saying.

17 Q. So to pick up on what Mr. Watson was saying,
18 then, to clarify that, you are not characterizing the OTA
19 report as saying that there is a probability that more
20 E/MF would be beneficial? What you are characterizing it
21 as saying is there is a possibility that more E/MF in
22 some circumstances would have no effect at all?

23 A. That is what it implies, yes.

24 Q. I am happy to stand corrected on that.

25 Now, on page 19 of your testimony you state that no

1 -- this is line seven through nine -- no utility
2 regulation has concluded that the concept of prudent
3 avoidance requires waiting for further research results.
4 Do you see that sentence there?

5 A. The one that starts "to my knowledge"?

6 Q. Right.

7 A. Yes.

8 Q. Are you aware of any utility commission
9 proceedings that have evaluated the need for the facility
10 and balanced it against the risk, without regard to the
11 conclusion that they came to?

12 A. I would not know how they reached conclusions.
13 I am only familiar, you know, just in general with
14 conclusions. I mean, I don't know what analysis they
15 might have gone through to reach a conclusion.

16 Q. Well, you purport in lines seven and eight to
17 know which utility commissions have evaluated the concept
18 of prudent avoidance.

19 A. Yes.

20 Q. And you are talking about in general now?

21 A. Yes.

22 Q. As opposed to any specific line?

23 A. Yes. You can read about it in newsletters,
24 which says that prudent avoidance was discussed at such
25 and such a meeting.

1 Q. I see. Now, would it be consistent -- could it
2 be part of prudent avoidance not to energize a line that
3 isn't needed?

4 (Pause.)

5 Q. Or to put it another way, not to buy an
6 electric blanket if you live in Jamaica.

7 A. I don't know about prudent avoidance, but it
8 would seem like common sense not to energize something
9 that is not needed.

10 Q. Would it be prudent for the utility to consider
11 acquiring additional right-of-way to avoid people being
12 within 50 feet -- living within 50 feet of a 238 kV line?

13 A. I don't know. I don't know if I want to be the
14 arbitrator of every application of prudent avoidance, but
15 if things can be done at modest cost to reduce field
16 levels then the things that are generally discussed in
17 prudent avoidance either by the authors in the report or
18 elsewhere, such as changes in line design, making lines
19 similar to other lines, things like that. I don't know
20 if buying more right-of-way has ever been suggested. I
21 don't think that has been suggested in the OTA report.

22 Q. Are you familiar with the Florida regulations
23 and the Rhode Island regulations?

24 A. I am familiar with the Florida standard for
25 field levels.

1 Q. And they have minimum rights-of-way?

2 A. They set minimum rights-of-way.

3 Q. So doesn't that mean requiring more
4 right-of-way?

5 A. I don't know what basis they set them for.

6 Q. What I'm saying is isn't it inherent that if
7 you require a minimum right-of-way the utility has to buy
8 more land?

9 A. But the minimum right-of-way as I understand it
10 in Florida was simply set as the minimum that they are
11 already buying anyhow for sites due to high wind and
12 things like that.

13 Q. Wouldn't prudent avoidance entail applying that
14 concept to the reenergization of an existing disused
15 right-of-way?

16 A. What concept?

17 Q. I'm sorry?

18 A. I'm sorry. The first part?

19 Q. Wouldn't the concept of minimum right-of-way
20 that Florida and other states use for rights-of-way,
21 wouldn't prudent avoidance entail including that,
22 applying that concept, when a utility is building a new
23 line on a disused right-of-way?

24 MR. WATSON: Your Honor, I am going to object to
25 that because I believe it misstates what the Florida

1 regulations are. And we don't have them presented to the
2 witness. I believe the regulations provide for field
3 levels at the edge of the right-of-way for various sizes
4 of lines rather than a specific distance. Because
5 obviously a change in the design, if the design were such
6 you might require a smaller right-of-way to meet the
7 field level limits at the edge. None of this foundation
8 is in this question nor is the information in front of
9 the witness.

10 JUDGE SMOLEN: Mr. Sugarman.

11 MR. SUGARMAN: I would like to find the description
12 of the regulations if I may just take a moment.

13 JUDGE SMOLEN: Yes. All right.

14 (Pause.)

15 BY MR. SUGARMAN:

16 Q. Are you familiar with -- I will withdraw that
17 question for the moment at least and substitute this
18 question, if I may. Are you familiar with the article by
19 Morgan, Florignate and Hester entitled Controlling
20 Exposure to Transmission Line Electromagnetic Fields, a
21 Regulatory Approach that is Compatible with the Available
22 Science? It was published in the Public Utility
23 Fortnightly for March, 1988.

24 A. Yes, I am familiar with that article.

25 Q. And you realize that that article proposes

1 minimizing -- proposes encouraging utilities to site new
2 powerlines in a way to minimize population exposure to
3 electromagnetic fields by enacting an exposure fee?

4 A. I would have to look at it, but I remember
5 generally that they may have said something like that in
6 an earlier paper.

7 Q. And do you agree with that concept as a way of
8 applying the concept of prudent avoidance?

9 A. Well, it didn't find its way into their most
10 recent document in the OTA report, the report they wrote
11 to the U.S. Congress.

12 Q. Are you talking about their background paper
13 that they prepared for --

14 A. No. I meant that concept of this exposure fee.

15 Q. Right. But you said it didn't find its way
16 into their most recent work.

17 A. The term exposure fee didn't.

18 Q. Right. But I'm asking what is their most
19 recent work?

20 A. The OTA report and the small layman's brochure
21 they wrote after that. I know after they had written
22 this paper that you talked about, this subject of dose
23 and windows is something that concerned them greatly. I
24 suspect that that was one of the problems with applying
25 fees, not knowing what aspect of exposure to apply a fee

1 to, if any.

2 Q. As I understand it, their fourth document
3 states as follows -- their most recent document, that is,
4 their report to OTA entitled Biological Effects of Power
5 Frequency, Electric and Magnetic Fields, page 79, states
6 "What would constitute prudence in the context of keeping
7 people out of 60 hertz fields. Here are a few
8 possibilities. One, attempt to route new transmission
9 lines so that they avoid people. Two, widen transmission
10 line rights-of-way." And they cite their previous
11 article. So can you explain --

12 A. I don't think they use the term exposure fee,
13 though, do they? Isn't that what you asked me about?

14 Q. What their earlier article had recommended was
15 to minimize population exposure to electromagnetic fields
16 by having an exposure fee. And they cite that
17 publication in their most recent report in support of
18 their proposition that -- they say in other writings we
19 have used the rates which our society invests in avoiding
20 known risks of death and injury to develop an upper bound
21 on the rates at which it might be prudent to invest in
22 field avoidance, and they cite that previous article.

23 And as I understand this article, I mean, this OTA
24 report that you referred to, they recommend widening
25 transmission line rights-of-way.

1 MR. WATSON: Your Honor, I don't know whether that
2 is a question. But to the extent it is, it's compound.
3 Secondly, Counsel has miscited those. The article cited
4 in the statement about invest in field avoidance were
5 Morgan '87 B and Morgan '87 C. They are not the 1988
6 article, Morgan 1988, which is cited at the bottom of
7 that note in footnote 18. So Counsel has not correctly
8 characterized the articles?

9 MR. SUGARMAN: And page 80 of the OTA report they
10 say, quote, in the case of transmission lines --

11 MR. WATSON: That's not the page he used. He was
12 on page '79, Your Honor.

13 MR. SUGARMAN: It's another example, that's all.

14 JUDGE SMOLEN: Let's get a question to the witness.

15 BY MR. SUGARMAN:

16 Q. The question is you said they didn't pick up on
17 their concept of exposure fees, and on page 80 of their
18 OTA report they say, "In the case of transmission lines
19 we have developed proposals for specific strategies based
20 on transmission line siting fees which could be used to
21 implement prudent avoidance. The basic idea is to charge
22 the utility a fee of X-dollars of each person who lives
23 within a given distance of the line. If properly
24 implemented, this approach should provide incentives for
25 the utility to avoid exposing people up to a marginal

1 investment rate of X-dollars per person exposure avoided.
2 We have argued that revenue generated by such a scheme
3 should be used to support 60 hertz health effects
4 research. Details on this strategy can be found
5 elsewhere," citing Morgan '87 D and Morgan '88. Morgan
6 '88 is a reference to the 1988 article.

7 JUDGE SMOLEN: What is the question?

8 BY MR. SUGARMAN:

9 Q. Now, my question is do you want to correct your
10 testimony that they didn't pick up on that article in
11 their OTA report?

12 A. No. That is not what I said. I thought I did
13 not remember them using the term exposure fee. I didn't
14 remember them using that term.

15 Q. But they used what they call in the OTA report,
16 quote, person exposure avoided, a fee for each person
17 exposure entailed. Isn't that the same as an exposure
18 fee?

19 A. It could be. You asked me if they used the
20 term exposure fee. I didn't remember that exactly
21 appearing.

22 Q. But you do agree, without regard for the
23 specific term, that the concept that I described from the
24 1988 article with which you're familiar, that concept is
25 picked up in the OTA report?

1 A. Yes. Let me take a look at it.

2 Q. And recommended again.

3 A. You know, I would be careful about saying what
4 the OTA recommends.

5 Q. I didn't say what the OTA recommends. I said
6 what Morgan recommends?

7 A. I have to read this to see if he does recommend
8 it. What these guys have tried to do in this paper and
9 in their layman's brochure is to lay out the policy
10 options that are available. And they range from doing
11 nothing to excessive action to some middle course of
12 action which they call prudent avoidance.

13 Q. And that is the one they recommended, isn't it?

14 MR. WATSON: Your Honor, I think it's unfair for
15 Counsel to keep characterizing this as recommend. The
16 witness can answer the question, but as I read the
17 paragraph it doesn't say recommend anywhere in there.

18 JUDGE SMOLEN: Let the witness read it.

19 A. I don't think these guys to mean to recommend
20 things. I will go even stronger than that. I know they
21 don't mean to necessarily recommend things. They want to
22 provide a framework for people to think about this, to be
23 able to reach conclusions on their own.

24 (Witness perusing document.)

25 BY MR. SUGARMAN:

1 Q. But you do agree that --

2 JUDGE SMOLEN: Let him read. He is reading.

3 MR. SUGARMAN: Okay.

4 (Witness perusing document.)

5 A. Okay. It looks like what he is doing is he's
6 saying to do these things, things that reduce exposure,
7 how do we avoid going overboard. How do we avoid the
8 equivalent of renting a helicopter -- from his previous
9 example of renting a helicopter to fly in broccoli and
10 cauliflower when you are in a mountain resort. And he
11 gives examples of ways to look at this. This is the
12 section which I was talking about. "It might make sense
13 to redesign new appliances, it might make sense to
14 selectively replace a few older appliances such as
15 electric blankets with new field-free versions where
16 probably it would not make sense to throw out all old
17 appliances before they wear out and replace them
18 immediately with new field-free ones." And then he goes
19 on to give examples which you were talking about, in
20 which he talks about making calculations.

21 Q. I was talking about transmission line widths
22 and I was reading to you from a description of his 1988
23 article which you said it was interesting he didn't pick
24 up on it in his OTA report, or their OTA report. And I
25 am asking you to please correct that statement.

1 A. I didn't say that. I said I didn't remember
2 the term exposure fee as that being in there.

3 Q. The record will reflect what you said. But I
4 just wanted to --

5 MR. WATSON: Then if it does, Your Honor, this is
6 repetitious.

7 BY MR. SUGARMAN:

8 Q. Instead of correcting it, then, I will use the
9 phrase clarify it. You do agree that he did announce
10 the same proposal as he did in his 1988 article, or they
11 did, in their OTA?

12 A. I don't know if it's exactly the same. He does
13 announce a similar sounding method for calculating
14 dollars to spend.

15 Q. And he says that is prudent avoidance, right?

16 A. Yes. He says, "To date there has been little
17 work done on field avoidance strategies. There is a need
18 for engineering, economic and legal studies. While DOA
19 supports research on 60 hertz effects from transmission
20 line..."

21 (Witness perusing document.)

22 JUDGE SMOLEN: Do we have an open question?

23 MR. SUGARMAN: Yes.

24 BY MR. SUGARMAN:

25 Q. He does describe that as prudent avoidance,

1 does he not?

2 A. Oh, let's see.

3 (Witness perusing document.)

4 MR. WATSON: Describe what, Your Honor?

5 MR. SUGARMAN: Charging a siting fee or a siting
6 exposure fee, that charges a fee to the utility based on
7 the number and extent of exposure.

8 MR. WATSON: Could we have a page and line
9 reference to where Mr. Sugarman --

10 MR. SUGARMAN: Page 80, the first full paragraph.

11 MR. WATSON: Page 80, the first full paragraph?

12 MR. SUGARMAN: Right.

13 (Witness perusing document.)

14 A. Okay. I see where he mentions prudent
15 avoidance. He says -- well, I see a couple of places.
16 Page 80, the first paragraph, "For example, if it were
17 undertaken with the explicit recognition that it did not
18 represent a safe exposure level, a field strength
19 standard might be justified in terms of prudent avoidance
20 arguments."

21 (Witness perusing document.)

22 A. Okay. I understand what you are saying now.
23 At the top he talks, in that first paragraph at the top
24 he talks about collecting this fee, I guess to offset the
25 cost of implementing prudent avoidance. And then it goes

1 on to say if a fee approach is considered unacceptable
2 various second best administrative procedures may be used
3 to achieve similar goals. For example, if it were
4 undertaken with the explicit recognition it did not
5 represent a safe exposure level, a field strength
6 standard might be justified in terms of prudent avoidance
7 arguments. So he kind of gives a couple different ways
8 to get there.

9 BY MR. SUGARMAN:

10 Q. Right. Do you have -- and I notice that you
11 don't hold yourself out as an E/MF scientist in the sense
12 of being able to determine what level of E/MF is
13 dangerous or if any level of E/MF is dangerous, but you
14 are not here to express an opinion as to what is a safe
15 level, are you?

16 A. No, I'm not.

17 MR. SUGARMAN: Thank you.

18 JUDGE SMOLEN: Let me interrupt -- have you
19 concluded?

20 MR. SUGARMAN: Yes, I have.

21 JUDGE SMOLEN: Much has been said here by Counsel
22 on questioning about this exposure fee and in as much as
23 we want to develop as complete a record as possible and
24 there is no jury here, let me ask this witness, how does
25 an exposure fee have the effect of reducing exposure?

1 Isn't it really a payment for permitting exposure?

2 THE WITNESS: Your Honor, it may have been to
3 offset the cost. It said this approach could provide
4 incentives for the utility to avoid --

5 JUDGE SMOLEN: For medical research, I believe.

6 MR. SUGARMAN: Your Honor, if you hear what
7 Mr. Silva is reading right now it will answer your
8 question.

9 JUDGE SMOLEN: Go ahead.

10 MR. SUGARMAN: Would you read that a little louder?

11 THE WITNESS: I see what you're saying, Your Honor.
12 The next sentence goes into the incentive part had.

13 JUDGE SMOLEN: Read the whole thing.

14 THE WITNESS: The whole paragraph?

15 JUDGE SMOLEN: Yes. Relating to this area.

16 THE WITNESS: I can read the whole paragraph.

17 JUDGE SMOLEN: Go ahead.

18 THE WITNESS: It's only four sentences.

19 Page 80, the first full paragraph: "In the case of
20 transmission lines we have developed proposals for
21 specific strategies based on transmission line siting
22 fees which could be used to implement prudent avoidance.
23 The basic idea is to charge the utility a fee of
24 X-dollars for each person who lives within a given
25 distance of the line. Properly implemented, this

1 approach should provide incentives for the utility to
2 avoid exposing people up to a marginal investment rate of
3 X-dollars per person exposure avoided. We have argued
4 that the revenue generated by such a scheme should be
5 used to support 60 hertz health effects research."

6 JUDGE SMOLEN: That's what I thought you said
7 before.

8 MR. SUGARMAN: In the prior sentence, Your Honor,
9 the argument is that if you charge a certain amount of
10 dollars the utility will relocate the line up to that
11 cost.

12 JUDGE SMOLEN: I understand the implication. It
13 might be to dissuade the utility from siting there.

14 MR. SUGARMAN: Exactly.

15 JUDGE SMOLEN: However, merely charging an exposure
16 fee in my view does not have any effect at all of
17 reducing exposure.

18 MR. SUGARMAN: Not if the fee gets charged.

19 JUDGE SMOLEN: It's really a payment for exposure.

20 THE WITNESS: I see what you are saying, Your
21 Honor. The people will continue to be exposed but the
22 money will go to research.

23 JUDGE SMOLEN: Well, I was only asking the
24 question.

25 THE WITNESS: That is what it sounds like they are

1 proposing, that the money will go to research. As I said
2 earlier, they say if this is unacceptable then you could
3 undertake a field strength standard using prudent
4 avoidance arguments, too, and they say that would achieve
5 similar goals.

6 JUDGE SMOLEN: Any redirect?

7 MR. WATSON: Could I have just a moment?

8 JUDGE SMOLEN: How is the witness? Do you want to
9 take a break?

10 THE WITNESS: I'm okay.

11 (Pause.)

12 MR. WATSON: No questions, Your Honor.

13 JUDGE SMOLEN: No questions. All right. Then the
14 witness is excused. Thank you very much for appearing
15 and testifying today.

16 (Witness excused.)

17 JUDGE SMOLEN: Let's go off the record at this
18 point.

19 (Discussion off the record.)

20 JUDGE SMOLEN: Back on recorded at this time.

21 At an off the record discussion the following
22 additional procedural schedule was agreed upon among the
23 parties. January 13, 1992, will be the due date for the
24 filing of surrebuttal testimony by the OCA and the
25 Protestants. That is an in-hand date and the surrebuttal

1 testimony may be filed via fax to be followed by regular
2 copies mailed.

3 We are going to set aside January 23, 24 and 27 of
4 1992 as hearing dates for the surrebuttal witnesses.
5 Mr. Sugarman will notify all parties as to the date on
6 which his witnesses will be available to appear, 23, 24
7 or 27 of January. If there are any problems with those
8 dates then we will notify all parties. It looks as
9 though we will be able to put on at least the OCA
10 witnesses on one of those three days, the OCA witnesses
11 on one of those three days.

12 Finally at the off the record discussion, January
13 2, 1992, is the date by which Mr. Sugarman will provide
14 to the parties the identification of any other witnesses
15 other than Dr. Liboff who he will present as part of his
16 surrebuttal testimony, and he has indicated he will
17 supply curriculum vitae and a list of other cases in
18 which that witness has testified if indeed the witness
19 has so testified.

20 Did I miss anything?

21 MR. WATSON: I guess the only thing I would ask is
22 that he simply answer our interrogatories or state a
23 reason why he could not answer. That would be the
24 cleanest way to get the information.

25 MR. SUGARMAN: I don't remember what the

1 interrogatories say and I wasn't required to answer them
2 before, I believe.

3 MR. WATSON: Well, I think actually you were by the
4 Commission's rules.

5 JUDGE SMOLEN: You don't mean of Dr. Liboff, do
6 you?

7 MR. WATSON: No. I mean the generic set.

8 JUDGE SMOLEN: Good. I don't want to see them
9 unless I have a motion.

10 MR. WATSON: We just have generic ones about their
11 witnesses giving us background information.

12 MR. SUGARMAN: Well, I would certainly object to
13 any ruling about that.

14 JUDGE SMOLEN: Well, you said you were going to
15 supply what you can by January 2. If there are
16 outstanding interrogatories then we have to follow the
17 rules. If they are answered they are answered. Or if
18 objected to then you take whatever action you have to
19 take in accordance with the rules. I'm not going to make
20 any rulings on it now. I have no motions before me.

21 Anything further?

22 (No audible response.)

23 JUDGE SMOLEN: Then we will adjourn today's
24 session. Greetings of the season, happy holidays to all
25 and we will see you after the new year.

1 MR. SUGARMAN: Thank you.

2 MS. McCLOSKEY: Thank you.

3 (Whereupon, at 11:44 a.m., the hearing was
4 adjourned, to be reconvened at a future time and place to
5 be designated by the Commission.)

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C E R T I F I C A T E

1
2 I hereby certify, as the stenographic reporter,
3 that the foregoing proceedings were taken
4 stenographically by me and thereafter reduced to
5 typewriting by me or under my direction; and that this
6 transcript is a true and accurate record to the best of
7 my ability.

8
9 COMMONWEALTH REPORTING COMPANY, INC.

10
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12 By: 

13 Robert J. Stonaker
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Philadelphia Electric Company Rebuttal Statement No. 6

A-112550 F055

12/17/91

w/ exhibits

JMS-1 -

JMS-4

Phila, PA

MS

**BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION**

**REBUTTAL TESTIMONY
OF
J. MICHAEL SILVA**

RECEIVED
APR 7 1992
SECRETARY'S OFFICE
Public Utility Commission

**ON BEHALF OF
PHILADELPHIA ELECTRIC COMPANY**

DECEMBER
1991

INDEXED
APR 17 1992

December 1991

REBUTTAL TESTIMONY OF J. MICHAEL SILVA

CONTENTS

I.	Background and Qualifications	1
II.	Background on Electric and Magnetic Fields	8
	A. Characteristics of Electric and Magnetic Fields	8
	B. Sources of Electric and Magnetic Fields	10
	C. Magnetic Fields in Philadelphia and Langhorne Borough ...	12
III.	Prudent Avoidance	15

1 **I. Background and Qualifications**

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Q Please state your name and business address.

A. My name is James Michael Silva. My business address is ENERTECH Consultants, Campbell, California.

Q What is your occupation?

A. I am a research engineer, specializing in assessing exposure to extremely low frequency (ELF) electric and magnetic fields (EMF).

Q Please describe your educational background.

A. I have a Bachelor of Science degree in Engineering from the University of Alabama and a Master of Science in Engineering from Auburn University.

Q Are you a registered professional engineer?

A. Yes, I am a registered professional engineer in five states, including the state of Pennsylvania.

Q Please describe your work experience.

A. I worked at the Southern Company for about 8-1/2 years in electric transmission line design. As supervising engineer, I was responsible for the detailed design of 115 kV to 500 kV high voltage electric lines on the Southern Company's electric transmission system in Alabama, Mississippi, and Florida. This included the engineering design details and specifications necessary for construction of these lines. I was also responsible for conducting a variety of technical and research studies of the electric environment in the vicinity of high voltage electric lines and substations.

- 1 Q Do you have personal experience with high voltage transmission
2 lines, particularly 230 kV lines?
3
- 4 A. Yes, I have designed many high voltage lines and conducted a number
5 of technical and research studies related to high voltage lines
6 including their design and operation. This has included a number of
7 230 kV transmission line projects.
8
9
- 10 Q Please continue the description of your work experience.
11
- 12 A. In 1977, I was appointed Project Manager of the Alternating Current
13 and Direct Current Research Program for the Electric Power
14 Research Institute (EPRI) in Palo Alto, California. I was responsible
15 for transmission line research at several facilities located across
16 North America. These research projects included design
17 considerations for electric lines, evaluations of electric and
18 magnetic fields, field induction, spark discharge and corona studies,
19 instrumentation for field measurements, and many other technical
20 areas.
21
- 22 From 1979 to early 1982, I worked at a consulting firm in
23 Pittsburgh, Pennsylvania. My duties included managing and
24 conducting several transmission line projects and various
25 transmission line design and engineering jobs nationwide.
26
- 27 About 10 years ago I started ENERTECH Consultants.
28
29
- 30 Q What is your position at ENERTECH Consultants?
31
- 32 A. I am President of ENERTECH Consultants.
33
34
- 35 Q What is ENERTECH Consultants?
36
- 37 A. ENERTECH Consultants is a scientific consulting firm that
38 specializes in applied research projects, engineering, exposure

1 assessment, and the development of electric and magnetic field
2 measurement instrumentation and computer software. We have
3 about 20 employees and are involved in a variety of research and
4 consulting projects for different clients throughout the world.
5
6

7 Q What do you mean by the term "exposure assessment?"
8

9 A. Exposure assessment means the evaluation of people's exposure to
10 electric or magnetic fields through measurement, modeling,
11 calculations, or other techniques.
12
13

14 Q Please describe some of ENERTECH's projects related to electric and
15 magnetic fields.
16

17 A. We perform work related to electric and magnetic fields in three
18 areas.
19

20 First, we conduct applied research projects involving electric and
21 magnetic field exposure assessment. In this area we are working on
22 several major projects, including studies conducted by researchers
23 for the Johns Hopkins University, the University of North Carolina,
24 the Electric Power Research Institute, the California Department of
25 Health Services, and the National Cancer Institute.
26

27 Second, we develop instrumentation for evaluation of electric and
28 magnetic fields and we conduct a variety of measurement programs
29 throughout the world.
30

31 Third, we develop computer software for calculating field levels and
32 for modeling electric and magnetic field environments and exposure.
33
34

35 Q Could you provide more detail on some of your applied research that
36 is currently underway?
37
38

1 A. Yes. We are the co-principal investigator, along with Dr. David
2 Savitz of the University of North Carolina, on a study of electric
3 utility workers. Our role has been to conduct field measurements to
4 characterize the magnetic field exposure encountered by these
5 electric utility workers. In a new EPRI nationwide residential
6 study, we are evaluating magnetic fields in 850 homes in 22 utility
7 service areas. For the California Department of Health Services, we
8 recently completed detailed measurements in 81 homes from the
9 original residential study by Dr. Savitz in Denver. In the National
10 Cancer Institute study, our research team is involved in the effort to
11 measure magnetic fields in homes in six states as part of a large
12 childhood epidemiological study.

13
14
15 Q Have you published any papers reporting the results of your research
16 on electric and/or magnetic fields?

17
18 A. Yes. While the research just described is ongoing, I have published a
19 number of papers and research reports on my previous research
20 work. A brief biographical sketch and description of some of my
21 research which includes those papers and research reports is
22 appended to my testimony as Exhibit JMS-1.

23
24
25 Q What kind of instrumentation systems have you developed for
26 measuring electric and/or magnetic fields?

27
28 A. For measuring fields and conducting exposure assessment, our
29 research team has developed portable instrumentation known as the
30 EMDEX system. EMDEX stands for Electric and Magnetic Digital
31 EXposure meter. It is a portable instrument that can be worn on the
32 belt for measuring and recording magnetic fields. It contains a
33 magnetic field meter circuit and a small onboard computer which
34 stores, in digital form, the values of the measured field.
35 Measurements can be taken over a period of time and the results
36 stored for several hours up to day. Later, a graphic computer
37 printout of the magnetic fields can be produced. The result is
38 perhaps the best data available to document a person's exposure to a

1 variety of magnetic field levels and sources and to identify the wide
2 variety of fields that people can encounter. We also developed
3 DATACALC, which is the computer software package that is used
4 with the EMDEX system.
5

6 The EMDEX system is used extensively in the United States and
7 overseas. In our research laboratories, we have recently completed
8 development of the new EMDEX II, a smaller version of the original
9 EMDEX for personal exposure assessment that can fit into a shirt
10 pocket. We have also developed the new EMCALC computer software
11 package that is used with the EMDEX II.
12
13

14 Q Have you measured actual electric and magnetic fields from electric
15 power lines, appliances and other electrical sources in the past?
16

17 A. Yes, I have conducted extensive measurements of power frequency
18 fields throughout the United States and in other countries. My work
19 has ranged from applied research projects to measurements and
20 calculations.
21
22

23 Q Other than the DATACALC and EMCALC software, have you developed
24 any other computer software for evaluating electric and magnetic
25 fields?
26

27 A. Yes. We also designed and developed the computer software
28 EXPOCALC, which is used for calculating electric and magnetic
29 fields from electric power lines and also for exposure modeling.
30 EXPOCALC was developed under my supervision for EPRI, and is
31 currently used throughout the world. We also assisted the High
32 Voltage Transmission Research Center with the development of
33 ENVIRO, another computer program for modeling electric
34 environments, and we have started work on a new research grant to
35 develop an EMF workstation, a comprehensive software package that
36 includes a variety of computer programs for EMF calculations and
37 modeling.
38

1 Q Have you calculated electric and magnetic fields from electric
2 power lines in the past?

3
4 A. Yes, numerous times for lines in many locations throughout the
5 United States and in other countries. These calculations were
6 performed using computer software, such as EXPOCALC and ENVIRO,
7 to model the electric and magnetic fields near electric power lines.
8

9
10 Q Are you a member of any professional organizations?

11
12 A. Yes. I am a senior member of the Institute of Electrical and
13 Electronics Engineers (IEEE). Within that organization, I served for
14 about ten years as the Secretary of the Power Engineering Society's
15 Corona & Field Effects Subcommittee. I am also a member of the
16 IEEE Design and Environmental Considerations Working Group, and the
17 AC Fields Working Group.
18

19 I am also a member of the International Conference on Large High
20 Voltage Electric Systems (CIGRE), an international organization
21 located in Paris that is composed primarily of electric power
22 systems engineers. I am also a full member of the
23 Bioelectromagnetic Society (BEMS).
24

25
26 Q Have you served on any other technical committees or acted as an
27 advisor or consultant concerning electric transmission lines?
28

29 A. Yes. For example, I have served as a member of the National
30 Electrical Safety Code (NESC) Committee of the Southeastern
31 Electric Exchange. The Committee is responsible for ongoing review
32 of proposed technical revisions and future recommendations for the
33 NESC.
34

35 I have been an advisor on U.S. Department of Energy transmission
36 line research projects, and I participated in the United States -
37 Soviet Union technical exchange program on electric and magnetic
38 fields, including transmission line fields, as a U.S. representative in

1 two sets of meetings with Soviet scientists arranged by the United
2 States Department of State.

3
4 I have also participated in the World Health Organization
5 International Association for Research in Cancer (IARC) meeting in
6 Lyon, France to discuss and plan coordination of research projects
7 involving electric and magnetic field exposure assessment.
8
9

10 Q Have you received any special recognition for your work involving
11 electric power lines and exposure assessment?
12

13 A. Yes. At the University of Southern California, I was the Lloyd Hunt
14 Distinguished Lecturer in Power Engineering. I have also been a
15 guest lecturer at the Ohio State University Electrical Engineering
16 Colloquium - Distinguished Lecture Series, and I was invited as a
17 guest lecturer at the University of Texas at Austin at the Power
18 System Seminar Lecture Series and the Power Distribution
19 Conference. I have also received recognition awards for my work on
20 IEEE and CIGRE technical papers.
21

22
23 Q Could you identify some of the organizations for whom ENERTECH
24 has acted as a consultant for field measurements and exposure
25 assessments?
26

27 A. Yes. We have conducted work related to exposure assessment,
28 including magnetic field measurements, for a number of electric
29 utilities in the United States, Australia, and Canada and a wide
30 variety of other clients, including the California Department of
31 Health Services, the U.S. Department of Justice, Stanford University,
32 the Montecito and Selma Unified School Districts in California, the
33 Jefferson County School District in Colorado, Mesa School District in
34 Arizona, Kaiser Permanente Hospitals, Bay Area Rapid Transit, the
35 Metropolitan Water District in Los Angeles, the Wisconsin Public
36 Service Commission, the Cancer Control Agency of British Columbia,
37 the Roadway Powered Electric Vehicle Project, and others.
38

1 Q What were you asked to do in connection with this case?

2

3 A. I was asked to conduct an independent evaluation of common
4 magnetic field levels that people encounter in their everyday lives
5 in Philadelphia and at some locations near the route of the
6 Woodbourne-Heaton 230 kV transmission line. I was asked to
7 generally compare the measured magnetic field levels in
8 Pennsylvania to those that people can routinely encounter from a
9 variety of sources.

10

11 I was also asked to evaluate the design and exposure assessment
12 aspects of the Woodbourne-Heaton 230 kV project to ascertain
13 which features of this project, if any, are consistent with the
14 concept of prudent avoidance described, among other places, in a
15 1989 paper published by the U.S. Office of Technology Assessment
16 (OTA).

17

18

19 II. Background on Electric and Magnetic Fields

20

21 A. Characteristics of Electric and Magnetic Fields

22

23 Q By way of background, what are electric and magnetic fields?

24

25 A. A field is a space or region in which an influence can be said to
26 exist. For example, a temperature field is said to exist in the space
27 around a hot or cold object. Two types of fields are produced by 60
28 Hertz (Hz) devices: electric fields and magnetic fields. All electric
29 devices, including electric power lines and even household
30 appliances, can produce these fields.

31

32 The earth itself has a static or DC electric field of about 0.15 kV/m.
33 Static electric fields can also result from taking off a sweater or
34 walking across a carpet. Induced body voltages as high as 4,000 to
35 8,000 volts (and higher) have been measured for walking across a
36 carpet. In addition to an electric field, the earth has a static
37 magnetic field. In Southeastern Pennsylvania the earth's magnetic
38 field is about 560 milligauss. It should be noted that since the

1 earth's fields are primarily static fields rather than alternating
2 fields, they do not necessarily compare directly with 60 Hz AC
3 fields.
4

5
6 Q You mentioned 60 Hertz (Hz) - what is a Hz?
7

8 A. Hz is a unit of frequency - frequency relates to the number of
9 alternations or cycles of a wave during a period of time. The term
10 60 Hz means 60 cycles per second. For alternating current (AC)
11 electric power lines like the one at issue here, the voltage and
12 electric current reverse polarity, or direction, at a rate of 60
13 complete alternations or cycles per second. If there are no
14 alternations, this is said to be direct current (DC), or static. For a
15 static field, the frequency is 0 Hz.
16

17
18 Q What is the frequency at which electric transmission lines in the
19 United States operate?
20

21 A. AC (alternating current) electric power transmission lines in the
22 United States operate at 60 Hz.
23

24
25 Q Please generally describe 60 Hz electric fields.
26

27 A. A 60 Hz electric field is the field associated with the voltage on the
28 conductors (energized wires) of a electric power line or device. The
29 units commonly used to describe an electric field are volts per
30 meter (V/m) or kilovolts per meter (kV/m). One of the
31 characteristics of a 60 Hz electric field is that it decreases with
32 distance away from the source. Electric fields are also easily
33 shielded by objects such as trees.
34

35
36 Q What factors influence the electric fields from an electric source?
37
38

1 A. In general, electric fields are a function of the voltage on the line,
2 phasing, the geometry or configuration of the device, and distance
3 away from the source of the fields.
4
5

6 Q Please generally describe 60 Hz magnetic fields.
7

8 A. A 60 Hz magnetic field is the field associated with the flow of
9 electric current (or amperes) on electric lines or devices. The most
10 common unit used by engineers for describing magnetic fields
11 (actually the magnetic flux density) is the Gauss (G). Often a much
12 smaller unit, the milligauss (mG), is used. One milliguass equals one
13 one thousandth of a Gauss. (1 mg = .001 G). One of the
14 characteristics of a 60 Hz magnetic field is that it decreases with
15 distance away from the source. Magnetic fields are not easily
16 shielded by objects such as trees.
17
18

19 Q What factors influence the magnetic fields from an electric source?
20

21 A. In general, magnetic fields are a function of the current (loading in
22 amperes), phasing, the geometry or configuration of the device, and
23 distance away from the source of the fields.
24
25

26 B. Sources of Electric and Magnetic Fields 27

28 Q What are some common sources of 60 Hz electric and/or magnetic
29 fields?
30

31 A. Electric and magnetic fields are created whenever there is a flow of
32 electricity. Household wiring, electric transmission and
33 distribution facilities, lighting, appliances, and office equipment
34 are all common sources of electric and magnetic fields. The 60 Hz
35 field is higher close to the source of the field and attenuates
36 (decreases) with distance from the source; the fields attenuate
37 more quickly with distance away from household appliances than
38 from power lines.

- 1 Q Have you studied and conducted measurements of the magnetic fields
2 from common household appliances?
3
- 4 A. Yes, many times. The results of some of these measurements have
5 been reported in the peer-reviewed literature.
6
7
- 8 Q Do you have an exhibit to illustrate the level of magnetic fields that
9 are associated with common household appliances?
10
- 11 A. Yes. Exhibit JMS-2 attached to my testimony illustrates these field
12 levels. For this exhibit, I used data from my published paper,
13 "Power Frequency Magnetic Fields in the Home." The exhibit gives
14 some examples of the kinds of appliances found in a typical home.
15 For each appliance I have given a range of measured field values (in
16 milligauss) associated with normal use of the appliance and a
17 maximum for the region next to the appliance. The range reflects
18 variations in the field levels among different brands of appliances
19 and also variations depending on how far away the appliance is from
20 the measuring point during normal use. Thus, an appliance used near
21 the head region would give a higher exposure to the head and a lower
22 exposure at waist level, with the maximum value being where the
23 appliance is touched.
24
25
- 26 Q Would you explain that by using the electric shaver as an example?
27
- 28 A. If you were holding an electric shaver in your hand and shaving your
29 face, you could experience fields as high as about 6800 milligauss at
30 your hand and face. The rest of your body would experience fields
31 anywhere from 300 milligauss at your head near the shaver to 50
32 milligauss or less somewhere near your waist.
33
34
- 35 Q What is shown by Exhibit JMS-2?
36
- 37 A. The exhibit demonstrates the variety of magnetic field exposures
38 associated with normal use of appliances and that some level of

1 exposure is associated with any number of everyday activities.
2
3

4 Q Are people exposed to electric and magnetic fields from appliances
5 for only a few minutes or hours a day?
6

7 A. Many appliances are only used for a relatively short length of time,
8 and the field level does quickly decrease with distance away from
9 the appliance. However, each activity and each location can have its
10 own sources of electric and magnetic fields that people encounter.
11 People do move from place to place and from one activity to the
12 next, and this can cause a continuous or almost continuous range of
13 exposures in a typical day.
14

15
16 **C. Magnetic Fields in Philadelphia and Langhorne Borough**
17

18
19 Q Have you measured fields that individuals experience as they go
20 about their everyday lives?
21

22 A. Yes. I conducted a measurement program in which we took over
23 1000 measurements of fields in about 90 homes located in six
24 states. I have also conducted a study in which I took measurements
25 in homes located both near and away from electric lines and we have
26 taken a variety of exposure measurements at typical locations
27 across North America. As I mentioned earlier, we have almost
28 completed a program that will collect data from 850 homes
29 (including Pennsylvania).
30

31
32 Q Was your firm asked to conduct any magnetic field measurements in
33 preparation for your testimony in this proceeding?
34

35 A. Yes, in preparation for these proceedings, we were asked to make
36 some magnetic field measurements in Southeastern Pennsylvania. In
37 September, 1991 we took a series of measurements at locations in
38

1 Southeastern Pennsylvania, using the EMDEX II meter described
2 previously in my testimony.
3

4
5 Q Where in Southeastern Pennsylvania did you take these EMDEX II
6 measurements?
7

8 A. Continuous EMDEX II measurements were made during a routine walk
9 through several common locations in the city of Philadelphia and
10 also during a walk through various locations in and around Langhorne
11 Borough, which is near the Woodbourne-Heaton line.
12

13
14 Q Have you prepared exhibits to illustrate the measurements that were
15 made in Philadelphia and Langhorne Borough?
16

17 A. Yes. As I noted earlier, the EMDEX II collects and stores the
18 measurement data and allows production of a graphic computer
19 printout of the magnetic fields encountered. Exhibit JMS-3 is a copy
20 of the actual printout from the data recorded by the EMDEX II during
21 the walk through Langhorne Borough. It shows a continuous plot of
22 magnetic field levels encountered during a walk around some typical
23 locations in the vicinity of Langhorne Borough. Exhibit JMS-4 is a
24 copy of the actual printout from the magnetic field measurement
25 data recorded during the walk around Philadelphia.
26

27
28 Q Could you briefly summarize for us the magnetic fields recorded
29 during the walk around Langhorne Borough and presented in Exhibit
30 JMS-3?
31

32 A. Exhibit JMS-3 shows a continuous plot of the measurement results
33 recorded at 1.5 second intervals during a 3-1/2 hour walk through
34 various locations in the Langhorne Borough area. The field levels in
35 a local grocery store and another convenience store range from about
36 1-12 mG. Magnetic fields in a nearby shopping mall range from a
37 fraction of 1 mG to 30 mG. In a nearby amusement park the fields
38 ranged from less than 1 mG to over 60 mG.

1 Q Can you please summarize the magnetic fields recorded during the
2 walk around Philadelphia and presented in Exhibit JMS-4?
3

4 A. Exhibit JMS-4 shows a continuous plot of the magnetic field levels
5 recorded at 1.5 second intervals during a 4 hour walk around various
6 locations in Philadelphia. The fields are generally in the range of
7 less than 1 mG to tens of mG, with some locations up to 100-250
8 mG, and one location in a shopping mall with a reading of 760 mG.
9

10
11 Q Do you know the sources of all the different magnetic field levels
12 recorded during these walks?
13

14 A. No. Frequently it is not possible without a more detailed
15 investigation to identify the variety of sources encountered in
16 everyday life.
17

18
19 Q How do the levels of fields that were measured in Southeastern
20 Pennsylvania compare with those in other locations across the
21 United States?
22

23 A. These values are similar to levels I have measured at other
24 locations in towns across the United States.
25

26
27 Q What are your conclusions regarding the EMDEX II measurements in
28 Southeastern Pennsylvania?
29

30 A. Exposure to magnetic fields results from a variety of situations and
31 sources routinely encountered in everyday life. Although no precise
32 measure of exposure has been identified, it is apparent that any
33 individual's total exposure will be composed of the many common
34 exposures at home, at work, at businesses, at school, at recreation,
35 and at other locations. Some of the exposures to appliances and
36 other electric devices can have a significant temporal component.
37 For example, a clock radio, fan or even water pipes (with ground
38 currents) located near the bed or a living room chair can bring people

1 near everyday field sources for longer than a brief period. I should
2 add, however, that we do not know whether brief exposures or longer
3 term exposures are important, if in fact either type of exposure is
4 important. A number of typical employment and other locations, for
5 example, near a cash register, service counter, display case, or video
6 games, could result in a range of field exposures. In summary, the
7 EMDEX II measurements provide a context for understanding total
8 magnetic field exposure and the relative contribution and variety of
9 sources encountered in everyday activities.

10
11
12 **III. Prudent Avoidance**

13
14
15 **Q** Are you familiar with the concept known as "prudent avoidance"?

16
17 **A.** Yes. This concept was described by researchers at Carnegie-Mellon
18 University most recently in a 1989 report sponsored by the
19 Congressional Office of Technology Assessment (OTA) and a brochure
20 distributed by Carnegie-Mellon University.

21
22
23 **Q** Please briefly describe the concept of prudent avoidance.

24
25 **A.** Prudent avoidance has been suggested as one possible framework for
26 analyzing exposure to electric and magnetic fields, and for
27 considering actions that might alter exposure to electric and
28 magnetic fields. Prudent avoidance incorporates several
29 assumptions from exposure assessment. For example, we do not
30 know which aspect of exposure, if any, is important in discussions
31 of EMF and health. A measure of magnetic field "dose" does not
32 exist; it is not clear if exposure on one day can be added, in some
33 manner, to exposure on another day, or whether short-term high
34 levels of exposure are different from long-term lower levels of
35 exposure. Prudent avoidance also is based on the assumption that
36 health effects from exposure to electric and magnetic fields have
37 not been demonstrated. Prudent avoidance is a concept that
38 recognizes that a scientific determination cannot be made that

1 changes in EMF levels will have any effect on health, and thus
2 prudent avoidance advocates only a modest effort in making such
3 changes.
4

5
6 Q When applying the concept of prudent avoidance to transmission
7 facilities, is it appropriate to evaluate design features of the
8 transmission facility?
9

10 A. Yes. The design features of a transmission facility can affect the
11 electric and magnetic fields that are associated with the facility.
12 To evaluate whether a transmission facility is consistent with the
13 concept of prudent avoidance, a person thus should have a good
14 understanding of transmission line design, what engineering factors
15 affect fields, and the relative feasibility, reliability, and cost of
16 different engineering options. In addition, calculation and
17 measurement experience is necessary to properly evaluate field
18 levels and provide a context for understanding what effect, if any,
19 prudent avoidance strategies will have on exposure.
20

21
22 Q Are there aspects of a transmission line other than design that are
23 relevant to a discussion of prudent avoidance?
24

25 A. Yes. For example, routing of the transmission line should be
26 considered. In addition, it is appropriate to consider whether the
27 transmission facility meets existing field standards that are
28 "similarity-based."
29

30
31 Q Have you evaluated the Woodbourne-Heaton 230 kV project with
32 respect to prudent avoidance?
33

34 A. Yes. I reviewed and evaluated the design, routing, and field levels
35 for this transmission line. Each of these elements has features that
36 are consistent with the concept of prudent avoidance.
37
38

1 Q What is your evaluation of the design of the Woodbourne-Heaton 230
2 kV transmission line.

3
4 A. The design for this 230 kV project is a compact delta (or triangular)
5 configuration. This type of line configuration is known to produce
6 fields that are generally lower than other typical configurations. As
7 discussed in Mr. Boeggeman's testimony in this proceeding, use of
8 other design configurations for the Woodbourne-Heaton line would
9 result in comparable or higher fields than those associated with the
10 compact delta configuration. Also, the phase transpositions (rolls)
11 used to mitigate induction effects on the railroad tracks and signal
12 equipment will result in more balanced (equal) phase currents (little
13 or no net current), thereby producing lower magnetic fields as a
14 function of distance due to almost equal cancellation of the balanced
15 phase currents. These design considerations result in lower field
16 levels at modest effort, and are consistent with the concept of
17 prudent avoidance.

18
19
20 Q What is your evaluation of the routing of the Woodbourne-Heaton 230
21 kV transmission line?

22
23 A. The 230 kV project uses an existing right-of-way (ROW), previously
24 used by an electric railroad and currently used by a diesel railroad,
25 that follows a near-linear route between the Woodbourne and Heaton
26 substations. This use of an existing utility corridor that was
27 previously used for an electrified railway also avoids the creation
28 of a new utility corridor. An additional feature of this route choice
29 is that it allows re-use of the existing poles on the ROW previously
30 used for electric power supply by the railroad, which is an important
31 factor leading to use of the compact delta configuration and phase
32 rolls, which themselves are consistent with prudent avoidance.
33 Taking these factors into consideration, I view the routing of this
34 transmission line as consistent with the concept of prudent
35 avoidance.

36
37
38

1 Q What is your evaluation of the field levels from the Woodbourne-
2 Heaton transmission line?
3

4 A. As I previously discussed, the concept of prudent avoidance
5 incorporates the assumption that we do not know which aspect of
6 exposure, if any, is important in discussions of EMF and health. One
7 approach to prudent avoidance, known as the "similarity-based"
8 approach, recognizes this assumption by suggesting that EMF from
9 transmission lines be similar to the levels from other transmission
10 lines. This approach was used in developing the field standards in
11 New York State and Florida, for example.
12

13 The fields that will be associated with the Woodbourne-Heaton 230
14 kV project are not materially different from other 230 kV
15 transmission lines already in operation in Pennsylvania and
16 throughout the United States. The fields that will be associated the
17 Woodbourne-Heaton line also are lower than the New York and
18 Florida standards. These feature are consistent with the similarity-
19 based approach to prudent avoidance.
20

21
22 Q Are there specific procedures or efforts that always must be
23 followed for a project to be consistent with prudent avoidance?
24

25 A. No. The concept of prudent avoidance is a general framework that
26 has not been codified. It suggests modest efforts to reduce field
27 exposure, and should be understood to be oriented toward that
28 result, rather than toward any required method of achieving that
29 result. The question of what is "modest" will vary depending upon
30 the specific project. Where, as here, the design and routing of the
31 transmission line result in lower fields at modest cost consistent
32 with prudent avoidance, the concept of prudent avoidance does not
33 require that any specific decisional or temporal process must be
34 followed in achieving that result.
35

36
37 Q Does prudent avoidance require waiting for the results of ongoing or
38 future research?

1 A. No. Prudent avoidance is a concept that allows us to act and move
2 forward while research continues. The authors of the OTA Report
3 have consistently stated that prudent avoidance is designed to help
4 guide action given the current state of scientific knowledge.
5 Delaying projects because of the current state of scientific
6 knowledge thus runs contrary to the basic assumptions of prudent
7 avoidance. To my knowledge, no utility regulatory commission that
8 has evaluated the concept of prudent avoidance has concluded that it
9 requires waiting for further research results.
10

11
12 Q What are your conclusions regarding your evaluation of the
13 Woodbourne-Heaton 230 kV transmission line project?
14

15 A. In comparison to other, similar transmission lines, there is nothing
16 unique or unusual about the fields associated with the Woodbourne-
17 Heaton 230 kV transmission line. The electric and magnetic fields
18 that will be associated with the Woodbourne-Heaton line are in the
19 same range as levels from other similar 230 kV lines. The magnetic
20 field levels associated with the 230 kV line are within the range
21 that people routinely encounter in everyday life from a variety of
22 sources. The 230 kV project will meet existing field standards in
23 other states, and it has design and routing features consistent with
24 the concept of prudent avoidance.
25

26
27 Q Does this conclude your testimony?
28

29 A. Yes.

**BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION**

**EXHIBIT JMS-1
OF
J. MICHAEL SILVA**

**ON BEHALF OF
PHILADELPHIA ELECTRIC COMPANY**

December 1991

RESUME

J. Michael Silva, BSE, MSE

Mr. Silva is the President of Enertech Consultants. He has almost 20 years of experience related to electric power facilities, project management and applied research projects. Early in his career, at the Southern company, he supervised an electric transmission line design group (1970-76) and worked as a loaned employee at the Electric Power Research Institute (1977-78). He has also worked as the manager of a variety of applied research projects at GAI (1979-81). In 1982, he founded Enertech Consultants and has focused on: applied research on EMF exposure assessment, hardware and software development and scientific consulting. He has authored numerous articles and papers on power frequency electric and magnetic field exposure assessment. He has served as principal investigator on a variety of EMF exposure studies, including some of the original work on using computers to model exposure and development of new hardware to measure exposure.

Mr. Silva has served as a past advisor to DOE on various research projects, participated in the U.S. Technical Exchange Program on EMF with the Soviet Union, and delivered a number of lectures and training seminars on EMF issues. He was the 1979 Lloyd Hunt Distinguished Lecturer in Power Engineering at the University of Southern California and an invited lecturer in programs at Ohio State University and the University of Texas. He also participated in the 1988 World Health Organization - IARC Meeting in Lyon, France on EMF exposure assessment. He is a senior member of IEEE and a member of CIGRE and BEMS. Mr. Silva is also a registered professional engineer in five states.

LIST OF PUBLICATION & PRESENTATIONS

JAMES MICHAEL SILVA

Lectures at University of Texas Power System Seminar - "Current Research Projects Relating to HV/EHV/UHV Transmission Lines", Austin, Texas, February 28, 1978.

Silva, J.M., "Environmental Considerations for the Modern Transmission System", Educational Television presentation Lloyd Hunt Distinguished Lecture Series in Power Engineering, Los Angeles, California, February 27, 1979.

Silva, J., "Aeolian Vibration: An Overview", presented at the International Symposium on Important Aspects of the Mechanical Design of the Transmission Line, Mexico City, July 23-25, 1979.

Silva, J.M., "Substation Electric Field Effects: An Overview", presented at the 1980 Winter Meeting of the Pennsylvania Electric Association, King of Prussia, Pennsylvania, February 14-15, 1980.

Lecturer at Ohio State University - Electrical Engineering Colloquium Distinguished Lecture Series, "Research on the Biological Effects of Electric and Magnetic Fields of Transmission Lines", Columbus, Ohio, April 10, 1980.

Chairman and Speaker at IEEE Transmission and Distribution Panel Session on the "NESC-5mA Rule and Electric Field Induction" at IEEE Winter Power Meeting, New York City, February 3, 1983.

Silva, J.M., "Electric Field Effects of Transmission Lines" presented at the February 14-17, 1983 American Public Power Association Conference in San Antonio, Texas and published in Conference Proceedings.

Chairman and Speaker at ESMOL "Health Effects Session" at Third International Conference on Live-Line Maintenance, Atlanta, Georgia, June 9, 1983.

Deno, D.W., Silva, J.M., "Method for Evaluating Human Exposure to 60 Hz Electric Fields", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-103, No.7, pp. 1699-1706, July, 1984

Silva, J.M., Kavet, R.I., "Estimating Public Exposure to Power-Frequency Electric Fields", DOE60 Symposium Series, 23rd Hanford Life Sciences Symposium on Interaction of Biological Systems with Static and ELF Electric and Magnetic Fields, pp. 419-435, Richland, WA, October 2-4, 1984

Deno, D.W., Silva, J.M., Hummon, N., "Framework For Assessment Of AC Transmission Line Induction Effects", Research Project 1591-1, Final Report, December, 1984

Silva, J.M. et.al, "AC Field Exposure Study: Human Exposure to 60 Hz Electric Fields", EPRI Report EA-3993, April, 1985

Silva, J.M., Zaffanella, L.E., Hummon, N.P., "An Activity Systems Model for Estimating Human Exposure to 60 Hz Electric Fields", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-104, No.7, pp. 1923-1929, July, 1985

Silva, J.M., Huber, D.L., "Exposure to Transmission Line Electric Fields During Farming Operations", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-104, No. 9, pp. 2632-2640, September, 1985

Deno, D.W., Silva, J.M., "Probability and Consequence of Gasoline Ignition Under HVAC Transmission Lines", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-104, No.11, pp. 3181-3188, November, 1985

The EXPOCALC Code, Version 1.10: A Tool for Estimating Human Exposure from Transmission Line Electric Fields - User's Manual and Documentation; EA-4489-CCMP; EPRI Research Project RP799-16; Enertech Consultants, J.M. Silva, Principal Investigator; Computer Code Manual, April 1986.

Deno, D.W., Silva, J.M., "Transmission Line Electric Field Shielding by Objects", IEEE Transactions on Power Delivery, Vol. PWRD-2, No. 1, pp. 269-280, January, 1987.

"Magnetic Fields: A Status Report", J.M. Silva, presented at Fortieth Annual Power Distribution Conference, University of Texas-Austin, published in Conference Proceedings, October, 1987.

EXPOCALC Version 2.1: An Exposure Assessment Tool for Transmission Line Electric and Magnetic Fields - User's Manual and Documentation; EA-5765-CCML; EPRI Research Project RP799-16; Enertech Consultants, J.M. Silva, Principal Investigator, Computer Code Manual, April 1988.

Domestic Magnetic Field Database: User's Manual and Documentation; EA-5972-CCML; EPRI Research Project RP799-16; Enertech Consultants, J.M. Silva, Principal Investigator; Computer Code Manual, August, 1988.

Silva, J.M., Hummon, N.P., Rutter, D.A., Hooper, H.C., "Power Frequency Magnetic Fields in the Home", IEEE Transactions on Power Delivery, Vol. PWRD-4, No. 1, pp. 465-478, January, 1989.

EMDEX System Manuals - Volume 1: User's Manual, EPRI EN-6518, Vol. 1, Research Project RP799-16; Enertech Consultants, J.M. Silva, Principal Investigator, October, 1989.

EMDEX System Manual - Volume 2: Technical Reference Manual, EPRI EN-6518, Vol. 2, Research Project RP799-16; Enertech Consultants, J.M. Silva, Principal Investigator, October, 1989.

"Extremely Low-Frequency Electric and Magnetic Fields and Risk of Human Cancer", World Health Organization-International Agency for Research on Cancer; IARC Ad Hoc Working Group (24 members including J.M. Silva), Bioelectromagnetics, 11:91-99, 1990.

"Measurements of Power Frequency Magnetic Fields Away From Power Lines", A Report of the IEEE PES AC Magnetic Fields Working Group, M. Misakian, M. Silva, R. Baishiki, principal authors, Paper No. 90 SM 423-4 PWRD presented at 1990 Summer Power Meeting, IEEE Transactions on Power Delivery, 1990.

"Studies of Power System Magnetic Fields: Characterization of Sources in Residential Environments, Measurements of Exposure, Influence on Computer Screens", U.S. Committee, CIGRE-ELECTRA, Paris, France, 1990.

Silva, J.M., Kavet, R., "An Alternative Hypothesis for Association Between Distribution Wiring Configurations and Cancer: Planning Phase", RP 2966-2, EPRI EN-6863, June 1990.

**BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION**

**EXHIBIT JMS-2
OF
J. MICHAEL SILVA**

**ON BEHALF OF
PHILADELPHIA ELECTRIC COMPANY**

December 1991

MAGNETIC FIELD ENVIRONMENT

Summary of Domestic Appliance Magnetic Field Measurements

<u>Appliance Type</u>	<u>Body Location</u>	<u>Magnetic Field - mG</u>	
		<u>Typical Range</u>	<u>Maximum Value</u>
Range	Belt	1-80	175-625
Refrigerator	Chest	1-8	12-187
Microwave Oven	Belt	3-40	65-812
Can Opener	Belt	30-225	288-2750
Oven	Belt	1-8	14-67
Toaster	Belt	2-6	9
CoffeeMaker	Chest	1-2	4-25
Freezer	Head	1-3	4-6
Mixer	Belt	2-11	16-387
Clothes Dryer	Belt	1-24	45-93
Dishwasher	Belt	1-15	28-712
Garbage Disposal	Belt	1-5	8-33
Ceiling Fan	Head	1-11	125
Electric Blanket	Belt	3-50	65
Waterbed Heater	Belt	1-9	20-27
Blow Dryer	Head	1-75	112-2125
Computer	Belt	1-25	49-1875
Typewriter	Belt	1-23	38
Make-Up Mirror	Chest	1-29	44-125
Shaver	Head	50-300	500-6875
Aquarium	Belt	1-40	50-2000
Sewing Machine	Chest	1-23	26-1125
Electric Drill	Chest	56-194	300-1500
Circular Saw	Belt	19-48	84-562

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

EXHIBIT JMS-3
OF
J. MICHAEL SILVA

ON BEHALF OF
PHILADELPHIA ELECTRIC COMPANY

***OVERSIZE
DOCUMENT(S)***

December 1991

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

EXHIBIT JMS-4
OF
J. MICHAEL SILVA

ON BEHALF OF
PHILADELPHIA ELECTRIC COMPANY

**OVERSIZE
DOCUMENT(S)**

December 1991