

CONFIDENTIAL

COMMONWEALTH OF PENNSYLVANIA
PUBLIC UTILITY COMMISSION

**UP
OLDER**

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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. :
:
Initial hearing. :
:
-----X

Docket No.
A-110550F055

**RECEIVED
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SECRETARY'S OFFICE
Public Utility Commission**

Pages 1 through 92

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

Thursday, August 15, 1991

Met, pursuant to notice, 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> |
|----------------------|---------------|--------------|-----------------|----------------|
| Ronald J. Oedemann | | | | |
| By Mr. Bonney | 6 | -- | -- | -- |
| By Ms. McCloskey | | 9 | -- | -- |
| By Mr. Sugarman | | 14 | -- | -- |
| Charles J. Boeggeman | | | | |
| By Mr. Bonney | 44 | -- | -- | -- |
| By Ms. McCloskey | | 47 | -- | -- |
| By Mr. Sugarman | | 56 | -- | -- |

E X H I B I T S

| <u>NUMBER</u> | <u>FOR IDENTIFICATION</u> | <u>IN EVIDENCE</u> |
|--|---------------------------|--------------------|
| <u>Philadelphia Electric Co.</u> | | |
| Statement Direct No. 1 (Oedemann) | 6 | 8 |
| Statement Direct No. 2 (Boeggeman) | 44 | 46 |
| Exhibit No. 1 (Oedemann) | 6 | 8 |
| Exhibit No. 2 (Boeggeman) | 44 | 46 |
| <u>Office of Consumer Advocate</u> | | |
| Cross-Exam Exhibit No. 1 (IR-OCA-I-8) | 12 | 13 |
| Cross-Exam. Exhibit No. 2 (IR-OCA-I-2) | 50 | 79 |
| <u>Protestants</u> | | |
| Cross-Exam. Exhibit No. 1 (PECo brochure) | 66 | 80 |

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P R O C E E D I N G S

1
2 ADMINISTRATIVE LAW JUDGE HERBERT SMOLEN: Good
3 morning, everyone. Welcome to the Public Utility
4 Commission.

5 This is the matter of the letter of notification of
6 Philadelphia Electric Company in connection with the
7 reconstructing and rebuilding of the existing 138 kv line
8 ~~to operate as a Woodbourne-Heaton 230 kv line in~~
9 Montgomery and Bucks Counties, in Docket No. A-110550,
10 Folder 055.

11 This hearing and series of hearings are scheduled
12 pursuant to the Commission order and the Commonwealth
13 Court order on remand for a hearing on the issues set
14 forth therein, that is, in the Commonwealth Court order.

15 My name is Herbert Smolen, Administrative Law Judge
16 assigned by the Commission to hear the evidence in this
17 ~~case and to render an initial decision in writing in due~~
18 course which will be served from the Commission's
19 Harrisburg office.

20 In view of the fact that there are a good number of
21 the public who are present this morning I am going to ask
22 Counsel for each of the parties to stand and orally enter
23 their appearance and identify the party whom they
24 represent.

25 Let's start with the company.

1 MR. BONNEY: Paul Bonney, for Philadelphia Electric
2 Company.

3 MR. SMITH: Ward Smith, Philadelphia Electric
4 Company.

5 MS. KHANWALKAR: Arundhati Khanwalkar, Pennsylvania
6 Power & Light.

7 MS. BURKET: Patricia Krise Burket for the
8 ~~Prosecutory Staff of the Public Utility Commission.~~

9 MS. McCLOSKEY: Tanya McCloskey for the Office of
10 Consumer Advocate.

11 MS. ENGLISH: Dorothy English, with PAUSE.

12 MR. SUGARMAN: Ms. English is my client, is one of
13 my clients.

14 My name is Robert Sugarman. I represent the
15 Protestants.

16 JUDGE SMOLEN: Ms. English is not an attorney,
17 then, as I understand it?

18 MR. SUGARMAN: No.

19 JUDGE SMOLEN: For the record, the appearances of
20 the attorneys and the parties whom they represent have
21 now been entered of record.

22 In accordance with the order of the Administrative
23 Law Judge today's hearing was scheduled for the purpose
24 of direct testimony in writing by the company and
25 cross-examination of the company's witnesses.

1 Are we ready to proceed, Mr. Bonney?

2 MR. BONNEY: Yes, Your Honor.

3 The company calls as its first witness Ronald
4 Oedemann.

5 JUDGE SMOLEN: Mr. Oedemann, do you want to take
6 the witness stand here.

7 Whereupon,

8 ~~NONES~~ ~~... WITNESS~~ RONALD J. OEDEMANN

9 having been duly sworn, testified as follows:

10 JUDGE SMOLEN: Keep your voice up. State your full
11 name and address for this record.

12 THE WITNESS: My name is Ronald J. Oedemann,
13 O-e-d-e-m-a-n-n. The business address is Philadelphia
14 Electric Company, 2301 Market Street, Philadelphia,
15 Pennsylvania 19101.

16 JUDGE SMOLEN: Mr. Bonney.

17 ~~MR. BONNEY:~~ Your Honor, I have previously
18 distributed to yourself, to the other parties and two
19 copies to the court reporter of a document that's marked
20 in the upper right-hand corner PECO Direct No. 1, the
21 direct testimony of Ronald J. Oedemann on behalf of
22 Philadelphia Electric Company. I ask that it be marked
23 for identification as such at this time.

24 JUDGE SMOLEN: They are marked for identification
25 as you have indicated. All Counsel have received copies

1 of them?

2 MS. McCLOSKEY: Yes, Your Honor.

3 (Whereupon, the documents were marked
4 as PECO Statement Direct No. 1 and
Exhibit No. 1 for identification.)

5 JUDGE SMOLEN: Please proceed.

6 MR. BONNEY: Does that go for the exhibits as well?

7 JUDGE SMOLEN: You have it marked PECO Exhibit No.

8 as the exhibit and PECO Direct No. 1 as the direct
9 written testimony of this witness.

10 DIRECT EXAMINATION

11 BY MR. BONNEY:

12 Q. Mr. Oedemann, by whom are you employed and in
13 what capacity?

14 A. I am employed by the Philadelphia Electric
15 Company. I am a senior engineer.

16 Q. Do you have before you a copy of what has just
17 been marked for identification as PECO Direct No. 1?

18 A. Yes, I have.

19 Q. Was this document prepared by you or under your
20 direction and supervision?

21 A. Yes, it was.

22 Q. Do you have any revisions or corrections to
23 make to the document?

24 A. I do not.

25 Q. If I were to ask you today the questions set

1 forth in PECO Direct No. 1 would your answers be the same
2 as those contained therein?

3 A. Yes, they would.

4 Q. Would your answers be true and correct to the
5 best of your knowledge, information and belief?

6 A. Yes, they would.

7 Q. Do you have a copy before you of what has just
8 been marked for identification as PECO Exhibit No. 1?

9 A. Yes, I have.

10 Q. And was this exhibit prepared by you or under
11 your direction and supervision?

12 A. Yes, it was.

13 Q. Do you have any revisions or corrections to
14 make to this exhibit?

15 A. No, I do not.

16 Q. Is the information contained in this exhibit
17 true and correct to the best of your knowledge,
18 information and belief?

19 A. Yes, it is.

20 MR. BONNEY: Your Honor, I ask ask at this time
21 that PECO Direct No. 1 and PECO Exhibit No. 1 be admitted
22 into the record.

23 JUDGE SMOLEN: Subject to any later motions which
24 may be made?

25 MR. BONNEY: Yes, Your Honor.

1 MR. SUGARMAN: May I reserve the issue of expertise
2 and incorporate any questions on expertise in the
3 cross-examination?

4 JUDGE SMOLEN: Mr. Bonney, any problem?

5 MR. BONNEY: Not knowing where he is going to go
6 with that...

7 JUDGE SMOLEN: Well, he is essentially asking to
8 hold off on the voir dire. Isn't that right,
9 Mr. Sugarman?

10 MR. SUGARMAN: Yes.

11 JUDGE SMOLEN: Do you want him to do it now or do
12 it later?

13 MR. BONNEY: He can do it later. That's fine.

14 (Whereupon, the documents marked as
15 PECO Statement Direct No. 1 and
16 Exhibit No. 1 were received in
evidence.)

17 JUDGE SMOLEN: Are you submitting the witness,
18 then, for cross-examination?

19 MR. BONNEY: He is available for cross-examination.

20 JUDGE SMOLEN: Let's have Mr. Sugarman go last so
21 he can cover anything which may be raised by other
22 Counsel on cross-examination. That may be a way to serve
23 some litigation time.

24 So why don't we take it around this table first,
25 the table to my right.

1 MS. KHANWALKAR: PP&L has no cross-examination.

2 JUDGE SMOLEN: All right.

3 MS. BURKET: The Prosecutory Staff has no
4 cross-examination.

5 MR. SUGARMAN: May I ask a question, Your Honor, as
6 to the position that Prosecutorial Staff is taking? I
7 note that they are seated at counsel table with the
8 Applicant. Can we infer from that that they are aligned
9 with the Applicant?

10 JUDGE SMOLEN: I think you are asking the wrong
11 party.

12 MR. SUGARMAN: May I inquire as to the
13 Prosecutorial Staff?

14 JUDGE SMOLEN: You can ask them.

15 MS. BURKET: At this time I believe our interests
16 are more coincidental with the company's, and so that is
17 why we are on this side at this time.

18 MR. SUGARMAN: Thank you.

19 JUDGE SMOLEN: OCA.

20 MS. McCLOSKEY: Thank you, Your Honor.

21 CROSS-EXAMINATION

22 BY MS. McCLOSKEY:

23 Q. Good morning, Mr. Oedemann. My name is Tanya
24 McCloskey. I am with the Office of Consumer Advocate.

25 I would like to start at page four of your

1 testimony, on lines 12 through 14, where you are
2 discussing the Conrail line. And you state there that
3 Conrail stopped using electric locomotives on the line in
4 1981 but the line remained energized until 1986, is that
5 correct?

6 A. That's correct.

7 Q. And what do you mean by energized?

8 A. It was in service until 1986.

9 Q. And when you say it was in service, was there
10 any flow of current or loading on the line between 1981
11 and '86?

12 A. Yes, there was.

13 Q. And what type of flow of current was on the
14 line at that time?

15 A. It was used as part of Amtrak's bulk power
16 transmission system until that time.

17 Q. And do you know how much loading was on the
18 line between 1981 and 1986 in that use?

19 A. I don't have that answer.

20 Q. And do you know what the voltage was on the
21 line between 1981 and 1986?

22 A. 132,000 volts.

23 Q. Now, if you could turn to page five of your
24 testimony, lines 12 through 17, where you are discussing
25 the 60 foot easement that PECO purchased. With the 60

1 foot easement, is the line that is proposed by PECO
2 centered on the easement so that there is 30 foot
3 clearance from the line to the edge of the right-of-way?

4 A. That's correct.

5 Q. And is that the position of the line along all
6 12.8 miles of the line?

7 A. That's correct.

8 ~~Q. Now, if you could turn to page 11 of your~~

9 testimony, where you start your discussion of the
10 alternative -- the three alternative designs, the
11 horizontal, the vertical and the longer-span delta
12 designs. When PECO originally designed the transmission
13 line was this analysis conducted as to these three
14 alternatives?

15 A. Yes, they were.

16 Q. And the analysis that you present in your
17 testimony, is that the analysis that was conducted by
18 PECO at the time that the line was designed or was that
19 conducted for the purpose of the testimony?

20 A. Like I said before, when the existing line was
21 decided we looked at these alternatives and in my
22 engineering judgement the design that was chosen resulted
23 in the lowest cost and it also resulted in a line that
24 would result in the lowest E/MF.

25 JUDGE SMOLEN: For this record, please define what

1 you mean by E/MF.

2 THE WITNESS: Electro-magnetic fields, Your Honor.

3 MS. McCLOSKEY: Your Honor, I would like to have
4 marked for identification OCA Cross-Examination Exhibit
5 No. 1.

6 JUDGE SMOLEN: So marked. Do you have copies for
7 the reporter and Counsel?

8 MS. McCLOSKEY: Yes, I do, Your Honor.

9 (Whereupon, the document was marked
10 as OCA Cross-Exam. Exhibit No. 1
for identification.)

11 BY MS. McCLOSKEY:

12 Q. Now, Mr. Oedemann, I would like to direct your
13 attention to OCA Cross-Examination Exhibit No. 1, which
14 is your response to OCA Interrogatory Set I, No. 8. And
15 if you could briefly review that and signal me when you
16 have completed your review.

17 (Witness perusing document.)

18 Q. Am I correct that this is your response to that
19 interrogatory?

20 A. That's correct.

21 Q. And in that response you indicate that no cost
22 information or field calculations were prepared for the
23 alternative designs, is that correct?

24 A. That's correct. At the time.

25 Q. So the cost information and the field

1 calculations that appear in your testimony were not
2 conducted for the initial design of the line but were
3 conducted sometime after that initial design was
4 completed, is that not correct?

5 A. That's correct.

6 Q. And when was the cost information contained in
7 your testimony concerning these three designs conducted
8 or obtained by the company?

9 A. The calculations that exist in the testimony
10 were made between the time we answered this interrogatory
11 and the time that I prepared the direct testimony that
12 you have.

13 Q. And to give us a general idea of the time
14 frame, are you speaking about July of 1991?

15 A. Yes. That's correct.

16 Q. And in July of 1991 how far along was
17 construction of the line, the proposed transmission line?

18 A. Approximately 90 percent complete.

19 MS. McCLOSKEY: Your Honor, I have no further
20 questions. And I would like to move for the admission of
21 OCA Cross-Examination Exhibit No. 1.

22 MR. BONNEY: No objection.

23 JUDGE SMOLEN: It is received in evidence.

24 (Whereupon, the document marked as
25 OCA Cross-Exam. Exhibit No. 1
was received in evidence.)

1 MS. McCLOSKEY: Thank you, Your Honor.

2 JUDGE SMOLEN: Mr. Sugarman.

3 MR. SUGARMAN: May I proceed, Your Honor?

4 JUDGE SMOLEN: Yes.

5 MR. SUGARMAN: Thank you.

6 CROSS-EXAMINATION

7 BY MR. SUGARMAN:

8 Q. ~~Mr. Oedemann, directing your attention to Ms.~~
9 McCloskey's questions and your answers, what is the
10 source of your knowledge that Conrail was supplying bulk
11 power to Amtrak until 1986?

12 A. Discussions with Conrail and Amtrak personnel
13 and also I received the bulk power diagram from Amtrak
14 where it indicates that the line was removed in May of
15 1986.

16 Q. Have you got that document with you?

17 A. ~~I do not personally have that with me at this~~
18 time.

19 MR. SUGARMAN: Could that be produced, Mr. Bonney?

20 MR. BONNEY: Yes.

21 MR. SUGARMAN: Thank you.

22 MR. BONNEY: Is that an on the record data request?

23 JUDGE SMOLEN: That is an on the record data
24 request and Mr. Bonney has indicated that he will produce
25 it.

1 MR. SUGARMAN: Thank you, Your Honor.

2 BY MR. SUGARMAN:

3 Q. Could you identify the Conrail or Amtrak
4 personnel who advised you that the line was being used
5 until 1986?

6 A. It's on the tip of my tongue and I just can't
7 think of it.

8 MR. SUGARMAN: Could that be provided to us as
9 supplemental information?

10 MR. BONNEY: Yes.

11 MR. SUGARMAN: Thank you.

12 BY MR. SUGARMAN:

13 Q. Mr. Oedemann, I would like to ask you to
14 address your attention, if you will, to your testimony,
15 page four, commencing at lines 22 through 26. And your
16 testimony -- and going over to page five, line three.

17 How did you acquire the property for the eastern
18 termination of the line?

19 A. The substation was on an existing property at
20 that location.

21 Q. And how did you acquire the land between the
22 substation and the Conrail corridor?

23 A. That was acquired by our real estate department
24 amicably.

25 Q. And what year was it acquired?

1 A. Approximately 1990 -- 1989 or 1990.

2 Q. Well, do you recall whether it was acquired
3 before or after the letter of notification was submitted
4 by the company which is attached as exhibit -- as number
5 one to your Exhibit 1, that is, November 21, 1989?

6 MR. BONNEY: Your Honor, I don't see the relevance
7 of the question and I object on that basis.

8 ~~MR. SUGARMAN: Well, I move to strike the testimony~~
9 starting at page four, line 17, and going over to page
10 five, line 11 if it's not relevant.

11 JUDGE SMOLEN: I will overrule the objection. You
12 may answer the question.

13 A. I do know that there was an agreement of sale
14 made between our real estate department and the owner of
15 that property about the same time the letter of
16 notification was sent. Exactly when the transfer of the
17 property took place, I don't have that information.

18 BY MR. SUGARMAN:

19 Q. All right. Did you have anything to do with
20 the preparation of the letter of notification?

21 A. Yes, I did.

22 Q. And why is it attached as an exhibit to your
23 testimony?

24 (Pause.)

25 Q. Well, perhaps I could ask you to direct your

1 attention to page five of your testimony. At page five
2 of your testimony you state, quote, more details about
3 the background and location of the line are contained in
4 the company's November 21, 1989, letter of notification
5 to the Commission, which I have reproduced as part of
6 PECO Exhibit 1. Is it the case that you are intending to
7 sponsor the information contained in the letter of
8 notification?

9 A. The letter of notification goes into a lot of
10 detail as to the amount of mileages that are in the
11 townships, it just gives you a pretty general description
12 of the route that we are taking.

13 Q. Well, what I am asking you is is it your
14 intention to stand behind or to sponsor for the
15 Commission all of the information in the letter of
16 notification?

17 A. Yes.

18 Q. All right. Now, it states in the letter of
19 notification, quote, Woodbourne substation property abuts
20 -- this is page five of the letter of notification at the
21 top, which is the first exhibit in PECO Exhibit 1. It
22 says, "Woodbourne substation property abuts the north
23 property line of Conrail's Trenton Cut-off Branch." Was
24 that statement true as of November, 1989?

25 A. Yes, it was.

1 Q. And it was true based on -- if it was true,
2 then why were you acquiring an additional piece of ground
3 between the substation and the Conrail line?

4 A. The property does abut the railroad, but it
5 abutted the railroad at a point where we couldn't enter
6 the substation property due to the location of Buehl
7 Field. In order to avoid a conflict with the airfield we
8 had to divert the line from the railroad before we
9 approached Buehl Field.

10 Q. All right. Now, at the time of writing the
11 letter of notification to the Commission had the company
12 at that time made the decision as to what it wanted to
13 do, that is, that it wanted to embark upon the present
14 project?

15 A. Yes.

16 Q. And did the company in making that decision
17 consider the alternatives, alternative designs, that are
18 identified in your testimony at pages 11 and 12, lines
19 ten and following -- well, let's start at the top of page
20 11. Had the company considered the alternative designs
21 at that time?

22 A. Yes, we have. And as I stated previously, in
23 my professional judgement the horizontal configuration
24 would have resulted in higher costs and higher E/MF
25 fields.

1 Q. Why did the Commission not identify the
2 alternative designs in the letter of notification?

3 MR. BONNEY: Your Honor, I believe he said why did
4 not the Commission.

5 MR. SUGARMAN: I meant the company. I'm sorry.

6 JUDGE SMOLEN: Do you want to restate the question
7 so that the witness understands it, please?

8 BY MR. SUGARMAN:

9 Q. Why did the company not identify the
10 alternative designs in the letter of notification?

11 A. Because the alternative designs, all three
12 alternative designs, would have resulted in a higher cost
13 to the customer and would have resulted in higher E/MF
14 fields and it was not -- I did not feel it was prudent to
15 recommend these designs to the Public Utility Commission.

16 Q. Well, I'm not asking you about recommending
17 them. I am asking you about identifying them. Why were
18 they not identified in the letter of notification?

19 A. The reason they were not identified is that we
20 just -- we did not think it was necessary.

21 Q. Now, you indicated in your answer to
22 Ms. McCloskey that the selected design would reduce E/MF,
23 is that correct, as opposed to the alternative designs?

24 A. That's correct.

25 Q. Did you make any calculations to support that

1 conclusion?

2 A. I did not make formal calculations when the
3 original design was chosen. But I knew through
4 experience that the compact delta would result in a lower
5 E/MF field. And as Mr. Boeggeman will point out in his
6 testimony, my prediction was correct.

7 Q. When you made that -- did you make a judgement
8 ~~to that effect and take that into consideration at the~~
9 time that you selected the design, that is, prior to
10 November, '89?

11 A. Yes, I did, Your Honor.

12 Q. And did you discuss that with anybody? In
13 other words, did you have any conversation with
14 Mr. Boeggeman or anybody else to the effect that what
15 would be the best design to minimize E/MF or will the
16 proposed design minimize E/MF, again, prior to filing the
17 letter of notification?

18 A. No, I didn't.

19 Q. You indicated that you based your judgement to
20 that effect on your experience.

21 A. That's correct.

22 Q. Is it correct to infer from that that you have
23 made yourself aware of the impact of different
24 configurations of high voltage facilities on E/MF in the
25 past, that you have had experience in taking E/MF into

1 account in the design of high voltage facilities?

2 A. Yes.

3 Q. Can you identify any high voltage line whose
4 design has been affected by E/MF considerations?

5 A. One would be the rebuild of the
6 Schuylkill-Island Road 66 kV line, where we used a very
7 tight configuration for that.

8 ~~Q. Any others? Is that in -- where is the~~
9 Schuylkill-Island Road?

10 A. That is in southwest Philadelphia.

11 Q. Okay. Any others?

12 A. I can't think of any others off-hand.

13 Q. When the company establishes a new right-of-way
14 for a high voltage line does typically it employ a tight
15 delta design, a compact delta design?

16 (Pause.)

17 ~~Q. In connection with high voltage lines on new~~
18 rights-of-way.

19 MR. BONNEY: Your Honor, I'm not sure what
20 relevance that question has to the question at issue
21 here, which is whether the line being constructed by the
22 company will have an adverse effect on the Protestants.
23 Whether some other line -- or whether the company when it
24 establishes right-of-way with other lines typically
25 employs a particular design is irrelevant to that

1 question.

2 MR. SUGARMAN: It's cross-examination on the direct
3 testimony which describes alternate line designs.

4 JUDGE SMOLEN: I am going to overrule the
5 objection. I am going to ask you to define what you mean
6 by typically. Is it always? Sometimes?

7 MR. SUGARMAN: Most of the time.

8 ~~JUDGE SMOLEN: All right. Let's hear the witness'~~
9 answer, if he remembers the question.

10 BY MR. SUGARMAN:

11 Q. Where you have a new right-of-way do you
12 normally most of the time employ a tight delta on high
13 voltage kV lines?

14 A. We look at every opportunity we can on any
15 project to take any actions that we can that would be
16 consistent with prudent avoidance. We do that.

17 Q. What does prudent avoidance mean?

18 A. I would like to, if I could, get into the
19 technicality of that issue, if I may --

20 Q. I would appreciate it --

21 A. -- with Mr. Boeggeman.

22 Q. Well, you say get into the technicality. What
23 I would like for you to tell me is as the line designer
24 what your instructions are, your policies are -- either
25 instructions that you are given by company policy or your

1 own professional judgement, either one -- as to what, to
2 put it another way, what prudent avoidance means to you
3 in your designing activities.

4 A. Basically we endeavor to build a transmission
5 line that will result -- that will -- that will result or
6 lower fields, substantially lower those fields, at a
7 modest increase in cost.

8 Q. And why, to your knowledge, do you attempt to
9 substantially lower those fields?

10 A. To make the line as safe as we possibly can for
11 our neighbors.

12 Q. Well, is it fair, therefore, to infer that you
13 recognize that E/MF transmission represents an absence of
14 safety?

15 A. No. We are not saying that. We are aware of
16 the issues at hand. We are aware that some studies have
17 been made -- a lot of studies have been made. But we are
18 not convinced that there is conclusive evidence that
19 there is a health effect. But we would still like to do
20 everything we can to help mitigate that effect.

21 Q. And for the purpose of making the line safe?

22 MR. BONNEY: Your Honor, he already answered that
23 question.

24 JUDGE SMOLEN: He can answer it again.

25 A. Yes. We do that to make the line as safe as we

1 possibly can keeping cost in mind for our neighbors.

2 BY MR. SUGARMAN:

3 Q. Understanding that, when did that policy come
4 into being in PECO?

5 (Pause.)

6 Q. I mean, there was a time when -- I think we all
7 know, but you're the witness -- there was a time when the
8 ~~concept of E/MF was not a factor, was not recognized as a~~
9 factor, as I understand it. Isn't that correct?

10 A. That's correct.

11 Q. When did it become a factor? Was it a formal
12 decision at PECO at some point or was there a consensus?
13 How did it become a factor and when?

14 A. It just didn't happen overnight. It evolved.
15 I would say that within the last four to five years is
16 when the E/MF issue, we started looking at that.

17 Q. When you say looking at it, you mean taking it
18 into account in making line, transmission line,
19 decisions?

20 A. Yes.

21 Q. Now, what effects of E/MF, or potential
22 effects, is the company concerned about from a safety
23 point of view?

24 MR. BONNEY: Your Honor, we have permitted some
25 questions about E/MF. Mr. Oedemann does not talk about

1 E/MF in his testimony at all. We have a witness,
2 Mr. Boeggeman, who has sponsored some testimony about
3 E/MF and I would suggest that he would be the
4 appropriate witness to ask some of these questions to. I
5 also note, however, that his testimony is somewhat
6 limited with respect to E/MF.

7 MR. SUGARMAN: Well, the witness testified that the
8 ~~proposed design would minimize E/MF and that was one of~~
9 the considerations.

10 JUDGE SMOLEN: What is the question?

11 MR. SUGARMAN: My question is what is his knowledge
12 as to the risks or the effects on safety that the company
13 is seeking to minimize through its policy of prudent
14 avoidance.

15 MR. BONNEY: I'm not sure whether that is relevant.

16 MR. SUGARMAN: If he doesn't know, he doesn't know.

17 JUDGE SMOLEN: To the extent that the witness has
18 knowledge on the subject, he may answer the question.

19 A. There again, as I stated before, there is some
20 evidence that links E/MF to cancer. It may be some, but
21 we think it is inconclusive.

22 BY MR. SUGARMAN:

23 Q. Also neurological conditions?

24 A. I don't know those details. I really don't.

25 Q. Okay.

1 Now, back to my question. I want to find out the
2 relationship between the tight delta formation and the
3 width of the right-of-way. Isn't it true that the
4 company does not normally use a tight delta formation
5 where it does not have a limitation on the right-of-way?

6 A. What drove the tight delta configuration was
7 the fact that the right-of-way also had structures,
8 ~~Conrail structures, and the span lengths that we have~~
9 require the use of a tight delta configuration. So
10 it's --

11 Q. Thank you. I appreciate that. And let me,
12 then, ask a different question.

13 Isn't it true that where the company has the
14 freedom to make an unconstrained design, in an
15 unconstrained right-of-way, relatively unconstrained
16 right-of-way, that a tight delta formation is not used?

17 MR. BONNEY: Is this a hypothetical question or are
18 you thinking of a particular line?

19 MR. SUGARMAN: In general. Again, normally.

20 JUDGE SMOLEN: Wait a minute. Let's get some
21 order --

22 MR. BONNEY: I'm not sure what you mean by
23 normally. I'm confused.

24 MR. SUGARMAN: Most of the time.

25 BY MR. SUGARMAN:

1 Q. Absent some special factor isn't it true that
2 the tight delta design is not a preferred method for the
3 company's own operation?

4 JUDGE SMOLEN: You may answer.

5 A. That is correct.

6 BY MR. SUGARMAN:

7 Q. Is that because it is less efficient or less
8 safe or both, from an electrical operating point of view?

9 A. If you would take a typical right-of-way, there
10 are no structures on that right-of-way. But like I said
11 before, this right-of-way had structures at approximately
12 300 foot spacing and -- which lended itself or I should
13 say required the use of a tight delta. And as a big
14 by-product of that, the tight delta configuration results
15 in low E/MF fields.

16 Q. I understand that. I understand your testimony
17 in that regard. But my question is given that there is
18 an effect, as you have testified, and given that the
19 company practices prudent avoidance --

20 MR. BONNEY: I'm sorry. There is an effect?

21 MR. SUGARMAN: An effect. A-n, new word,
22 e-f-f-e-c-t.

23 MR. BONNEY: No one has testified to that.

24 MR. SUGARMAN: An effect of E/MF.

25 JUDGE SMOLEN: Wait. We have an objection to at

1 least that part of your question.

2 MR. SUGARMAN: Oh, I see.

3 BY MR. SUGARMAN:

4 Q. Given that you feel there is an effect on
5 safety such that you practice prudent avoidance, my
6 question is directed towards whether --

7 MR. BONNEY: Your Honor, I still object at this
8 point. I don't think he said there is an effect on
9 safety from E/MF.

10 MR. SUGARMAN: I think he did.

11 JUDGE SMOLEN: Well, the record will show what the
12 witness said. But we can ask the witness.

13 MR. SUGARMAN: Again? We can ask the witness
14 again?

15 JUDGE SMOLEN: Yes, you can ask the witness again.

16 MR. SUGARMAN: Okay.

17 BY MR. SUGARMAN:

18 Q. Do you recall testifying a few minutes ago that
19 you practice -- the company practices prudent avoidance
20 with respect to E/MF in order to alleviate the effect of
21 E/MF on safety?

22 MR. BONNEY: Your Honor, that is not what he
23 testified to.

24 JUDGE SMOLEN: Well, he is asking him now.

25 Did you testify to that in the past, earlier in

1 this proceeding?

2 A. If we talk about safety, we have to go back to
3 codes.

4 BY MR. SUGARMAN:

5 Q. We do? I am asking what the company does. Are
6 you saying you ignore anything that is not in a code?

7 A. No. We don't ignore it.

8 ~~Q. Okay. I was going to get to the code. But you,~~

9 said earlier that -- did you not say earlier that the
10 company practices prudent avoidance in order to alleviate
11 the safety -- or in order to enhance the safety of the
12 line with respect to E/MF?

13 A. We practice you prudent avoidance to minimize
14 E/MF and to minimize any possible health effects from
15 E/MF. I don't consider this to be -- I don't consider
16 prudent avoidance and safety to be the same thing.

17 Q. All right. I understand what you are saying
18 and the record will reflect this answer and the other
19 answers. And I think the witness' -- well, it doesn't
20 matter what I think at this point.

21 Let me, then, take the present testimony as the
22 predicate for the next question.

23 JUDGE SMOLEN: Ask your question.

24 BY MR. SUGARMAN:

25 Q. As I understand it, you practice prudent

1 avoidance to reduce the E/MF effect because of the
2 possible health risk.

3 MR. BONNEY: I object, Your Honor.

4 MR. SUGARMAN: That's what he just said.

5 JUDGE SMOLEN: That's his understanding. Let's
6 hear the question. That is Counsel's understanding.

7 MR. BONNEY: I'm not sure that it's relevant.

8 JUDGE SMOLEN: It's not. Let's get the question,
9 now.

10 BY MR. SUGARMAN:

11 Q. Does that include the issue of location as well
12 as the issue of design? That is to say, when you select
13 a location for a facility do you consider the
14 desirability of minimizing E/MF?

15 A. Yes, we do.

16 Q. Okay. Now, if you have a new right-of-way for
17 a facility and you can avoid using the delta, the tight
18 delta, isn't that a way of minimizing E/MF and also at
19 the same time enhancing your electrical performance?

20 MR. BONNEY: Your Honor, is that a hypothetical
21 question? If so, I would ask what you mean by a new
22 right-of-way.

23 MR. SUGARMAN: It is.

24 JUDGE SMOLEN: He answered it is a hypothetical.

25 MR. SUGARMAN: A right-of-way that is not

1 constrained by the fact that it is an effort to employ an
2 existing right-of-way.

3 A. Yes, we definitely would. If we had an
4 unconstrained right-of-way, as you mentioned, we would
5 keep the line as far from the edge of that right-of-way
6 as we can to keep E/MF levels at the edge of the
7 right-of-way as low as we can.

8 BY MR. SUGARMAN:

9 Q. And in your answer to the OCA interrogatory
10 which has been identified and I believe admitted as OCA
11 Exhibit 1, it says the choices for the siting and design
12 of this transmission line were guided by the availability
13 of an existing Conrail right-of-way. And then you go on
14 to say given the special situation of an existing
15 railroad right-of-way with structures only minimal
16 consideration was given to alternative routes. In PECO's
17 view, use of the existing right-of-way and structures was
18 obviously superior to any alternatives and therefore no
19 cost information or field calculations were prepared for
20 alternate routes.

21 Now, I am going to ask you what alternate routes
22 you identified.

23 A. As I stated in this interrogatory, the route
24 that we selected was so obvious to be the best route, if
25 you took a ruler and drew a straight line from Woodbourne

1 substation to Heaton substation, it would be 64,000 feet.
2 If you get your calculator out that will measure out to
3 12.1 miles as the crow flies. Our line is 12.8 miles in
4 length. You can't get a route more direct between these
5 two substations.

6 Q. I was waiting for you to answer my question.
7 Would you identify the alternate routes that you
8 identified?

9 A. I did not formally investigate other routes for
10 this transmission line.

11 Q. Would you identify the routes that you
12 informally identified?

13 A. We didn't have any other alternate routes. I
14 mean, when you look at an alternate route you think about
15 buying a new right-of-way. But this area has so many --
16 is so built up that buying a new route would be unheard
17 of.

18 Q. Did you consider employing or overbuilding on
19 an existing route?

20 MR. BONNEY: Your Honor, I think you have ruled
21 that the need for this line is not at issue in this case.

22 MR. SUGARMAN: I didn't eliminate the line.

23 JUDGE SMOLEN: He is talking about alternative line
24 designs, and that is raised in the testimony.

25 MR. BONNEY: You are talking about alternative

1 locations.

2 MR. SUGARMAN: Yes.

3 MR. BONNEY: And now your question goes to whether
4 we needed to build this line.

5 MR. SUGARMAN: No, it doesn't. It goes to
6 whether --

7 JUDGE SMOLEN: I am going to overrule the
8 objection. Let's not waste time.

9 Answer the question if you recall what the question
10 was.

11 A. There are other rights-of-way into Woodbourne
12 substation. There is only one private right-of-way that
13 we have that we could take into Woodbourne substation
14 right now.

15 BY MR. SUGARMAN:

16 Q. And what is that?

17 A. I beg your pardon?

18 Q. What is that?

19 A. That comes from the Buckingham area. That is
20 way out of the road.

21 Q. Did you perform any system models to determine
22 whether the Buckingham terminus could be hooked into the
23 grid in order to provide an alternate source into Heaton
24 or Woodbourne?

25 A. As the letter of notification states, this line

1 is being put in there to prevent -- in case we lose the
2 line out of Buckingham. So that would not be a
3 possibility.

4 Q. Did you perform a system model to determine
5 whether the line to Buckingham could be used to hook into
6 the grid?

7 MR. BONNEY: Your Honor, that goes directly to need
8 for this line.

9 MR. SUGARMAN: Your Honor, it's a question of an
10 alternate route.

11 JUDGE SMOLEN: Well, it is mentioned in the letter
12 of notification which is part of his exhibit. Now, need
13 for the line can be interpreted several ways: need for
14 this design of the line or need for additional power.
15 And I think this -- since the letter of notification is
16 attached as an exhibit and the witness answered that he
17 is ready to stand to answer questions about the letter of
18 notification I am going to permit the question, if he
19 remembers it.

20 THE WITNESS: I believe I do. Would you repeat the
21 question, please?

22 BY MR. SUGARMAN:

23 Q. It is a yes or no question. Did you perform a
24 system model to determine whether using the Buckingham
25 corridor to the grid could supply the necessary power at

1 the Heaton or Woodbourne substations?

2 A. No, I did not.

3 Q. Is the Buckingham station connected to the grid
4 independently of Woodbourne or Heaton?

5 A. The Buckingham substation is on the same 220 kV
6 grid.

7 Q. Now, you indicated earlier that code is
8 considered, and in your direct testimony you refer to the
9 National Electric Safety Code at pages eight to ten of
10 your testimony. You list there on page ten eight -- you
11 paraphrase eight code requirements. Are those the only
12 requirements of the NESC code which are relevant to this
13 line?

14 A. No, they are not.

15 Q. And why did you list those?

16 A. I just tried to give an example of some of the
17 requirements in the code.

18 Q. Are there any requirements of the code that are
19 related to considerations of electro-magnetic fields?

20 A. No.

21 Q. Now, in your testimony at pages ten and 11 you
22 were asked are there any other safety considerations that
23 the company has incorporated. And your response
24 indicates removal of an aviation hazard and some removal
25 of some switches and transformers. Can you explain why

1 you didn't address E/MF in that answer in light of your
2 answers to Ms. McCloskey and to me?

3 A. There again, when I talk about safety
4 considerations here I did not put the E/MF issue in this
5 answer because as far as I am concerned that E/MF is not
6 really a safety issue to keep the public from getting
7 hurt by the line.

8 Q. What is it?

9 A. What is what?

10 Q. E/MF?

11 A. E/MF is a field that surrounds the line. It's
12 a magnetic field that surrounds the line.

13 Q. Why does the company practice prudent avoidance
14 to minimize exposure to it? Why spend the ratepayers'
15 money on minimizing exposure to E/MF?

16 A. Because we care.

17 Q. About what?

18 A. We care about our neighbors and our customers.

19 Q. But if there is no safety issue why does your
20 care for your neighbors and customers induce you to
21 practice prudent avoidance?

22 A. Because we are aware of the fact that studies
23 have been made and there is basically inconclusive
24 evidence that there may be some health risk or health
25 effect due to E/MF.

1 Q. So it is a safety issue, then?

2 A. Well, if it were a safety issue, in my opinion,
3 it should be listed in the National Electric Safety Code
4 and as of now that code does not address E/MF, does not
5 give any minimum values of E/MF to design your line to.

6 Q. Now, isn't it true that PECO has advised its
7 customers to avoid E/MF in their daily lives?

8 MR. BONNEY: Do you have a reference that you are
9 talking about?

10 MR. SUGARMAN: Yes. It's a brochure published by
11 PECO.

12 MR. BONNEY: Do you have a copy of that available?

13 MR. SUGARMAN: I do have a copy. I just have one
14 copy. I just got it.

15 JUDGE SMOLEN: Why don't you show it to Counsel?

16 MR. SUGARMAN: I would be happy to do that.

17 (Document handed to Mr. Bonney.)

18 MR. BONNEY: Do you have a particular reference in
19 that brochure that you are picking out?

20 MR. SUGARMAN: I beg your pardon?

21 MR. BONNEY: Is your question directed to a
22 particular reference in that brochure or is it the entire
23 brochure that you are referring to?

24 MR. SUGARMAN: No. There is a particular
25 reference. And it's on the last page and it says, "I

1 understand milligauss as a unit of measure. Now what?"

2 And it says, "Consider what one researcher has
3 called prudent avoidance. Prudent avoidance is simply
4 common sense reduction of your exposure to electric and
5 magnetic fields."

6 BY MR. SUGARMAN:

7 Q. Are you familiar with the company having
8 offered that advice to its customers?

9 MR. BONNEY: Your Honor, I think the report speaks
10 for itself.

11 MR. SUGARMAN: I am asking if he is familiar with
12 it.

13 MR. BONNEY: He didn't ask that. He said has the
14 company given that advice. I don't see any advice that
15 the company has given. It just repeats what others have
16 indicated.

17 MR. SUGARMAN: It puts the company --

18 JUDGE SMOLEN: Well, wait a minute. What is the
19 question?

20 MR. SUGARMAN: I am asking if he is familiar that
21 brochure having been published by the company.

22 JUDGE SMOLEN: That's the question.

23 MR. BONNEY: That's not the question he asked.

24 JUDGE SMOLEN: Well, that is the question that's
25 now before the witness.

1 Are you familiar with this brochure?

2 (Witness perusing document.)

3 THE WITNESS: To be truthful, I don't remember
4 seeing this.

5 JUDGE SMOLEN: Next question.

6 BY MR. SUGARMAN:

7 Q. Now, would the E/MF exposure induced by the
8 proposed line be reduced if the right-of-way were all
9 above the natural topography rather than in a cut?

10 MR. BONNEY: Your Honor, that is well beyond the
11 scope of Mr. Oedemann's testimony. As I pointed out
12 earlier, he does not discuss E/MF in his direct testimony
13 at all. Mr. Boeggeman does and he is the witness that we
14 are presenting with respect to the expected field levels
15 from this line.

16 MR. SUGARMAN: I am only asking if he knows.

17 JUDGE SMOLEN: Well, you didn't ask if he knows.

18 Do you know -- well, what is the question again?

19 BY MR. SUGARMAN:

20 Q. Do you know whether the E/MF exposure on the
21 ground adjacent to the right-of-way would be reduced if
22 the right-of-way were at existing topography rather than
23 in a cut?

24 JUDGE SMOLEN: Is this within your field?

25 THE WITNESS: I'm not still -- Your Honor, I'm not

1 sure exactly how -- what the question is.

2 BY MR. SUGARMAN:

3 Q. Well, let me ask a preliminary question.

4 A. Can you give me an example, perhaps?

5 Q. Yes. Let me ask a preliminary question. You
6 are aware of where the line -- where the Conrail corridor
7 passes under the Davisville Road bridge near Willow
8 Grove?

9 A. Yes. Yes, I am familiar with that.

10 Q. And the line is in a deep cut at that point, is
11 it not?

12 MR. BONNEY: What do you mean by deep cut?

13 A. Yes --

14 JUDGE SMOLEN: Wait a minute. Now, your Counsel
15 has an inquiry here.

16 MR. SUGARMAN: How deep is a deep cut?

17 MR. BONNEY: What do you mean by a deep cut?

18 BY MR. SUGARMAN:

19 Q. How deep is the cut there?

20 A. Twenty feet.

21 Q. Okay. So is it correct that the top -- that
22 the elevation of the conductors in regard to the
23 topography is lower than it would be if the line were at
24 the surrounding topography?

25 A. That's not true.

1 Q. It's not true? Are you saying that the poles
2 are raised in height to compensate for the cut?

3 A. Absolutely.

4 Q. So it's the same height that you would have if
5 you were on existing topography?

6 JUDGE SMOLEN: As if there were no cut there? Is
7 that what you are asking?

8 MR. SUGARMAN: Yes.

9 A. As I understand the question, you are asking do
10 we adjust the height of a line, of a transmission line,
11 to account for the topography that we are passing across?

12 BY MR. SUGARMAN:

13 Q. Yes. Yes. That is another way of asking it,
14 yes.

15 A. Okay. The answer to that is yes. We have
16 adequate clearance at that location.

17 Q. But do you have as much clearance as you would
18 have if the line were on the same level -- if the bottom
19 of the poles were on the same level as the surrounding
20 topography?

21 A. Well, that is a unique case in that the wire at
22 Davisville Road is not governed by ground clearance at
23 that location. We have a distribution crossing at
24 Davisville Road. So the wires at Davisville Road are
25 probably higher than they normally would be.

1 Q. For that reason?

2 A. For that reason.

3 Q. Let me ask you to eliminate that as a
4 consideration, and if that makes Davisville Road not a
5 fair example I will ask you to select an example, perhaps
6 a mile east of Davisville Road as an example where there
7 is no distribution line.

8 Again, my question is do you compensate for any
9 deviation because the railroad is in a cut on a one for
10 one basis? Do you raise the line enough so the
11 conductors would be at the same elevation above the
12 ground?

13 A. Yes, we do.

14 Q. As if it were on the existing topography?

15 A. Yes, we do.

16 MR. SUGARMAN: Thank you. I don't have any other
17 questions.

18 JUDGE SMOLEN: Redirect?

19 MR. BONNEY: May we have a few moments?

20 JUDGE SMOLEN: Yes. Let's take a break. I have
21 approximately 11:05. Let's reconvene at 11:15.

22 MR. BONNEY: Thank you, Your Honor.

23 (Recess.)

24 JUDGE SMOLEN: Back on the record.

25 Mr. Bonney, redirect?

1 MR. BONNEY: We have no redirect for the witness,
2 Your Honor.

3 JUDGE SMOLEN: Anything further of the witness?

4 MR. BONNEY: Yes. I would move that his testimony,
5 PECO Direct No. 1 and his accompanying exhibit, PECO
6 Exhibit No. 1, be admitted into the record.

7 JUDGE SMOLEN: I think you already moved that and
8 it was received subject to motions.

9 The witness is excused. Thank you very much for
10 appearing and testifying.

11 (Witness excused.)

12 JUDGE SMOLEN: Mr. Bonney, do you have another
13 witness?

14 MR. BONNEY: Yes, Your Honor. The company calls
15 Charles Boeggeman.
16 Whereupon,

17 CHARLES BOEGGEMAN
18 having been duly sworn, testified as follows:

19 JUDGE SMOLEN: State your full name and address for
20 the record.

21 THE WITNESS: My name is Charles J. Boeggeman,
22 B-o-e-g-g-e-m-a-n. The company address is Philadelphia
23 Electric Company, 2301 Market Street, Philadelphia 19101.

24 JUDGE SMOLEN: Mr. Bonney.

25 MR. BONNEY: Your Honor, I have previously

1 distributed to yourself, two copies to the court reporter
2 and to the other parties copies of what have been marked
3 as PECO Direct No. 2, the direct testimony of Charles J.
4 Boeggeman on behalf of Philadelphia Electric Company, and
5 his accompanying exhibit, PECO Exhibit No. 2.

6 JUDGE SMOLEN: They are marked for identification
7 as you have indicated. PECO Direct No. 2 is the
8 testimony of this witness and PECO Exhibit No. 2 is the
9 exhibit accompanying that testimony.

10 (Whereupon, the documents were marked
11 as PECO Statement Direct No 2 and
12 Exhibit No. 2 for identification.)

13 JUDGE SMOLEN: Let me ask whether or not the
14 reporter has been supplied with the corrected copies of
15 PECO Exhibit No. 2?

16 MR. BONNEY: He has been.

17 JUDGE SMOLEN: As well as other Counsel?

18 MR. BONNEY: Yes, Your Honor.

19 JUDGE SMOLEN: Let's proceed.

20 MR. BONNEY: And we will be referring to that.

21 JUDGE SMOLEN: Okay.

22 DIRECT EXAMINATION

23 BY MR. BONNEY:

24 Q. Mr. Boeggeman, by whom are you employed and in
25 what capacity?

A. Philadelphia Electric Company. I am an

1 electrical engineer.

2 Q. Do you have before you a copy of what has been
3 marked for identification as PECO Direct No. 2?

4 A. Yes, I do.

5 Q. Was this document prepared by you or under your
6 direction and supervision?

7 A. Yes, it was.

8 Q. Do you have any revisions or corrections to
9 make to this document?

10 A. No, I do not.

11 Q. If I were to ask you today the questions set
12 forth in PECO Direct No. 2 would your answers be the same
13 as those contained therein?

14 A. Yes, they would.

15 Q. Would your answers be true and correct to the
16 best of your knowledge, information and belief?

17 A. Yes, they would.

18 Q. Do you have before you a copy of what has been
19 marked for identification as PECO Exhibit No. 2?

20 A. Yes, I do.

21 Q. Was this exhibit prepared by you or under your
22 direction and supervision?

23 A. Yes, it was.

24 Q. Do you have any revisions or corrections to
25 make to this exhibit?

1 A. No, I do not.

2 Q. Is the information contained in this exhibit
3 true and correct to the best of your knowledge,
4 information and belief?

5 A. Yes, it is.

6 MR. BONNEY: Your Honor, at this time I ask that
7 these exhibits be admitted into the record, PECO Exhibit
8 No. 2 and PECO Direct No. 2, be admitted into the record
9 subject to timely motions and cross-examination.

10 JUDGE SMOLEN: They are received subject to those
11 motions.

12 MR. SUGARMAN: May I reserve the same way on --

13 JUDGE SMOLEN: Yes, you may.

14 (Whereupon, the documents marked as
15 PECO Statement Directo No. 2 and
16 Exhibit No. 2 were received in
evidence.)

17 MR. BONNEY: Mr. Boeggeman is available for
18 cross-examination.

19 JUDGE SMOLEN: PP&L?

20 MS. KHANWALKAR: No cross, Your Honor.

21 JUDGE SMOLEN: Prosecutory Staff?

22 MS. BURKET: No cross, Your Honor.

23 JUDGE SMOLEN: OCA?

24 MS. McCLOSKEY: Thank you, Your Honor.

25

CROSS-EXAMINATION

1
2 BY MS. McCLOSKEY:

3 Q. Good morning, Mr. Boeggeman.

4 A. Good morning.

5 Q. I would like to start at page five of your
6 testimony in the chart that you present on magnetic
7 fields.

8 A. Yes.

9 Q. And just for clarity, do the inches there
10 represent the distance away from the source?

11 A. Yes, that's correct.

12 Q. And am I also correct that these are the fields
13 produced when the appliance that is listed there is in
14 use?

15 A. That is correct.

16 Q. So, for example, if the microwave oven is
17 turned off, there would be no magnetic field produced, is
18 that correct?

19 A. That's correct.

20 JUDGE SMOLEN: No residual?

21 THE WITNESS: Well, the clock. The microwave oven
22 clock would certainly have a field associated with it.
23 If there is no current draw by the device then there is
24 no magnetic field associated with it.

25 BY MS. McCLOSKEY:

1 Q. Now, on page nine of your testimony you list
2 the possible loading scenarios for the Woodbourne-Heaton
3 transmission line. I would like to focus on the normal
4 loading situation.

5 Am I correct that under the normal loading scenario
6 there would be a flow of current at that level on a 24
7 hour per day basis?

8 A. I will have to go back to percentage.

9 (Witness perusing document.)

10 A. No, that is not correct. No. The load varies
11 throughout the day.

12 Q. Maybe my question made it a little too simple.
13 The load will vary throughout the day but there will be a
14 load of some magnitude on the line at all hours of the
15 day?

16 A. That's right.

17 Q. Unless the line is out of service for repairs
18 or some other reason?

19 A. That's right.

20 Q. Now, in calculating the magnetic fields
21 associated with the five loading situations that you have
22 presented, did you consider the effects of the rail lines
23 on the magnetic fields?

24 A. I knew what the rail currents were from
25 calculations independent of the magnetic field

1 calculations that were done when we were modeling with
2 software called CORRIDOR. That software models induced
3 currents in the rail because we were trying to mitigate
4 effects to Conrail equipment. I knew from the low
5 currents that the effects on the overall magnetic fields
6 would be low so I did not include them in my calculations
7 for magnetic field.

8 Q: And in making those calculations did you
9 consider the effect of any parallel pipelines that may
10 run along that transmission corridor on the magnetic
11 field calculation?

12 A. No, I did not. And the pipelines, we are aware
13 of where they are. Phase rolls, what we did technically
14 to reduce the currents on the rail, would also reduce any
15 effects on the pipeline. The pipelines were coincident
16 with the rail.

17 JUDGE SMOLEN: Are there pipelines there?

18 THE WITNESS: There are two pipelines in the area.

19 JUDGE SMOLEN: What are they? I'm sorry if I'm
20 stepping on your questioning.

21 MS. McCLOSKEY: That's fine, Your Honor.

22 THE WITNESS: I need help in that area.

23 MR. BONNEY: We answered an interrogatory, if that
24 would be helpful.

25 JUDGE SMOLEN: All right. Go ahead.

1 BY MS. McCLOSKEY:

2 Q. Now, starting on page ten of your testimony and
3 continuing through page 12, I think we have covered some
4 of this with Mr. Oedemann and just to summarize, am I
5 correct that these calculations of the magnetic fields
6 were conducted in approximately July of 1991?

7 A. Correct.

8 Q. For the purpose of this testimony?

9 A. In preparation of the testimony, yes.

10 Q. Now, in all the calculations that you have
11 conducted to create Table 4 of your testimony did you use
12 a 12 foot phase spacing in those calculations?

13 A. That's correct.

14 MS. McCLOSKEY: Your Honor, if I could have marked
15 for identification OCA Cross-Examination Exhibit No. 2?

16 JUDGE SMOLEN: So marked.

17 (Whereupon, the document was marked
18 as OCA Cross-Exam. Exhibit No. 2
for identification.)

19 BY MS. McCLOSKEY:

20 Q. Is Cross-Examination Exhibit No. 2 your
21 response to OCA Interrogatory Set I, No. 2?

22 A. That's correct.

23 Q. And if you could look on the third page of the
24 response, that excludes the cover sheet, am I correct
25 that in these calculations you used a 14 foot phase

1 spacing to calculate both the electric and the magnetic
2 fields?

3 A. Yes, I used a 14 foot phase spacing there
4 because in one of Mr. Oedemann's exhibits he shows the
5 variation in phase spacing which varies from, I believe,
6 12 to 15 or 16 feet in phase spacing. About 90 percent
7 of the length of this transmission line is represented by
8 a 12 foot phase spacing. At the time that I did this I
9 took the middle of the road. But in preparing my
10 testimony I felt it was more accurate to represent the
11 majority of the line.

12 Q. Ninety percent is represented by 12 foot phase
13 spacing and what is the other phase spacing that occurs
14 in the other ten percent of the line?

15 A. Phase spacing increases in two cases. When the
16 phase rolls are accomplished we have to create greater
17 distances because the wires are passing by each other.
18 And also when we get to a deadend structure where you
19 take a vast turn. We actually tie to both ends of the
20 structure and loop around with wires. We have to create
21 bigger spacing there.

22 Q. At the phase rolls what does it increase to?
23 How many feet?

24 A. I believe it is 14.

25 Q. And at the end deadend structures how many

1 feet?

2 A. I believe it's 16 at the deadend.

3 Q. And would there be an effect on the electric
4 and the magnetic fields of increasing the phase spacing
5 to the 14 feet and the 16 feet at those points?

6 A. The electric and magnetic fields would increase
7 with the wider phase spacing.

8 Q. Now also on Table 4, where you are showing the
9 comparison of the electric and magnetic fields between
10 the compact delta designs and the other alternatives, am
11 I correct that these comparisons were made at the
12 mid-span?

13 A. That's correct -- just to correct, you said
14 electric and magnetic fields. Table 4 represents
15 strictly magnetic.

16 Q. I'm sorry. Thank you.

17 A. They were calculated at the maximum sag, and
18 the sag is something that really would not be achieved
19 because it is at maximum conductor temperature.

20 Q. Just to be clear for the record could you try
21 to explain the mid-span and the sag a little further for
22 us?

23 A. Would you mind if I illustrate? I do have a
24 easel pad here. Is that okay?

25 MS. McCLOSKEY: That would be fine with me, Your

1 Honor.

2 JUDGE SMOLEN: You can demonstrate with the easel
3 but articulate what you are putting on the easel so it
4 appears of record.

5 THE WITNESS: That's fine.

6 JUDGE SMOLEN: Go ahead.

7 A. Between two towers you have a span of wire.

8 The wire will loop --

9 MR. BONNEY: You can use the easel if you want to.

10 JUDGE SMOLEN: Wait a minute just for a second. Do
11 you want to use the easel or don't you?

12 THE WITNESS: It's up to the Court. I thought it
13 would provide a better illustration.

14 JUDGE SMOLEN: Then let's use the easel.

15 Can Counsel see it?

16 MS. McCLOSKEY: Yes.

17 JUDGE SMOLEN: Go ahead. But articulate what
18 you're doing.

19 A. These represent two towers roughly 300 feet
20 apart. I will just put one wire across. The weight of
21 the wire sags the conductor. And we calculate the
22 magnetic field at the maximum sag. We do not calculate
23 it at either end.

24 JUDGE SMOLEN: At the point closest to the ground,
25 you're saying?

1 THE WITNESS: Exactly. The point closest to the
2 ground, the ground down here. If we calculated it at
3 this end the electric and magnetic fields would be lower.
4 Calculating it here presents a worst case scenario.

5 JUDGE SMOLEN: Thank you.

6 BY MS. McCLOSKEY:

7 Q. When you calculate the magnetic fields at the
8 tower am I correct that they change because the actual --
9 because of the height of the conductor at that point?

10 A. That's correct. Although for the electric
11 field the grounded structure would perturb that electric
12 field and reduce that electric field. The structure
13 would have virtually no effect on the magnetic.

14 Q. And am I also correct that the height of the
15 conductors for the alternative designs at the towers
16 would be in the range of 42 to 50 feet as compared to the
17 32.5 feet for the compact delta design?

18 A. I would have to see the illustrations that
19 Mr. Oedemann had. If his illustrations communicate that,
20 then that is the case. For a longer span, for a 600 foot
21 span, there is about 300 foot.

22 Q. Would you accept that subject to checking
23 Mr. Oedemann's design?

24 A. Certainly.

25 MR. BONNEY: Would you repeat the numbers, please,

1 so we make sure we get them correctly.

2 MS. McCLOSKEY: In the range of 42 to 50 feet for
3 the alternative designs as compared to the 32.5 feet for
4 the compact delta design.

5 MR. BONNEY: Thank you.

6 A. You said 32.5 at the structure?

7 BY MS. McCLOSKEY:

8 Q. Yes.

9 A. I know that is wrong. Can we clarify that now?

10 JUDGE SMOLEN: Go ahead. You have been asked the
11 question.

12 (Pause.)

13 THE WITNESS: Let me pull back from that. I'm
14 sorry. I think 32.5 feet is a minimum.

15 JUDGE SMOLEN: Off the record for a moment.

16 (Discussion off the record.)

17 JUDGE SMOLEN: Back on the record.

18 Do you want to restate your question again and
19 let's see if we get a more definitive answer from this
20 witness?

21 BY MS. McCLOSKEY:

22 Q. Am I correct that the height of the conductors
23 for the alternative designs at the towers would be in the
24 range of 42 to 50 feet as compared to 32.5 feet for the
25 compact delta design?

1 MR. SUGARMAN: My question is what other
2 alternative designs PECO could have used on this
3 right-of-way.

4 MR. BONNEY: That is beyond the scope of his direct
5 testimony.

6 JUDGE SMOLEN: I agree that it is beyond the scope.
7 But now if you -- I don't want to tell you what to ask, but
8 if you are asking about E/MF then let's ask about E/MF.

9 BY MR. SUGARMAN:

10 Q. What other alternative designs are available on
11 a right-of-way other than the four that were identified
12 for this one?

13 A. Again, on the Woodbourne-Heaton right-of-way?

14 Q. I beg your pardon?

15 A. On the Woodbourne-Heaton right-of-way?

16 Q. No. In general.

17 A. The designs that were discussed basically
18 represent the typical or conventional designs that we use
19 on all rights-of-way.

20 Q. There are no other typical or conventional
21 designs other than those four?

22 A. The only other conventional, we have very
23 little of it but there are some double circuit designs, a
24 tower with two vertical circuits on them.

25 Q. Do you have any towers with single vertical

1 circuits?

2 A. Yes. That is one of the conventional designs I
3 considered in the testimony.

4 Q. Are there any unconventional designs that have
5 a different E/MF effect?

6 A. Yes.

7 Q. What would they be?

8 A. There is a design called split phase, which is
9 similar to a double circuit vertical. It is called
10 phrase phase because it is a single circuit with six
11 wires arranged in a vertical configuration, and they have
12 different levels of E/MF associated with them.

13 Q. Are the E/MF levels associated with that design
14 generally higher or lower than the tight delta?

15 A. I think probably lower fields could be achieved
16 with that design subject to phase spacing.

17 Q. Was that design considered for -- did you
18 evaluate that design from an E/MF perspective for this
19 particular line?

20 A. Not formally for this line, no.

21 Q. Did you informally --

22 A. I considered all the alternatives, pretty much
23 sticking with the conventional. But the fact that I am
24 aware of the split phase went through my mind. But for
25 this particular line, comparing the conventional designs

1 that we use, the compact delta presented less fields.

2 Q. I think you indicated in response to
3 Ms. McCloskey that your work on this line was done in
4 1991, is that correct?

5 A. That's correct.

6 Q. So your answer to me just now also related to
7 1991?

8 A. No. My considerations were back at the design
9 of the line. I knew of the design, I knew of the
10 project, I knew of the chosen design and I knew that was
11 the best alternative.

12 Q. Well, did you recommend that the unconventional
13 split phase alternative be considered?

14 A. No. Because we could not use the existing
15 structures to do that. We would have had to replace all
16 of the structures to do that.

17 Q. Now, as PECO's coordinator for E/MF, have you
18 -- and in giving your testimony, or preparing for your
19 testimony -- have you attempted to evaluate and describe
20 in quantitative or qualitative fashion the risk of health
21 effects from E/MF associated with either the selected
22 design or any of the alternatives?

23 A. No. I did not try to quantify that.

24 Q. Did anybody else to your knowledge in
25 determining -- well, let me ask another question about

1 yourself. Did you make any such exercise or attempt any
2 such exercise in connection with the decision to build
3 the line as proposed?

4 A. No, I did not do an alternate.

5 Q. Do you know if anybody else did on behalf of
6 PECO?

7 A. No.

8 JUDGE SMOLEN: Now what? No, you do not know?

9 A. No, there was nothing done on behalf of PECO.

10 BY MR. SUGARMAN:

11 Q. Does PECO -- in your capacity as coordinator of
12 the E/MF issue at PECO, does PECO have a procedure for
13 evaluating and describing either qualitatively or
14 quantitatively the risk associated with different -- the
15 E/MF risk associated with different transmission line
16 decisions?

17 A. No, no quantitative.

18 Q. How about a descriptive or qualitative?

19 MR. BONNEY: Your Honor, I don't think anyone has
20 testified that there is a risk of health effects from
21 E/MF. So this whole line of questions is predicated on
22 evidence that is not in the record yet.

23 JUDGE SMOLEN: Your comment is noted on the record.

24 MR. SUGARMAN: My question presumes that the answer
25 could be yes, we have calculated it and its zero. So I'm

1 not predicating it on any positive conclusion. But since
2 the witness has described E/MF and the consideration that
3 was given to E/MF by PECO, I think it is a fair question
4 to ask whether -- and responsive to the direct testimony
5 -- as to whether the company has made any calculation of
6 the risk. Not on this particular line --

7 JUDGE SMOLEN: Assuming there is a risk.

8 MR. SUGARMAN: I'm sorry?

9 JUDGE SMOLEN: Assuming there is a risk.

10 A. I now understand --

11 JUDGE SMOLEN: Wait just a minute.

12 Are you asking him to assume that there is a risk?

13 MR. SUGARMAN: I am asking if the company has
14 developed any methodology for calculating any such risk.

15 JUDGE SMOLEN: All right. That's the question.

16 BY MR. SUGARMAN:

17 Q. You said not quantitatively, so the question
18 now is descriptively.

19 A. We have not calculated risk nor have we hired
20 anyone because there is no known risk. There is no
21 established risk.

22 Q. Do you recall your testimony before the
23 Congressional committee in 1990?

24 A. Yes.

25 Q. And in that testimony did you tell the --

1 MR. BONNEY: Do you have a copy of the testimony to
2 show the witness?

3 MR. SUGARMAN: Yes. It was provided to us. But I
4 want to ask him first --

5 MR. BONNEY: I am asking that you show the witness
6 the testimony that you are referring to.

7 MR. SUGARMAN: Well, I haven't asked a question
8 yet. Can I ask a question first?

9 JUDGE SMOLEN: Let's not spar with words. Ask the
10 question. If there is an objection, make an objection.

11 Do you have a copy of your testimony?

12 THE WITNESS: I don't have it with me.

13 JUDGE SMOLEN: What is the question? Does he
14 recall the testimony?

15 MR. SUGARMAN: Yes.

16 A. I don't recall it verbatim. I would have to
17 see it.

18 BY MR. SUGARMAN:

19 Q. Do you recall telling the committee that since
20 media coverage brought this issue to the forefront --

21 MR. BONNEY: Your Honor, he just testified that he
22 does not recall it verbatim, he would have to see the
23 document.

24 MR. SUGARMAN: I am going to give him the testimony
25 before he answers the question.

1 JUDGE SMOLEN: Let him ask the question and then
2 show him the document.

3 BY MR. SUGARMAN:

4 Q. Since media coverage --

5 MR. BONNEY: What page are you referring to?

6 MR. SUGARMAN: Page two at the bottom, customer
7 concerns.

8 MR. BONNEY: --Thank you.

9 BY MR. SUGARMAN:

10 Q. I'm imposing the word since from the second
11 sentence to the first sentence. Since media coverage
12 brought this issue to the forefront --

13 MR. BONNEY: Your Honor, that is not what the
14 document says.

15 MR. SUGARMAN: Can I ask the question and if it is
16 objectable when I am finished he can object.

17 JUDGE SMOLEN: Go ahead.

18 BY MR. SUGARMAN:

19 Q. I'm not purporting that it's a total quote
20 because I am moving one word to combine the two
21 sentences.

22 Since media coverage brought this issue to the
23 forefront with the release of the New York State Power
24 Lines Project report in July, 1987, PECO has been
25 proactively addressing increased customer concerns about

1 E/MF.

2 Do you recall telling that to the Congressional
3 committee?

4 MR. BONNEY: Your Honor, that is not what it says.

5 JUDGE SMOLEN: Let him look at the testimony. The
6 question is do you recall saying that.

7 MR. BONNEY: That is a paraphrase of what was said.

8 MR. SUGARMAN: I agree, it's a paraphrase.

9 MR. BONNEY: Then it's not what he said.

10 JUDGE SMOLEN: The witness can answer that that is
11 what he said or that is not what he said.

12 MR. BONNEY: Very well.

13 (Witness perusing document.)

14 A. Okay. I have read it.

15 BY MR. SUGARMAN:

16 Q. Is it correct that since the New York power
17 study was released in 1987 the company has been
18 proactively addressing the E/MF issue?

19 A. That is correct.

20 Q. All right. And is it also true that you told
21 the committee, quote, we have experienced some delays in
22 transmission line and substation projects due to
23 customers' concerns for aesthetics and the questions
24 surrounding electrical and magnetic fields?

25 JUDGE SMOLEN: Let him see the transcript of his

1 statement, Mr. Sugarman. Let him take a look at it.

2 (Witness perusing document.)

3 A. Yes.

4 BY MR. SUGARMAN:

5 Q. Now, I am looking for page one of your
6 testimony, but if you can answer this question without --
7 pending my finding it -- did you tell the committee that
8 ~~the company has published literature for customer~~
9 consumption on E/MF?

10 A. You're saying of my testimony?

11 Q. I am referring to your testimony to the
12 Congressional committee.

13 A. Page one is not here.

14 Q. That's correct.

15 A. Assuming that I said it, I said it.

16 JUDGE SMOLEN: Wait a minute. The question was do
17 you recall saying that to the committee.

18 THE WITNESS: I don't recall. It was back in March
19 of 1990. So I don't recall.

20 BY MR. SUGARMAN:

21 Q. Showing you a document that I have previously
22 asked be marked as Protestant's Exhibit 1 --

23 JUDGE SMOLEN: If it was not marked previously it
24 is now marked.

25 MR. SUGARMAN: Thank you, Your Honor.

1 (Whereupon, the document was marked
2 as Protestant's Cross-Exam. Exhibit No.
1 for identification.)

3 BY MR. SUGARMAN:

4 Q. I will ask if you had anything to do with the
5 preparation or publication of P-1.

6 MR. BONNEY: Excuse me. Do you have copies?

7 MR. SUGARMAN: We will get you copies. That is the

8 ~~only copy I've got.~~ I just got it.

9 A. Yes, I was involved in the preparation of this
10 document.

11 BY MR. SUGARMAN:

12 Q. Does it state in that document...

13 (Pause.)

14 Q. Does it state the following: "I understand
15 milligauss as a unit of measure. Now what?."

16 "Consider what one researcher has called prudent
17 avoidance." Prudent avoidance is simply common sense
18 reduction of your exposure to electric and magnetic
19 fields. Some cases in point: don't stand close to your
20 microwave oven, your dishwasher or your television set
21 while they are on. Move radios, answering machines,
22 electric clocks and other appliances so they are not
23 right next to you. Consider using your electric blanket
24 to preheat your bed to a comfortable temperature and then
25 turn it off when you climb in for the night. At work

1 keep your video display terminal at least 18 inches from
2 you."

3 Did you participate in giving that advice to the
4 company's customers?

5 A. We were simply stating what a researcher said
6 that prepared a report for OTA, Office of Technology
7 Assessment.

8 Q. Are you saying that the company made no
9 independent judgement that it should advise its
10 customers --

11 MR. BONNEY: Your Honor, the report says what it
12 says.

13 BY MR. SUGARMAN:

14 Q. -- as stated in the brochure.

15 MR. BONNEY: The brochure says what it is says.
16 You can argue about what that means.

17 MR. SUGARMAN: I'm not asking what that means.

18 JUDGE SMOLEN: Just a minute. One voice at a time
19 because the reporter can only take one voice at a time.

20 Now, do you have an objection, Mr. Bonney?

21 MR. BONNEY: Yes, Your Honor. The document states
22 what it states. And it speaks for itself.

23 JUDGE SMOLEN: That was not the question.

24 What was the question?

25 MR. SUGARMAN: The question was did he participate

1 in the company's decision to give this advice to the
2 customers.

3 MR. BONNEY: He just testified it is not advice.
4 He just said it's --

5 A. I am pointing out the researcher said consider
6 that.

7 JUDGE SMOLEN: All right. That's the answer to
8 your question. Next question.

9 BY MR. SUGARMAN:

10 Q. So then my next question was are you saying
11 that the company did not make any independent judgement
12 to advise its customers to do these things?

13 JUDGE SMOLEN: You may answer.

14 A. That is correct. We have simply pointed out
15 what a researcher is telling the public from an OTA
16 report. We are pointing that out so the public can make
17 up their own mind what they want to do absent any
18 verification of health risks.

19 Q. Where does it say in here that the company does
20 not join in this recommendation that is contained?

21 A. We don't say it. We say consider what one
22 researcher says.

23 Q. So you are advising people to consider it?

24 A. So that they can make their own decisions. It
25 is something that is out there. We felt the

1 responsibility to let them know that was out there.

2 Q. And to advise them to consider it?

3 MR. BONNEY: He answered that.

4 JUDGE SMOLEN: Asked and answered. Sustained.

5 BY MR. SUGARMAN:

6 Q. Did you assume in calculating the E/MF to be
7 anticipated with the line that the line would be used

8 essentially as a low level line and that it would carry
9 high loads only in emergency conditions?

10 A. I don't understand the question.

11 Q. Let me direct you to your testimony. That
12 might make it clearer. In determining or estimating the
13 expected magnetic field levels --

14 A. Where is this? What page?

15 Q. Commencing on page six, lines ten to 22, and
16 page seven, lines 11 to -- over to page nine, line 20.

17 You state there you considered five different
18 loading conditions, correct?

19 A. That is correct.

20 Q. And that is five different currents, is that
21 correct?

22 A. That is correct.

23 Q. And the loading conditions, the five loading
24 conditions that were considered are set forth on page
25 eight, is that correct?

1 A. That's correct.

2 Q. Now, on lines eight to ten you state that the
3 amperes -- which is the current, is that right?

4 A. Yes.

5 Q. That the normal load on this line would be 360
6 amperes?

7 A. Correct.

8 Q. ~~And that the emergency, going down to the~~
9 bottom of the page, the final loading condition, the four
10 hour condition would be a thousand amperes?

11 A. That is correct.

12 Q. And it may not occur at all in any given year,
13 is that your testimony?

14 A. That is correct.

15 Q. Now, what is the basis of that testimony, which
16 is characterized as, quote, what we anticipate, end
17 quote?

18 A. The zero amperes represents an extended period
19 of time by which the transmission line could be out of
20 service for repairs or for some other reason.

21 Q. Let me interrupt for a minute. My question
22 goes to the relative frequency of the different loading
23 situations. I'm not asking you to explain what they
24 mean. But the relative frequency.

25 A. I was going to get to that.

1 Q. Okay.

2 A. The zero amperes could be there in any given
3 year for a period of days to weeks, depending upon the
4 situation.

5 The second two loading scenarios, 180 amperes to
6 360 amperes, represents approximately 90 percent of the
7 loading, or in other words that the load on that line
8 ~~would be represented 90 percent of the time by the span~~
9 of 180 to 360 amperes.

10 Q. My question is where did you get that? Is that
11 something that you calculated?

12 A. No. Our system planning people estimated that
13 to be the loading scenario.

14 Q. So you didn't, yourself, determine that?

15 A. No.

16 Q. Did you make any independent evaluation of the
17 ~~system loading to determine whether it was an accurate~~
18 projection?

19 A. That is not my area of expertise.

20 Q. I understand that and I'm not questioning that.
21 I am only trying to find out.

22 So the systems planning people gave you the
23 different conditions of frequency that are set forth on
24 page eight of your testimony?

25 A. That's correct.

1 Q. Did you get from any of them any explanation of
2 why the normal load on this line would be approximately
3 one-third of the emergency maximum?

4 A. No, I didn't. I took what they gave me at face
5 value. They know what they are doing.

6 Q. Is there any reason why the system planning
7 people could not change their mind and load this line up
8 to a thousand amperes as a normal load?

9 A. The wire can sustain that load.

10 Q. Yes.

11 A. But as far as a projected load growth is
12 concerned, it won't achieve that.

13 Q. But you know, without being a systems planning
14 engineer, that the decision which lines to use for heavy
15 load is an elective decision. Given that the system load
16 growth may be not entirely within the company's control,
17 the distribution of that load growth on lines that can
18 carry it is a matter within the company's control, isn't
19 it?

20 MR. BONNEY: Your Honor, he just testified that
21 questions about system planning and operations are
22 outside his expertise.

23 JUDGE SMOLEN: Yes, he did, Mr. Sugarman.

24 MR. SUGARMAN: I'm not asking him to do the system
25 planning. I am just asking him whether he is aware that

1 the system planning people have the ability to distribute
2 the load among different lines as an elective matter.

3 JUDGE SMOLEN: Are you aware of that?

4 THE WITNESS: I'm not very familiar with the
5 network system to give that determination.

6 JUDGE SMOLEN: All right. Next question.

7 BY MR. SUGARMAN:

8 Q. Do you agree that the estimated E/MF from the
9 line would increase substantially if the systems planning
10 people were to use this line as part of a base load
11 planning?

12 A. Could you be more clear about that? If the
13 amperes increase the magnetic field increases linearly.
14 If you double the current you double the magnetic field.

15 Q. Does the frequency of heavy loading have an
16 effect on E/MF as a safety matter? What I mean by that
17 is if you take a given number of milligauss and if you
18 are exposed to that 100 hours a week instead of ten hours
19 a week does that change the effect of the milligauss as a
20 safety consideration?

21 MR. BONNEY: Your Honor, he has not testified about
22 the effect of E/MF so it's outside the scope of his
23 testimony.

24 JUDGE SMOLEN: I am going to sustain that.

25 BY MR. SUGARMAN:

1 Q. Are you providing any testimony to the
2 Commission relative to whether the proposed line with the
3 magnetic fields which you estimate or with any other
4 magnetic fields is safe?

5 A. I'm not providing that testimony to the
6 Commission.

7 Q. In your testimony to the Congressional
8 ~~committee you indicated that, and I will read it, "In~~
9 closing, the issue of electro-magnetic field health
10 effect is not just a utility issue. Rather, this is a
11 societal issue."

12 Is it the company's policy to treat E/MF as a
13 societal issue?

14 MR. BONNEY: Do you have a reference in the
15 testimony so that he can find it?

16 MR. SUGARMAN: At the very end of the last
17 paragraph. At the bottom of page three and at the top of
18 page four.

19 (Witness perusing document.)

20 A. Yes.

21 BY MR. SUGARMAN:

22 Q. What does the company mean by that phrase?

23 A. It means that society as a whole are exposed to
24 both electric and magnetic fields. We live with this
25 daily in our lives. And by virtue of that exposure, it

1 is a societal issue. It is not just a utility issue.
2 They are not just exposed to powerline fields, they are
3 exposed to appliance fields and things like that.

4 Q. As coordinator of the E/MF effort at PECO, does
5 PECO practice prudent avoidance?

6 A. PECO employees practice prudent avoidance?

7 Q. As a corporate policy does PECO practice
8 prudent avoidance with respect to E/MF?

9 A. We have practiced it on the Woodbourne-Heaton
10 line.

11 Q. Can you tell us how you practiced it on the
12 Woodbourne-Heaton line?

13 A. The design for that right-of-way, which was the
14 only design we could use for using the structures --
15 pardon me, I've got a tickle in my throat.

16 Q. Go ahead. Take your time.

17 (Pause.)

18 A. In other words, the design that was chosen for
19 the Woodbourne-Heaton right-of-way just fell in our laps
20 as being the optimum design for reducing E/MFs.

21 Q. How did PECO?

22 A. So in that case --

23 Q. I'm sorry.

24 A. -- it turned out to be prudent avoidance. We
25 didn't have to do anything extra to reduce the fields.

1 And to go further and change out towers and come in with
2 a ridiculous -- not ridiculous -- outlandish design to
3 reduce them further is not prudent.

4 Q. What consideration did the company give to
5 alternative ways of satisfying providing power to the
6 substation without building a line in that narrow
7 right-of-way?

8 A. ~~That was no other alternative because that~~
9 right-of-way was needed to get from one specific
10 substation to another. You brought up before, the
11 Buckingham corridor was not an option.

12 Q. My question was what consideration did the
13 company give to other alternative ways of addressing its
14 power needs other than utilizing that narrow corridor?

15 A. You are assuming that we did not build the
16 transmission line anywhere?

17 Q. Whether another transmission line or whether
18 whatever. Other alternatives in general. What
19 consideration did the company give to other alternatives
20 other than building a transmission line on that narrow
21 corridor?

22 A. Again, that would be a system planning thing.
23 System planning determines the need for a line and where
24 it needs to go, from substation A to substation B.

25 Q. Was system planning asked to take E/MF into

1 account in specifying or in determining its
2 considerations?

3 MR. BONNEY: Your Honor, he is not from system
4 planning, so I'm not sure he can answer what system
5 planning was asked to take into consideration.

6 MR. SUGARMAN: If he can answer it, he can answer
7 it.

8 JUDGE SMOLEN: Is the question did this witness
9 advise or request system planning to take that into
10 consideration?

11 MR. SUGARMAN: To his knowledge was system planning
12 asked.

13 MR. BONNEY: I also object, Your Honor, that this
14 goes to the need for the line.

15 JUDGE SMOLEN: Yes, it does. I was waiting for
16 that. The need for additional power is not an issue in
17 this case in accordance with the Commonwealth Court's
18 remand order and the Commission's order scheduling this
19 hearing.

20 MR. SUGARMAN: The Commonwealth Court's order says
21 nothing about that. It simply says the Commission's
22 prior action was invalid because we didn't get notice and
23 it says that we have a right to be heard.

24 JUDGE SMOLEN: Yes, and you're being heard and we
25 are on a specific question now. Let's ask you to repeat

1 the question.

2 BY MR. SUGARMAN:

3 Q. The question was was system planning asked to
4 take E/MF into consideration --

5 JUDGE SMOLEN: I can't take testify what they were
6 asked. He can only testify as to what he did.

7 MR. SUGARMAN: To his knowledge.

8 ~~JUDGE SMOLEN: Then phrase the question that way.~~

9 BY MR. SUGARMAN:

10 Q. Are you knowledgeable of system planning having
11 been asked to take E/MF into account in defining its
12 proposed project?

13 A. To my knowledge, they -- I have no idea whether
14 they were contacted.

15 Q. Now, how can the company practice prudent
16 avoidance without considering alternate methods of
17 achieving the same power supply?

18 MR. BONNEY: Your Honor, that is an argumentative
19 question.

20 JUDGE SMOLEN: It is argumentative. Sustained.

21 BY MR. SUGARMAN:

22 Q. Do you agree that it cannot be -- that prudent
23 avoidance cannot be practiced without considering a range
24 of alternative methods of achieving the power that is
25 desired or needed?

1 A. I do not agree with that.

2 MR. SUGARMAN: Thank you. I have no further
3 questions.

4 JUDGE SMOLEN: Do you need some time?

5 MR. BONNEY: May I have just a minute, Your Honor?

6 JUDGE SMOLEN: Let's take a ten minute break for
7 the reporter and for the witness and for everyone else.

8 We will reconvene at 12:15.

9 (Recess.)

10 JUDGE SMOLEN: Back on the record.

11 Redirect, Mr. Bonney?

12 MR. BONNEY: Thank you, Your Honor.

13 We have no redirect of this witness. We ask that
14 the witness be excused.

15 JUDGE SMOLEN: Anything further of the witness by
16 any party?

17 MS. McCLOSKEY: Your Honor, I would like to move
18 into evidence OCA Cross-Examination Exhibit No. 2.

19 JUDGE SMOLEN: Hearing no objection, that is
20 received.

21 (Whereupon, the document marked as
22 OCA Cross-Exam. Exhibit No. 2
was received in evidence.)

23 MR. SUGARMAN: I would like to move into evidence
24 Protestants Cross-Examination Exhibit No. 1.

25 MR. BONNEY: No objection.

1 JUDGE SMOLEN: That is received.

2 (Whereupon, the document marked as
3 Protestant's Cross-Exam. Exhibit No.
4 1 was received in evidence.)

5 JUDGE SMOLEN: And you previously moved the
6 testimony and exhibit of this witness.

7 MR. BONNEY: Right.

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

10 MR. BONNEY: That concludes the presentation of our
11 direct case.

12 JUDGE SMOLEN: All right. According to our
13 procedural schedule there is a date for the filing of
14 Protestant's and opposing party written testimony, August
15 30th. And the next hearing date is scheduled for
16 September 6, 1991. Is that correct?

17 MR. SUGARMAN: Yes, Your Honor.

18 JUDGE SMOLEN: I know there are outstanding
19 discovery matters. But I have just received earlier this
20 week the motion to compel and copies of the objections.
21 Now, I can deal with them following the close of this
22 session if Counsel want to remain. So we can close now
23 and then deal with them. But I will ask the reporter to
24 remain so I can make any rulings on the record. But
25 insofar as the evidentiary portion of today's hearing is
concerned, does any party want to present anything

1 further?

2 (No audible response.)

3 JUDGE SMOLEN: Then the evidentiary portion of this
4 hearing is concluded for today and we will reconvene
5 September 6, 1991, here at 10:00 a.m.

6 MR. SUGARMAN: Your Honor, at this point I would
7 like to make a motion which I would then like to place in
8 writing before Your Honor.

9 JUDGE SMOLEN: Go ahead.

10 MR. SUGARMAN: The motion is in the alternative to
11 either deny the application on the ground that the
12 company has not addressed the issues required to be
13 addressed by the regulations, namely, the safety issues.
14 But I will specify it in a motion. Or in the alternative
15 that Your Honor's first pretrial ruling, prehearing
16 ruling, based on the application of the Commission's
17 "limitations" in its remand and order to Your Honor, that
18 the issue of effect has been already proved by the
19 company's own witnesses, that E/MF does present a health
20 risk and therefore, again in the alternative, that the
21 scope of the proceedings should now be enlarged to
22 include the issue of need since the company's witnesses
23 have conceded that there is evidence of a health risk and
24 the company itself practices prudent avoidance.

25 So therefore, it would be more efficient, if the

1 proceeding is not dismissed altogether, to expand it so
2 that as the Commission's rules require the electrical and
3 energy considerations can be balanced in a single record
4 against the risk rather than trying to do it in a
5 bifurcated stage. In other words, I think we have met
6 the threshold of the Commission's order.

7 I would like the opportunity to put that in writing
8 for the Commission.

9 JUDGE SMOLEN: Yes, I would suggest that you put it
10 in writing and accompany it with any memorandum of law
11 which you deem advisable. And of course the company and
12 other parties will have an opportunity to respond either
13 in favor of or in opposition to said motion.

14 Mr. Bonney, do you want to say anything today?

15 MR. BONNEY: Yes, I will just say a few things but
16 I would like to reserve the opportunity to respond fully
17 in writing.

18 JUDGE SMOLEN: Yes.

19 MR. BONNEY: First of all, this proceeding is not
20 about approval or denial of our application, as the Court
21 and the PUC and Your Honor have made clear in their
22 orders. The question here is whether the Protestants
23 will be adversely affected by the reconstruction of this
24 line. So it is inappropriate to request a denial of our
25 application, which has already will been granted.

1 Second, I believe Mr. Sugarman stated that our
2 witnesses have admitted that there is a health risk from
3 E/MF. I don't think that was established by the
4 testimony.

5 And third, I think it is clear that the scope of
6 this proceeding does not include need and there is no
7 need to expand it at this time.

8 JUDGE SMOLEN: When you say need, you mean need for
9 additional power?

10 MR. BONNEY: Need for additional power or need for
11 this line.

12 JUDGE SMOLEN: Having stated that, you have
13 reserved the opportunity to file a responsive answer to
14 whatever Mr. Sugarman may file, as well as an
15 accompanying brief or memorandum along with it. And that
16 goes for all Counsel.

17 I might say this, that there have been suggested by
18 the Protestants in the response in opposition to PP&L's
19 petition for leave to intervene certain alternatives or
20 certain suggestions for the Administrative Law Judge to
21 at least consider. Among those is to convert this
22 proceeding to an investigation statewide on E/MF. That
23 is not within the power of this Administrative Law Judge
24 to order even if the Administrative Law Judge deemed it
25 necessary or advisable. That is something for the

1 Commission to determine if, as and when asked. I just
2 want to spread that on the record so that all parties are
3 advised.

4 Having stated that, anything further that we have
5 to discuss this morning?

6 (No audible response.)

7 JUDGE SMOLEN: In that event, this portion of the
8 hearing is adjourned and I will see Counsel and whoever
9 wants to remain on those discovery matters. Do you want
10 to do it now or wait until after lunch to do it? It's
11 only 12:25 now. Suppose we take another five minute
12 break, give Counsel an opportunity to review their
13 documents on the discovery matters and then let's
14 reconvene at 12:30 on discovery matters.

15 (Recess.)

16 JUDGE SMOLEN: This is on the discovery issues and
17 procedure, principally on the motion to compel and the
18 objections to certain interrogatory by Prosecutory Staff.

19 Mr. Sugarman, do you want to be heard on the
20 motion?

21 MR. SUGARMAN: Yes, Your Honor.

22 If I may very briefly, our request is to know what
23 the Commissioners and the staff considered in reaching a
24 decision on March 8, 1991, which was reached, of course,
25 without an opportunity for hearing or any consideration

1 or knowledge by us as to what was considered by the
2 Commission. The individual Commissioners made statements
3 at the meeting of March 6 in which they talked about
4 whether there is or is not documentation. The Commission
5 staff in writing the opinion of the Commission cited
6 various documents that were public, but nowhere did the
7 Commission or the Commissioners refer to the fact that
8 ~~the Commission had been holding informal seminars on E/MF~~
9 for about five years.

10 JUDGE SMOLEN: When you say Commission staff, are
11 you referring to this Prosecutory Staff that is here?

12 MR. SUGARMAN: As far as I know, I'm not.

13 JUDGE SMOLEN: You are not?

14 MR. SUGARMAN: As far as I know, I am not.

15 JUDGE SMOLEN: All right.

16 MR. SUGARMAN: As far as I know, the Prosecutory
17 Staff had nothing to do with the decision of March 6.

18 JUDGE SMOLEN: Now, your statement -- let me
19 interrupt you. Your statement with respect to all of the
20 discovery that you are seeking relates to -- is really
21 addressed to the Commission?

22 MR. SUGARMAN: Yes, sir. And in fact the request
23 was addressed to the Commission and it was sent to the
24 Secretary. How the Prosecutory Staff got involved in it
25 and why they responded to the request is a mystery to me

1 because I don't understand where the Prosecutory Staff
2 fits in. They seem to go wherever they want and whenever
3 they want. But I don't know that they represent the
4 Commission.

5 JUDGE SMOLEN: Let's hear what Prosecutory Staff
6 has to say. I have read your objections. And let's hear
7 what you have to say about it.

8 MS. BURKE: What I have to say about it is that
9 there is a statute that controls when the Commission
10 answers interrogatories and it is 300 --

11 JUDGE SMOLEN: 66 Pennsylvania Consolidated
12 Statutes Annotated, Section 333(d). And that is what I
13 have in front of me. That is contained in the pocket
14 part.

15 It seems to me that in view of the fact that
16 Mr. Sugarman has stated now of record as well as in his
17 motion to compel that these interrogatories are really
18 addressed to the Commission, the statute provides a
19 procedure for a party submitting interrogatories to
20 obtain or to serve interrogatories upon the Commission.

21 Now, let me ask Mr. Sugarman, you said that you
22 served -- who did you serve?

23 MR. SUGARMAN: The Secretary of the Commission.

24 JUDGE SMOLEN: And who were the interrogatories
25 addressed to?

1 MR. SUGARMAN: The Commission. The Pennsylvania
2 Public Utility Commission.

3 JUDGE SMOLEN: Under the terms of the statute, this
4 Administrative Law Judge really has no power to compel the
5 Commission or the Commissioner's staffs to respond to
6 interrogatories, particularly because the Legislature in
7 the consolidated statutes has enacted this particular
8 provision and this particular method of serving
9 interrogatories on the Commission.

10 Now, have you followed it up at all, Mr. Sugarman,
11 namely this procedure? Have you followed it up as to
12 what action the Commission is going to take in connection
13 with your interrogatories? What I am really asking is
14 did you make it clear to them that the interrogatories
15 were addressed to the Commission?

16 MR. SUGARMAN: Yes. I addressed the
17 interrogatories, I believe -- they were actually a
18 request for production of documents.

19 JUDGE SMOLEN: Yes.

20 MR. SUGARMAN: Let me check my original letter of
21 May 31.

22 JUDGE SMOLEN: I don't know that we have to have
23 you check all your papers now. You may have some in the
24 office. But my suggestion would be, since there is
25 sufficient time between now and the next hearing, that

1 you follow up with the procedures set forth in the
2 statute in connection with addressing written
3 interrogatories to the Commission.

4 I might say this: with respect to the production of
5 documents at E/MF seminars, I am going to ask Staff did
6 it recently conduct a seminar?

7 MS. BURKET: We had a series of four seminars in
8 1991.

9 JUDGE SMOLEN: By whom was it conducted?

10 MS. BURKET: Three individuals and a number of
11 representatives from power companies.

12 JUDGE SMOLEN: I mean under whose auspices?

13 MS. BURKET: Actually, I was in charge of putting
14 it together.

15 JUDGE SMOLEN: So it was the Prosecutory Staff?

16 MS. BURKET: Well, I wasn't Prosecutory Staff at
17 the time.

18 JUDGE SMOLEN: That's what I'm asking. Under whose
19 auspices was the seminar conducted. Was it the
20 Commission, was it the Prosecutory Staff, was it the Law
21 Bureau, was it OSA?

22 MS. BURKET: It was under the Law Bureau.

23 JUDGE SMOLEN: Under the Law Bureau?

24 MS. BURKET: Yes.

25 JUDGE SMOLEN: Do you have copies of the documents

1 which were distributed at that seminar?

2 MS. BURKET: Yes, I do.

3 JUDGE SMOLEN: Do you have any particular
4 objection, since it was a public thing and everyone was
5 invited -- was everyone invited? Let me ask that.

6 MS. BURKET: A number of different agencies were
7 invited and an invitation was extended at some point to
8 the Protestants to attend.

9 JUDGE SMOLEN: Do you have any objection to
10 supplying a copy of what was distributed at that seminar
11 since was public?

12 MS. BURKET: Yes, I do.

13 JUDGE SMOLEN: You have an objection?

14 MS. BURKET: Yes, I do because the seminars, the
15 materials presented at the seminars not only came from
16 the speakers but also through my efforts of accumulating
17 articles on E/MF in my role as an advisor to the
18 Commission.

19 JUDGE SMOLEN: In your role as an advisor to the
20 Commission?

21 MS. BURKET: Yes.

22 JUDGE SMOLEN: Were these materials made public at
23 the --

24 MS. BURKET: Your Honor, they are just that. They
25 are public documents already. Not public documents as in

1 the definition of the term as being orders of the
2 Commission or anything like that. They are journal
3 articles from various disciplines, they are reports, they
4 are studies. They are available from alternate sources.

5 JUDGE SMOLEN: I understand that.

6 MS. BURKET: Yes.

7 JUDGE SMOLEN: Are the documents in a compiled form
8 from the seminar?

9 MS. BURKET: Compiled form? Well, it is in a box
10 if that is what you mean.

11 JUDGE SMOLEN: How extensive is it?

12 MS. BURKET: I would say somewhere around -- I've
13 not stacked them up. They might be, you know, less than
14 500 pages. But I object, Your Honor, to providing
15 research material to the Protestants. I'm not their
16 research librarian.

17 JUDGE SMOLEN: I understand that. You said that.
18 However, let me ask this question. Were these documents
19 distributed at the seminars to which PAUSE was invited?

20 MS. BURKET: That is true. They were.

21 JUDGE SMOLEN: They were distributed or made
22 available?

23 MS. BURKET: They were made available for people to
24 pick up until we ran out.

25 JUDGE SMOLEN: Until you ran out?

1 MS. BURKET: Yes.

2 JUDGE SMOLEN: Since they were made available to
3 the public at that time and PAUSE was invited and for one
4 reason or another did not obtain them, I am going to
5 direct Prosecutory Staff to make those documents from
6 this last seminar available to Mr. Sugarman for copying
7 at his expense if he wants to. And that is with respect
8 to his request for number four.

9 All of the other items I am going to direct or
10 suggest -- I am going to deny them now because
11 Mr. Sugarman has to follow what the statute requires in
12 connection with interrogatories to the Commission.

13 Anything further? Anything you want to add or say?

14 MS. BURKET: No.

15 JUDGE SMOLEN: Anything further?

16 MR. SUGARMAN: Nothing further, Your Honor.

17 JUDGE SMOLEN: All right. Then we will adjourn
18 today's session and we will see everybody on September 6.

19 The hearing is adjourned.

20 (Whereupon, at 12:45 p.m., the hearing was
21 adjourned, to be reconvened on Friday, September 6, 1991,
22 in Philadelphia, Pennsylvania.)

23

24

25

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.

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12 By: Robert J. Stonaker

13 Robert J. Stonaker
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DOCKETED
AUG 23 1991

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

EX-10

RECEIVED

AUG 26 1991

SECRETARY'S OFFICE
Public Utility Commission

DIRECT TESTIMONY
OF
RONALD J. OEDEMANN
ON BEHALF
OF
PHILADELPHIA ELECTRIC COMPANY

DESIGN, CONSTRUCTION AND MAINTENANCE OF THE
WOODBOURNE-HEATON 230 KV TRANSMISSION LINE;
SAFETY CONSIDERATIONS INCORPORATED THEREIN;
AND ALTERNATIVE LINE DESIGNS

AUGUST 1991

1 My responsibilities also include design of transmission
2 lines. I have been involved in the design and construction
3 of over 10 transmission lines that currently are in service.
4 My responsibilities also include monitoring costs,
5 developing project concepts and parameters, selecting
6 designs and materials, approving of engineering drawings and
7 construction specifications, assuring all permits are
8 acquired, and monitoring schedule.

9 I also assist our Construction and Transmission
10 Department (Old Overhead Transmission Section) with
11 assistance on specific maintenance problems.

12 Q. Are you a registered professional engineer in Pennsylvania?

13 A. Yes.

14 Q. Are you a member of any professional groups and, in
15 particular, any committees dealing with the construction and
16 operation of transmission facilities?

17 A. Yes, I am a Senior Member (since 1981) of the Institute of
18 Electrical and Electronics Engineers ("IEEE"). I am a
19 member of one subcommittee and five working groups of the
20 Transmission and Distribution Committee of the IEEE Power
21 Engineering Society. In 1975 I was elected Chairman of the
22 Transmission and Distribution Technical Subcommittee of the
23 Philadelphia Chapter of the IEEE Power Engineering Society.

24 II. SCOPE OF TESTIMONY

25 Q. What is the purpose of your testimony in this proceeding?

1 A. First I will describe the design and methods of construction
2 in the Woodbourne-Heaton line. Second, I will explain the
3 safety considerations that have been incorporated into the
4 design, construction and planned maintenance of the line.
5 Third, I will describe transmission line designs other than
6 the design selected by PECO and describe the reasons that
7 those designs were not selected.

8 Q. Did you prepare an exhibit to accompany your testimony?

9 A. Yes. I am sponsoring PECO Exhibit No. 1, which includes the
10 Company's Letter of Notification dated November 21, 1989,
11 photographs before and after construction, diagrams of
12 alternative designs and a diagram of a typical phase roll.

13 III. DESCRIPTION OF THE WOODBOURNE-HEATON 230 KV
14 LINE AS DESIGNED AND CONSTRUCTED BY THE COMPANY

15 Q. What has been your involvement in the design and
16 construction of the Woodbourne-Heaton 230 kV transmission
17 line?

18 A. I am the Lead Project Engineer for this project. I am
19 responsible for coordinating all aspects of the transmission
20 line, including the acquisition of necessary right-of-way,
21 coordination and approval of construction specifications and
22 drawings, assuring that all applicable codes are met,
23 specifying material, acquiring necessary permits,
24 coordinating the project with Conrail, coordinating the
25 project schedule and costs, and monitoring construction.

- 1 Q. Where is the Woodbourne-Heaton line located?
- 2 A. This line connects two substations, the Woodbourne
3 substation in Middletown Township, Pennsylvania and the
4 Heaton substation in Upper Moreland Township, Pennsylvania.
5 The line is being built on an existing Conrail railroad
6 right-of-way and existing PECO property.
- 7 Q. Did Conrail use this right-of-way for transmission
8 facilities?
- 9 A. Yes. This electrification system, including a 138 kV
10 transmission line, a major substation, 11 kV catenary
11 (overhead supply to the locomotive) wires, and a 6,600 volt
12 signal power system, was placed in service in about 1938.
13 Conrail ceased using electric locomotives on this line in
14 1981 and the catenary wires were removed in 1986. The 138
15 kV transmission line was de-energized in 1986 and the 6600
16 volt signal power feeder was de-energized in January 1991.
- 17 Q. Please briefly describe this project and the transmission
18 line that PECO will operate in this right-of way.
- 19 A. This project involves the removal of the de-energized
20 Conrail facilities from the existing structures. PECO's
21 230 kV transmission line will use 208 of the 238 existing
22 transmission line structures. Thirty new structures are
23 required on railroad right-of-way to replace existing
24 railroad structures which are not suitable because of
25 strength and other reasons, and five new structures are
26 required on adjacent PECO property. PECO located its line

1 within the existing railroad right-of-way -- that is, PECO
2 employed the "common corridor" approach. PECO's line
3 required no condemnation of property.

4 More details about the background and location of the
5 line are contained in the Company's November 21, 1989 Letter
6 of Notification to the Commission, which I have reproduced
7 as part of PECO Exhibit 1. Note that I have included the
8 four Exhibits to the Letter of Notification, which contain a
9 map showing the general location of the line with respect to
10 existing roads and sketches of the line configuration
11 design.

12 Q. You stated that PECO located its line within the existing
13 railroad right-of-way. Please elaborate.

14 A. The nominal 60-foot easement that PECO purchased from
15 Conrail is located entirely within the Conrail property
16 lines. In some places along the line, Conrail's property
17 extends over 100 feet past the edge of PECO's easement.

18 Q. Please describe the design of the Woodbourne-Heaton line.

19 A. This line will use many of the existing structures that were
20 used by Conrail for its transmission facility. The line
21 will be supported on single steel poles with three phase
22 conductors (i.e. those wires that are carrying electrical
23 energy) in a compact triangular (also known as delta)
24 configuration and a ground wire (designed for lightning
25 protection) attached to the top of the structure. The three
26 phase conductors are arranged in a form that represent a

1 triangle with two being on one side of the supporting pole
2 and one being on the other. A diagram illustrating this
3 configuration is attached as part of PECO Exhibit 1.

4 Q. Why was a compact delta configuration used for this line?

5 A. The existing structures are approximately 300 feet apart.
6 This distance is appropriate for a compact delta
7 configuration.

8 Q. Mr. Oedemann, you stated that the line as designed by PECO
9 utilizes the structures (poles) that were already in place.
10 Have any modifications to the structures been made in the
11 reconstruction of the line?

12 A. Yes. Some of the existing transmission line structures that
13 were utilized for the 230 kV line required extensions, new
14 support guys, new anchors, anchor poles, and new foundation
15 caps. These modifications were necessary to ensure the
16 safety and integrity of the line. The use of these existing
17 structures saved our customers approximately \$2.5 million as
18 compared to total replacement of the structures.

19 Q. Were there any other special features incorporated into the
20 design of this line?

21 A. Yes. At selected locations "phase rolls" were used on this
22 line. A phase roll is an engineering technique to minimize
23 interference between transmission facilities and nearby
24 signal communication facilities. A phase roll changes the
25 relative location of all three phases or energized

1 conductors from one supporting structure to another. A
2 diagram of a phase roll is included in Exhibit No. 1. These
3 phase rolls were included to reduce the affects of PECO's
4 proposed transmission line on Conrail's Signal and
5 Communication System.

6 Q. When did construction of the line commence?

7 A. Line construction commenced in the Spring of 1990.

8 Q. When do you expect that construction will be completed and
9 the line will be ready to be energized?

10 A. In approximately the Spring of 1992. I have included in
11 PECO Exhibit No. 1 two pictures of portions of the line
12 where construction has been completed. I have also included
13 pictures of the previous Conrail line taken from the same
14 locations.

15 Q. At this point, what is the estimated total cost of the
16 project, including the purchase of the easement and the
17 design and construction of the line?

18 A. The estimated total cost for the project is \$19.8 million.
19 The Company has spent approximately \$17.2 million to date.

20 IV. SAFETY CONSIDERATIONS INCORPORATED INTO THE
21 DESIGN, CONSTRUCTION AND MAINTENANCE OF THE
22 WOODBOURNE-HEATON LINE

23 Q. How many miles of 230 kV transmission lines does PECO own
24 and how many miles are on railroads right-of-ways similar to
25 this Conrail right-of-way?

1 A. PECO owns and operates over 500 miles of 230 kV transmission
2 line, the first being installed in 1927. One hundred forty
3 miles are on railroad right-of-ways similar to this Conrail
4 right-of-way. PECO has been responsible for the engineering
5 and design of these lines.

6 Q. Mr. Oedemann, what safety considerations have been
7 incorporated into the design, construction and maintenance
8 of the Woodbourne-Heaton transmission line?

9 A. The primary safety consideration that has been incorporated
10 is that the line has been designed and constructed, and will
11 be maintained, in accordance with National Electrical Safety
12 Code requirements.

13 Q. What is the National Electrical Safety Code?

14 A. The National Electrical Safety Code (NESC), published by
15 IEEE, is an American National Standard, American National
16 Standards Institute (ANSI) Number C2. This standard
17 includes provisions for safeguarding persons during the
18 installation, operation, or maintenance of overhead electric
19 supply lines. The Code provides protection both for the
20 public and those actually operating and maintaining the
21 line. The contents are continuously monitored by 25
22 independent organizations, approved by ANSI, and republished
23 every three years by IEEE. The Code is the utility industry
24 standard for safe operation of transmission facilities
25 across the country. In fact, the Commission's regulations,
26 at 52 Pa. Code Section 57.26, expressly provide that

1 transmission facilities "shall be constructed and maintained
2 in accordance with safe and reasonable standards, as set
3 forth in the National Electrical Safety Code" The
4 Woodbourne-Heaton line meets all requirements of the latest
5 edition (1990).

6 Q. Please provide some specific examples of National Electrical
7 Safety Code requirements, explain the safety reason for the
8 requirement, and describe how the line as designed,
9 constructed and maintained by PECO meets the National
10 Electrical Safety Code standards.

11 A. The NESC requires that certain minimum conductor clearances
12 and structure loads be maintained during both normal and
13 abnormal weather and electrical load flow conditions. NESC
14 requirements include that the transmission line will
15 withstand specified amounts of radial ice (i.e. thickness of
16 ice that can form around a wire), transverse wind (i.e. wind
17 perpendicular to conductor), and clearance to ground under a
18 maximum conductor temperature (i.e. maximum conductor
19 temperature with maximum load flow), with no wind or even
20 slight breeze. Listed below are examples of how the
21 Woodbourne-Heaton transmission line will not only meet but
22 exceed the requirements of NESC.

| 1 | <u>NESC Code Requirement</u> | <u>Woodbourne-Heaton Design</u> |
|----------------------------|--|--|
| 2 3 4 5 6 | Structures must withstand 63 mph transverse wind on conductors with 1/2 " Radial ice. | Structures will withstand 70 mph transverse wind on conductors with 1/2" radial ice. (25% increase in strength) |
| 7 8 9 | Structures must withstand 70 mph transverse wind on bare conductors. | Structures will withstand 100 mph transverse wind on bare conductors. |
| 10 11 12 | Climbing steps shall not be closer than 8 feet from the ground. | Climbing steps will not be closer than 15 feet from the ground. |
| 13 14 15 | Maximum design tension in phase conductor shall not exceed 31,800 lbs. | Maximum design tension in phase conductor is 10,625 lbs. |
| 16 17 18 | Maximum design tension in ground wire shall not exceed 16,200 lbs. | Maximum design tension in ground wire is 4,400 lbs. |
| 19 20 21 22 23 | Minimum clearance over ground and roads shall not be less than 24 feet at maximum conductor temperature. | Minimum clearance over ground and roads is not less than 28 feet at maximum conductor temperature. |
| 24 25 26 27 | Minimum clearance over rails shall not be less than 32 feet at maximum conductor temperature. | Minimum clearance over rails is not less than 36 feet at maximum conductor temperature. |
| 28 29 30 31 32 | Conductors shall be displaced 1.9 feet by a 49 mph wind to calculate right-of-way width. | Conductors were displaced 3.2 feet by a 68 mph wind to calculate right-of-way width. The 60 foot right-of-way allows for this condition. |
| 33 34 | Q. Are there any other safety considerations that the Company has incorporated? | |
| 35 36 37 38 | A. Yes. For example, six structures are to be removed at the end of Buehl Field (an airport near this line), eliminating an aviation hazard. Nineteen 6,600 volt open wire switches, transformers containing PCB's, and access ladders to ground | |

1 elevation, which were maintained by Conrail as part of its
2 operations, were safely removed.

3 V. ALTERNATIVE LINE DESIGNS

4 Q. Is the compact "delta" configuration chosen for the design
5 of this line the only type of design that is available for
6 230 kV transmission lines?

7 A. No. Three examples of alternative designs are: (1)
8 "horizontal" (or flat), (2) "vertical", or (3) "longer-span
9 delta." These alternatives are shown in PECO Exhibit No. 1.

10 Q. Please describe these three alternative designs you just
11 mentioned.

12 A. All three alternatives assume a span length of 600 feet.
13 The vertical configuration, shown in Exhibit 1, places the
14 three conductors on one side of the pole on individual
15 supporting arms over the track, with a ground wire at the
16 top. The average pole height for vertical configuration
17 would be 103 feet.

18 The longer-span delta configuration, shown in Exhibit
19 1, places two conductors on one side of the pole and one
20 conductor on the other side of the pole (over the track) on
21 individual supporting arms, with a ground wire at the top.
22 The average pole height for longer-span delta configuration
23 would be 82 feet.

24 The horizontal configuration, shown in Exhibit 1,
25 places two conductors on the track side of the pole and one

1 conductor on the other side on a single crossarm, with a
2 ground wire at the top. The average pole height for
3 horizontal configuration would be 88 feet.

4 Q. Would it be technically feasible to implement these designs
5 on the existing Conrail right-of-way, using the existing
6 structures?

7 A. No. None of the three alternative designs could use the
8 existing structures (poles) to support the line. Rather,
9 new structures, which are costly, would have to be
10 installed. The existing poles will not withstand the
11 additional structural loads created by the longer spans and
12 higher conductors.

13 In addition, under the "horizontal" and "longer-span
14 delta" configurations, additional right-of-way would need to
15 be acquired along some parts of the line, due to the larger
16 swing of conductors. Acquisition of this additional
17 property would be expensive. Also, none of these designs
18 could be used in the vicinity of Buehl Field because of the
19 higher poles required by these configurations would exceed
20 safe heights for use near an airport. (The existing poles
21 average 68 feet in height whereas longer-span delta would
22 average 82 feet, vertical would average 103 feet and
23 horizontal would average 88 feet.)

24 Q. Mr. Oedemann, you indicated earlier in your testimony that
25 the project as being constructed by the Company is expected
26 to cost approximately \$19.8 million in total. How much do

1 you estimate it would cost to construct the line under the
2 three alternatives you have identified?

3 A. Many factors must be considered in reaching cost estimates
4 for design alternatives. For purposes of comparing these
5 three alternatives with the compact delta configuration,
6 three elements are especially important: (1) removal of the
7 existing structures and foundations; (2) purchase and
8 installation of new structures and foundations to support
9 the line; and (3) for the horizontal and longer-span delta
10 configurations, acquisition of additional right-of-way at
11 the some locations.

12 I have not attempted to estimate right-of-way
13 acquisition for these alternatives.

14 I estimate that the project cost of the alternative
15 designs, without including any estimate for additional
16 right-of-way, would be as follows:

| | | |
|----|-------------------|----------------|
| 17 | Vertical | \$23.9 million |
| 18 | Longer-Span Delta | \$22.3 million |
| 19 | Horizontal | \$22.1 million |

20 Q. In your opinion, do these alternative designs provide any
21 safety advantages compared to the design used by PECO?

22 A. No.

23 Q. Does this conclude your testimony?

24 A. Yes.

A-110550, E, 055

8/15/91

Phila, Pa

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

DOCKETED
AUG 8 1991

RECEIVED

AUG 26 1991

DIRECT TESTIMONY
OF
CHARLES J. BOEGGEMAN

SECRETARY'S OFFICE
Public Utility Commission

ON BEHALF

OF

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC AND MAGNETIC FIELDS EXPECTED TO BE
PRODUCED BY THE WOODBOURNE-HEATON TRANSMISSION LINE

AUGUST 1991

1. DIRECT TESTIMONY OF CHARLES J. BOEGGEMAN

2 Q. Please state your name and business address.

3 A. Charles J. Boeggeman, 2301 Market Street, Philadelphia,
4 Pennsylvania 19101.

5 I. EXPERIENCE AND QUALIFICATIONS

6 Q. By whom are you employed and in what capacity?

7 A. I am an Electrical Engineer in the Consulting Services
8 Branch of the Engineering and Design Division of the
9 Transmission and Distribution Services Department of the
10 Philadelphia Electric Company ("PECO" or the "Company").

11 Q. What is your educational background?

12 A. I received a Bachelor of Electrical Engineering Degree from
13 Villanova University in 1982.

14 Q. Please describe your professional experience.

15 A. Since my graduation from Villanova, I have been employed by
16 PECO as an Electrical Engineer in the Transmission and
17 Distribution Department. For the first three years of my
18 employment I was a Project Engineer and, as such, designed
19 aerial and underground electric distribution lines. For the
20 next three and one-half years I was an Equipment and
21 Standards Engineer handling transmission and distribution
22 equipment design. During those three and one-half years I
23 also was responsible for monitoring and responding to EMF-

1. related issues. For the last two years, EMF issues have
2 been my only responsibility.

3 Q. What are your current responsibilities with regard to EMF
4 issues?

5 A. In my current position, I provide technical EMF evaluations
6 on existing and proposed electric transmission, distribution
7 and substation facilities. These evaluations include
8 electric and magnetic field measurements and calculations
9 for any given source (actual or projected) and analyses of
10 methods to reduce the fields. I coordinate research efforts
11 at PECO in the areas of epidemiology, exposure assessment,
12 and EMF management. I also conduct EMF education programs
13 for the Company's customers and employees as well as for the
14 general public and the media. I also monitor EMF research
15 and literature.

16 Q. What steps do you take to monitor EMF research?

17 A. I have been attending and participating in conferences on
18 EMF since 1986. Among the conferences I have participated
19 in were those sponsored by the Electric Power Research
20 Institute (EPRI), the Edison Electric Institute (EEI), the
21 Department of Energy (DoE), the Bioelectromagnetic Society
22 (BEMS), the Institute of Electrical and Electronics
23 Engineers (IEEE) and the Pennsylvania Electric Association
24 (PEA).

1. Q. Have you ever been asked to speak at any of these
2 conferences?

3 A. I was invited to deliver presentations at several of the
4 conferences, where I spoke about how PECO is addressing the
5 EMF issue in terms of employee and public education as well
6 as the support PECO is giving to outside research.

7 Q. Do you serve on any EMF-related committees or task forces?

8 A. Yes. I am Chairman of the Company's EMF Task Force, a
9 member of the Pennsylvania Electric Association's (PEA) EMF
10 Task Force, a member of the Edison Electric Institute's
11 (EEI) EMF Task Force, and a member of the Electric Power
12 Research Institute (EPRI) Technical Steering Committee on
13 EMF. I also serve on the Institute of Electrical and
14 Electronics Engineers Standard Coordinating Committee on
15 Extremely Low Frequency Electric and Magnetic Fields.

16 Q. Have you previously testified or made formal presentations
17 regarding EMF?

18 A. Yes. On March 8, 1990, I testified in Washington, D.C. at
19 an Oversight Hearing before the Committee on Interior and
20 Insular Affairs, United States House of Representatives, on
21 Electric Power Lines: Health and Public Implications. I
22 also made a formal presentation on "EMF Management in the
23 Field" at the Pennsylvania Public Utility Commission
24 Workshop on EMF held in Harrisburg on May 20, 1991.

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II. SCOPE OF TESTIMONY

Q. What is the purpose of your testimony in this proceeding?

A. I will identify the electric and magnetic field levels that the new Woodbourne-Heaton 230 kV transmission line is expected to produce once it is completed and energized. I also will identify the EMF levels that would be produced under three alternative line designs described in Mr. Oedemann's testimony in this proceeding (PECO Direct No. 1).

Q. Did you prepare an exhibit to accompany your testimony?

A. Yes. I am sponsoring PECO Exhibit No. 2, which includes graphs and tables showing calculated electric and magnetic field levels expected from the Woodbourne-Heaton 230 kV transmission line as well as the field levels expected from three alternative line designs.

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III. BACKGROUND ON ELECTRIC AND MAGNETIC FIELDS

Q. What is a field?

A. A field is a space or region in which an influence can be said to exist. For example, a campfire has a "temperature field" around it that decreases as you move away from the fire.

Q. Where are electric and magnetic fields found?

A. Electric and magnetic fields exist whenever electricity is present. Power lines, electric appliances and internal home

1 and business wiring all generate electric and magnetic
2 fields.

3 Q. How is an electric field created?

4 A. An electric field is created by voltage. The higher the
5 voltage, the higher is the strength of the electric field.
6 The unit of measure of the electric field is expressed in
7 kilovolts per meter (kV/m).

8 Q. How is a magnetic field created?

9 A. A magnetic field is created by the flow of current. The
10 higher the current, the higher is the strength of the
11 magnetic field. The unit of measure of the magnetic field
12 is expressed in milligauss (mG).

13 Q. What is a "milligauss"?

14 A. A milligauss is 1/1,000th of a larger unit of measurement
15 known as a "Gauss." For purposes of comparison and to
16 provide some understanding of the size of a milligauss, the
17 following table provides some average milligauss levels that
18 have been reported in the published literature.

19 MAGNETIC FIELD (milligauss)

| | <u>1.2 inches</u> | <u>12 inches</u> | <u>39 inches</u> | |
|----|-------------------|------------------|------------------|-------|
| 20 | | | | |
| 21 | Microwave Oven | 750-2,000 | 40-80 | 3-8 |
| 22 | Electric Range | 60-2,000 | 4-40 | 0.1-1 |
| 23 | Hair Dryer | 60-20,000 | 1-70 | 0.1-3 |
| 24 | Television | 25-500 | 0.4-20 | 0.1-2 |

25 Gauger, J.R., 1985 Household Appliance Magnetic Field Survey, IEEE
26 Transactions on Power Apparatus and Systems PAS 104(9):2436-2444.

- 1 Q. Does the strength of electric fields and magnetic fields
2 decrease with distance from the source of the fields?
3 A. Yes. Similar to the decrease in heat that you experience as
4 you walk away from the campfire, you also experience lower
5 electric and magnetic fields as you move away from the
6 source of these fields.

7 IV. EXPECTED ELECTRIC AND MAGNETIC FIELD LEVELS
8 FROM THE WOODBOURNE-HEATON LINE AS DESIGNED
9 AND CONSTRUCTED BY PECO

- 10 Q. How do you determine the electric and magnetic field levels
11 that will be associated with a transmission line that has
12 not yet been energized?
13 A. Electric and magnetic field levels from transmission lines
14 can be calculated using computer programs that have been
15 developed for this purpose. One computer program used by
16 PECO is called "ENVIRO." ENVIRO was developed for the
17 Electric Power Research Institute (EPRI) and is used by
18 utilities worldwide. It has been verified for accuracy
19 through extensive testing at EPRI's High-Voltage
20 Transmission Research Center in Lenox, Massachusetts. I
21 used ENVIRO to perform the calculations presented in this
22 testimony.
23 Q. What will be the electric field levels associated with the
24 Woodbourne-Heaton 230 kV transmission line using the compact
25 delta configuration?

1 A. The electric field levels are presented in Table 1 of the
2 Exhibit attached to my testimony. The highest electric
3 field level, in the middle of the right-of-way, will be 1.87
4 kV/m. At the edge of the right-of-way, the electric field
5 is approximately 1.2 kV/m, and the electric field continues
6 to decrease further away from the line. Table 1 provides
7 electric field values for distances 300 feet either side of
8 the center line. Figure 1-1, also included in the Exhibit
9 attached to my testimony, is a "field profile" showing this
10 same information in graphic form.

11 Q. What will be the magnetic field levels associated with the
12 Woodbourne-Heaton 230 kV transmission line using the compact
13 delta configuration?

14 A. As I noted previously in my testimony, magnetic field levels
15 are created by "current," or "amperage." The current that
16 will pass through the Woodbourne-Heaton line will vary
17 depending on a number of factors. The magnetic fields
18 therefore will also vary.

19 Q. Have you prepared any calculations regarding the magnetic
20 fields, that will be associated with the Woodbourne-Heaton
21 line?

22 A. Yes. I prepared calculations for five different "loading"
23 conditions that represent five different "currents" on the
24 line.

25 Q. What are those five loading conditions?

1 A. The first loading condition represents an "emergency
2 minimum" situation when the line is de-energized for
3 emergency or maintenance reasons. The expected current in
4 that situation is 0 amperes.

5 The second loading situation represents what we
6 anticipate as a "light" load on this line. The expected
7 current in that situation is 180 amperes.

8 The third loading situation represents what we
9 anticipate as a "normal" load on this line. The expected
10 current in that situation is 360 amperes.

11 We anticipate that the "light" and "normal" loading
12 situations will occur for over 90% of the time this line is
13 operating.

14 The fourth loading situation represents what we
15 anticipate as a "heavy" load on this line. The expected
16 current in that situation is 600 amperes.

17 The final loading situation represents an "emergency
18 maximum" situation in which another transmission line in the
19 PECO system has been de-energized because of an emergency
20 situation, and the Woodbourne-Heaton line must carry this
21 additional load. The expected current in that situation is
22 1,000 amperes. We anticipate this situation will not exceed
23 four hours per year, although it may not occur at all in any
24 given year.

25 Q. What were the results of your calculations?

1 A. The "emergency minimum situation results in no magnetic
2 fields, since there is no current on the line.

3 The "light" loading situation results in a maximum
4 magnetic field of approximately 21 milligauss in the middle
5 of the right-of-way, and a level of approximately 13
6 milligauss at the edge of the right-of-way.

7 The "normal" loading situation results in a maximum
8 magnetic field of approximately 42 milligauss in the middle
9 of the right-of-way, and a level of approximately 25
10 milligauss at the edge of the right-of-way.

11 The "heavy" loading situation results in a maximum
12 magnetic field of approximately 70 milligauss in the middle
13 of the right-of-way, and a level of approximately 42
14 milligauss at the edge of the right-of-way.

15 The "emergency maximum" loading situation results in a
16 maximum magnetic field of approximately 117 milligauss in
17 the middle of the right-of-way, and a level of approximately
18 70 milligauss at the edge of the right-of-way.

19 The magnetic field levels for all loading scenarios
20 continue to decrease with distance from the line.

21 Q. Have you prepared tables and graphs that present the results
22 of these calculations?

23 A. Yes. Table 2, of the Exhibit attached to my testimony,
24 provides the magnetic field levels for the five loading
25 situations of 0, 180, 360, 600 and 1,000 amperes. Figures

1 1-2 through 6-2, of the Exhibit attached to my testimony,
2 show the tabular information in graphic form.

3 Q. Have you determined the electric and magnetic field levels
4 from the three alternative line designs described by Mr.
5 Oedemann (PECO Direct No. 1)?

6 A. Yes. I determined these electric and magnetic field levels
7 using the same method and computer program as I used to
8 determine the expected levels from the line as designed by
9 PECO.

10 Q. Have you prepared any graphs or tables to show the results
11 of those calculations?

12 Yes. Table 3, of the Exhibit attached to my testimony,
13 provides a comparison of electric field levels produced by
14 the compact delta design employed by PECO and three other
15 alternative design configurations; a longer-span delta
16 (triangular), a flat (horizontal) and a vertical
17 configuration.

18 Accompanying Table 3 are Figures 1-3 through 3-3, of
19 the Exhibit attached to my testimony, showing, in graphic
20 form, the comparison between electric field levels produced
21 by the compact delta design versus the other design
22 alternatives.

23 Table 4, of the Exhibit attached to my testimony,
24 provides a comparison of the magnetic field levels produced
25 by the compact delta design employed by PECO and three other
26 alternative design configurations; a longer-span delta

1 (triangular), a flat (horizontal) and a vertical
2 configuration.

3 Accompanying Table 4 are Figures 1-4 through 3-4, of
4 the Exhibit attached to my testimony, showing, in graphic
5 form, the comparison between magnetic field levels produced
6 by the compact delta design versus the other design
7 alternatives.

8 Q. How do the expected electric field levels compare between
9 the compact delta line design employed by the Company and
10 the alternative designs for which you performed these
11 calculations?

12 A. The vertical configuration produces lower electric field
13 levels close to the edge of the right-of way, but are higher
14 than from the compact delta configuration further away from
15 the edge of the right-of-way.

16 The electric fields from the horizontal configuration
17 and longer-span delta are generally higher than the electric
18 fields from the compact delta configuration.

19 Q. How do the expected magnetic field levels compare between
20 the compact delta line design and the alternative designs?

21 A. I prepared comparisons for only one of the loading
22 scenarios, the "heavy" load of 600 amperes.

23 The vertical design results in lower magnetic fields on
24 the right-of-way, but higher magnetic fields beyond the edge
25 of the right-of-way.

1 The horizontal and longer-span delta designs result in
2 higher magnetic fields both on and off of the right-of-way.
3 Other loading conditions would result in similar results.

4 I should note that these comparative results, along
5 with the information presented by Mr. Oedemann, provide the
6 second of the two pieces of information that Commissioner
7 Rhodes requested in his June 13, 1991 Statement.

8 Q. Does this conclude your testimony?

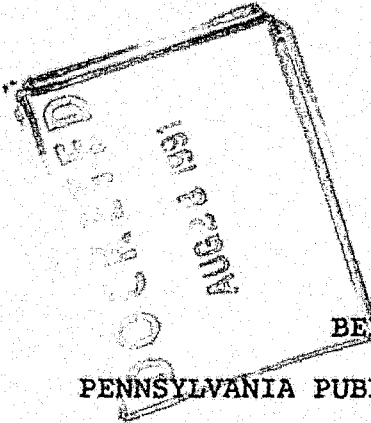
9 A. Yes.

PECO EXHIBIT NO. 1

A-110550, F. 085

8/15/91 0166,00

MS



BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

RECEIVED

AUG 26 1991

SECRET
Public Utility Commission

EXHIBIT
OF
RONALD J. OEDEMANN
ON BEHALF
OF
PHILADELPHIA ELECTRIC COMPANY

AUGUST 1991

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PHILADELPHIA ELECTRIC COMPANY

LEGAL DEPARTMENT

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November 21, 1989

Mr. Jerry Rich, Secretary
Pennsylvania Public Utility Commission
P. O. Box 3265
Harrisburg, PA 17120

Re: Letter of Notification
Woodbourne-Heaton 230 KV Transmission Line

Dear Mr. Rich:

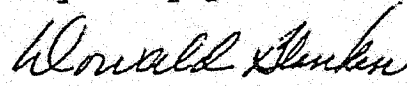
In accordance with the Commission's regulations at 52 PA. Code, Section 57.72(d)(1)(IV),(V), Philadelphia Electric Company (hereinafter "PECO"), submits the enclosed Letter of Notification regarding the proposed reconductoring of the Woodbourne-Heaton 230 KV Transmission Line. There is enclosed an original and six copies of the Letter of Notification, together with an Affidavit of Service showing the identity of those served with a copy of the Letter of Notification.

In addition, PECO will make available to the public, during ordinary business hours, a copy of the Letter of Notification, together with exhibits, at its offices in Philadelphia and Bucks Counties located at:

Main Office
2301 Market Street
Philadelphia, PA

Warminster Service Building
400 Park Avenue
Warminster, PA

Very truly yours,



Donald Blanken

DB:bmt
Enclosures (7)

BEFORE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Letter of Notification of :
PHILADELPHIA ELECTRIC COMPANY :
under 52 PA. Code §57.72(d) :
with respect to a proposed : Docket No.
reconductoring and rebuilding : P-
of an existing 138 kV line to :
operate as a Woodbourne-Heaton :
230 kV line in Montgomery and :
Bucks Counties, Pennsylvania :

TO THE PENNSYLVANIA PUBLIC UTILITY COMMISSION:

This Letter of Notification is submitted pursuant to 52 PA. Code §57.72(d)(1) by Philadelphia Electric Company (hereinafter referred to as "PECO" or "Applicant") with respect to a proposed rebuilding and reconductoring of an abandoned railroad 138 kV transmission line. Consolidated Rail Corporation (Conrail) owns and operates a rail line known as the "Trenton Cut-off Branch freight line." The aforementioned 138 kV transmission line was constructed along this rail line. PECO has entered into an agreement to purchase from Conrail an easement along the rail line, together with the structures supporting the abandoned 138 kV transmission line and electrification system for the purpose of building the proposed 12.8 mile long Woodbourne-Heaton 230 kV line. The proposed rebuilding and reconductoring will be done entirely within the existing railroad right-of-way. In addition, PECO has purchased a two acre parcel of land situate

between the railroad and Woodbourne Substation to enlarge the substation so that it will abut the railroad and provide access from the substation to the railroad.

Accordingly, PECO believes that the procedure for a Letter of Notification is appropriate and the aforesaid rebuilding and reconductoring of the 138 kV transmission line and railroad electrification system will not substantially alter the existing right-of-way within the meaning of 52 PA. Code §57.71(d)(1)(IV) and (V). PECO is therefore submitting this Letter of Notification and in support thereof, sets forth the following:

1. The name and address of Applicant are:

PHILADELPHIA ELECTRIC COMPANY
2301 Market Street
Philadelphia, PA 19101

2. The name and address of Applicant's attorney and the person authorized to receive notices and communications with respect to the application is:

DONALD BLANKEN, ESQUIRE
Assistant General Counsel
2301 Market Street
Philadelphia, PA 19101

3. PECO proposes to construct all of the 230 kV

transmission line within the existing right of way of the 138 kV transmission line and the railroad. In order to facilitate entry into Woodbourne Substation and avoid conflict with the runway approach at Buehl Field airport, Applicant has purchased a parcel of land adjacent to the substation and railroad. This small parcel of two (2) acres will contain a 0.06 mile section of the proposed line. The proposed line will be constructed within an existing transmission line right-of-way and meet the common corridor approach for transmission line siting thereby coming within the policy considerations permitting utilization of the letter of notification procedure in 52 PA. Code Sec. 57.72(d). The Commission has permitted filing Letters of Notification in similar cases under similar factual circumstances as are in this case. See Petitions of Philadelphia Electric Company at Docket Nos. P-810309, P-870228 and P-880293. The proposed route is shown on a Key Map Drawing C-241332-A, sheets 1 and 2, attached hereto, made a part hereof and marked Exhibit "A", a general description of which is as follows:

(a) Route Description

The proposed Woodbourne-Heaton 230 kV line will

follow the existing Consolidated Rail Corporation's (Conrail) Trenton Cut-Off Branch freight line for the entire 12.8 mile length and will utilize the existing catenary structures for support. The proposed line will exit Heaton Substation from the northeast corner and enter adjacent railroad property. Heaton Substation is located off Fitzwatertown Road west of Old York Road. Upon entering the railroad property, the line will cross the tracks and join the railroad catenary system which is located on the north side of the tracks. From this point, the line will head due east on the railroad right-of-way which parallels the Pennsylvania Turnpike for approximately 3.85 miles. At the point the turnpike turns southeast and crosses over the railroad, the line and railroad will continue another 1.5 miles eastward and cross Street Road in Feasterville. In the vicinity of Street Road the railroad curves to an east-north-east direction for the remaining 7.45 miles. Approximately 3.42 miles from Street Road the line crosses the Neshaminy Creek on catenary structures supported by an existing stone arched railroad bridge. After crossing the creek the line will continue the remaining 4.03 miles to Woodbourne Substation.

Woodbourne Substation property abuts the north property line of Conrail's Trenton Cut-Off Branch. Just west of the substation and abutting the railroad property on the south side is Buehl Field Airport. Existing railroad structures cannot be used in this area due to the required height limitation near the airport runway.

PECO has purchased a two (2) acre vacant, irregular shaped property which separates the substation property from the railroad. This property will be used to divert the line from the railroad into the substation prior to reaching the approach to runway 24 at Buehl Field. This will greatly reduce or eliminate conflict with the runway.

Exhibit "A", the Key Map for the proposed 230 kV line, shows the route of the line with respect to existing roads. The total length of the line is 12.8 miles.

(b) Line Location and Structure Description

Work on the proposed line will take place in Upper Moreland (2.5 miles) and Lower Moreland (0.9 mile) Townships in Montgomery County and Upper Southampton (1.9 miles), Lower Southampton (1.6 miles), Northampton (1.6 miles), and Middletown Townships (4.0 miles), as well as the Borough of Langhorne (0.3 mile), all in Bucks County, Pennsylvania.

Structures to be utilized for the proposed line were part of the railroad catenary system which supported a two phase, 138 kV transmission line. These catenary structures are placed approximately 250 to 300 feet apart. The proposed line will utilize approximately 176 of the 236 existing railroad structures. Approximately ten structures require replacement due to damage resulting from train derailments and another 50 railroad structures must be replaced because they cannot support the new line's mechanical loads. Also, it is estimated that a total of eight new structures will be necessary to connect the transmission line to the substations at both ends. Therefore, approximately 244 structures, including both existing and new, will be used to support the proposed transmission line.

The proposed 230 kV transmission line will be supported by railroad structures which are approximately 50 years old. Prior to installation of the new insulators and conductors the existing railroad conductors, insulators crossarms, 6.6 kV feeder line, catenary support arm, and all unnecessary guy wires will be removed from each

structure. Once all unnecessary hardware is removed from the wide-flange column, reinforcement and extensions (5 to 10 feet) will be added where necessary.

A new ground wire will be added to the top of the wide-flange column and 3 post insulators will be bolted to the structure to support the phase conductors in a delta configuration. The typical configuration of the existing railroad structures vs. the future configuration of the PECO structure are shown in sketch SK-407890, attached hereto, made a part hereof, and marked Exhibit "B".

Replacements for the inadequate railroad structures and any new structures will be single circuit tubular weathering steel poles. These poles will be supported by cylindrical concrete foundations. Two types of new tubular poles will be used in the construction of this line. For tangents and light angles the line will be supported by single circuit weathering steel poles with conductors supported from porcelain post insulators in a delta configuration. Sketch SK-407891, attached hereto, made a part hereof, and marked Exhibit "C", depicts the proposed tangent and light angle poles with approximate dimensions of major members shown. For heavy angles

and dead ends, the line will be supported by single circuit weathering steel poles with conductors supported from steel cross arms. Sketch SK-407892, attached hereto, made a part hereof, and marked Exhibit "D", depicts the proposed heavy angle and dead end poles with approximate dimensions of major members shown.

Conductor for this transmission line will be one 1590 kcmil 54/19 ACSR (1.545 in. dia.) wire per phase. The shield wire will consist of one 7#5 alumoweld (0.546 in. dia.) wire.

4. A general statement of the need for the line in meeting identified present and future demands for service, how the proposed line will meet that need and the engineering justification for the proposed rebuilding and reconductoring of the existing line are as follows:

(a) Need for the Line

The area served by our existing substations at Warrington, Buckingham, Woodbourne, Byberry, and Heaton is one of the fastest growing load areas on the PECO system. In the three year period from the summer of 1985 to the summer of 1988, load on the 34.5 kV system in this area grew by more than 32 percent. This compares with a

system-wide growth in peak demand of slightly more than 13 percent. This very high load growth has resulted in both the expansion of existing distribution facilities, and the scheduling of new distribution substations. The Heaton-Woodbourne 230 kV line will provide a source of supply for new distribution substation, as well as much needed support for expansion of existing facilities.

(b) Engineering justification for the proposed HV line

One new distribution substation of particular concern is Linton. This 230-34.5 kV substation, which will be in service for the 1990 summer peak, will be installed on the existing 230 kV line between Buckingham and Woodbourne. It will have the firm capacity to supply approximately 120 MVA of load. Unlike Woodbourne, Linton will have no 34.5 kV network support. Linton will depend entirely on the transmission systems for its supply. In the event of an outage of the 230 kV line between Buckingham and Linton, without the Woodbourne-Heaton 230 kV line, the supply for both Woodbourne and Linton 230 kV substations will have to come from the 138 kV system at

Byberry. This outage could cause emergency overloads on the 138 kV system and severe voltage drops throughout the area.

Although the Crescentville-Fox Chase 138 kV (130-24) is being upgraded to provide an emergency rating, approximately 75 MVA higher than is now in effect, this is only a stop-gap measure. Unless the Woodbourne-Heaton 230 kV line is installed, load growth at Linton and Woodbourne will soon cause emergency overloads on either the Crescentville-Fox Chase 138 kV line or the Fox Chase-Blue Grass 138 kV line for the loss of the Buckingham-Linton 230 kV line.

An additional problem caused by trying to supply Linton and Woodbourne from the 138 kV system is voltage drops. Previous load-flow studies indicate that the outage of the Buckingham-Linton 230 kV line could result in a voltage drop of 8 percent on the 230 kV bus at Linton and as much as 10 percent on the 34.5 kV bus at Linton. Installation of the Heaton-Woodbourne 230 kV line would restrict these voltage drops to the 1 to 1.5 percent range.

5. The safety considerations which will be incorporated into the design, construction, and maintenance of the proposed line are as follows:

(a) Design

Design criteria will meet or exceed National Electric Safety Code (NESC) requirements. The maximum conductor and ground wire loading condition for this line will be 1/2" of radial ice and an 8 pound per square foot transverse wind load at 0°F. The minimum ground clearance at the maximum conductor temperature of 284°F will be greater than the 24 foot NESC clearance requirement for a 230 kv line. The average ruling span between structures will be 300 feet.

Typically, for a level 300 foot span with the loading conditions given, the following tabulation illustrates minimum conductor to ground and conductor to rail clearances:

| <u>Cond.Temp.</u> <u>(°F)</u> | <u>Radial Sce.</u> <u>(Inches)</u> | <u>Wind</u> <u>(PSF)</u> | <u>Tension</u> <u>(Lbs.)</u> | <u>Sag</u> <u>(Ft.)</u> | <u>Outsd.Phase</u> <u>(Over Gd.)</u> <u>Minimum Gd.</u> <u>Clr. (Ft.)</u> | <u>Insd.Phase</u> <u>(Over Tk..)</u> <u>Min.Rail</u> <u>Clr. (Ft.)</u> |
|----------------------------------|---------------------------------------|-----------------------------|---------------------------------|----------------------------|--|---|
| 0 | 1/2 | 8 | 10,350 | 4.1 | 32.7 | 40.7 |
| 60 | 0 | 0 | 4,610 | 5.0 | 31.8 | 39.8 |
| 284 (Max.) | 0 | 0 | 2,640 | 8.8 | 28 (Min.) | 36 (Min.) |
| | | | | | 24 (NESC) | 32 (NESC) |

(b) Construction and Maintenance

Construction and maintenance will also be accomplished in accordance with the National Electric Safety Code (NESC). The following excerpt from the code describes its coverage:

"This standard covers basic provisions for safeguarding of persons from hazards arising from the installation, operation or maintenance of:
(1) conductors and equipment in electric supply station; and (2) overhead and underground electric supply and communications lines. It also includes work rules for the construction, maintenance and operation of electric supply and communication lines and equipment."

In all cases, the minimum standards set forth by the NESC will be met or exceeded by the design, construction, maintenance and operation of the proposed transmission line.

6. The proposed 230 kV line is approximately 12.8 miles long. Line construction is scheduled to start in the spring of 1990 and is expected to be in service the spring of 1991.

7. Evidence that the size, character, design and configuration of the proposed modifications to the existing railroad electrification system will not substantially alter the existing right-of-way is as follows:

(a) The proposed 230 kV line will be constructed on Conrail's Trenton Cut-off Freight line, an established railroad corridor. PECO will occupy a sixty (60') foot wide right-of-way for the proposed line.

(b) There are two independent railroad tracks, an abandoned railroad catenary system and a wood pole line supporting signal and communication cables on the railroad right-of-way creating an existing corridor to be utilized as a common corridor for the proposed 230 kV line.

(c) The existing railroad right-of-way presently has located on it catenary structures with twenty-eight (28') foot catenary support cross arms, two (2) 6.6 kV signal power cables and one two (2) phase 138 kV transmission line supported by a cross arm mounted near the top and a ground wire mounted on the top of the structure. The catenary trolley wires were removed from the structures approximately three (3) years ago.

(d) PECO plans to remove all railroad facilities from the structures prior to installing its 230 kV transmission line facilities as previously described. Exhibit "B" shows the existing and future structure arrangement.

(e) The existing right-of-way will not be substantially altered because the proposed HV line will be on existing structures in the same configuration and at the same height. In fact, the structures will, after the proposed construction, have fewer attachments and therefore project a cleaner, less obtrusive appearance.

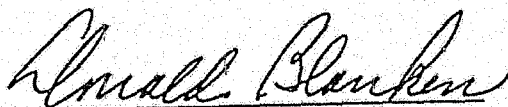
(f) Between Woodbourne and Heaton Substations the proposed line traverses industrial, residential and wooded areas. The existing railroad catenary structures are approximately 50 years old and most of the industrial and residential properties adjacent to the railroad were developed with the structures in place and to some extent accepted their existence. PECO's mitigation plan for this line is to retain the catenary structures at their present height and make changes only when absolutely necessary. All necessary new structures will be made of weathering steel which will turn a deep brown and will closely match the existing railroad facilities.

8. This Letter of Notification is being filed on the date set forth below. The Pennsylvania Public Utility Commission will review and, by Order, approve or disapprove this Letter of Notification. If the Commission approves this Letter of

Notification, the proposed rebuilding and reconductoring shall be located and constructed without the application process set forth in subchapter G of Title 52 of the Pennsylvania Code (relating to Commission review of siting and construction of electric transmission lines). If the Commission does not approve this Letter of Notification, its order shall direct the Applicant to comply with the application process set forth in subchapter G of Title 52 of the Pennsylvania Code.

Respectfully submitted,

BY:

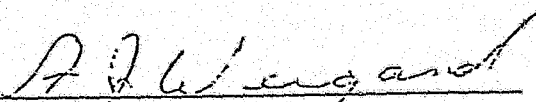


DONALD BLANKEN, ESQUIRE
Counsel for
PHILADELPHIA ELECTRIC COMPANY

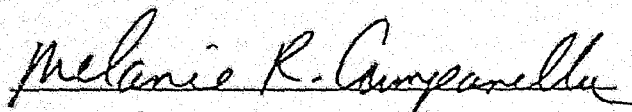
724/bmt

COMMONWEALTH OF PENNSYLVANIA :
: SS.
COUNTY OF PHILADELPHIA :

A. J. WEIGAND, being duly sworn according to law, deposes and says that he is Vice President of Engineering and Production of Philadelphia Electric Company, the Petitioner above-named; that he is authorized to and does make this affidavit for it; and that the facts as set forth above are true and correct to the best of his knowledge and belief, and he expects the said Philadelphia Electric Company to be able to prove the same at any hearing hereof.


A. J. WEIGAND

Sworn to and subscribed
before me this 8th day
of November, 1989.



NOTARIAL SEAL
MELANIE R. CAMPANELLA, Notary Public
City of Philadelphia, Phila. County
My Commission Expires Feb. 12, 1990

CERTIFICATE OF SERVICE

I hereby certify that I have this 21st day of November, 1989, served a copy of the Letter of Notification in the above matter by First Class Mail, postage prepaid, and properly addressed as follows:

Kathleen R. Chiolan, Manager
Lower Southampton Township
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Feasterville, PA 19047

Dennis O'Brien, Chairman
Board of Supervisors
Lower Southampton Township
1500 Desire Avenue
Feasterville, PA 19047

Joseph M. Seborowski, Chairman
Planning Commission
Lower Southampton Township
1500 Desire Avenue
Feasterville, PA 19047

Robert M. Pellagrino
Township Manager
Upper Southampton Township
939 Street Road
Southampton, PA 18966

David Shafter, Chairman
Board of Supervisors
Upper Southampton Township
939 Street Road
Southampton, PA 18966

Jerry S. Goldman, Chairman
Planning Commission
Upper Southampton Township
939 Street Road
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John S. Burke
Township Manager
Middletown Township
2140 Trenton Road
Levittown, PA 19056

Thomas R. Kearns, Chairman
Board of Supervisors
Middletown Township
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Clark Weitzel, Chairman
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William Seiverlich, President
Board of Commissioners
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Charles Esayian, Chairman
Planning Commission
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Andrew L. Warren
Chairman of Commissioners
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Main and Court Streets
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Executive Director
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Paul B. Bartle, Chairman
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County of Montgomery
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Montgomery County Planning Commission
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Norristown, PA 19404

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Langhorne, PA 19047

Kathy Horwalt
Council President
Borough of Langhorne
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Denise Traub, Secretary
Borough of Langhorne
114 East Maple Avenue
Langhorne, PA 19047

Elsie Knight, Chairperson
Planning Commission
Borough of Langhorne
151 West Maple Avenue
Langhorne, PA 19047

C. W. Wogan
Consolidated Rail Corporation
Room 200
15 North 32nd Street
Philadelphia, PA 19104

Arthur A. Davis, Secretary
Pennsylvania Department of Environmental Resources
Attention: Bureau of Environmental Planning
P. O. Box 2357
101 S. Second Street
Harrisburg, PA 17120

Howard Yerusalim, P.E.
Secretary
Department of Transportation
Commonwealth of Pennsylvania
room 1200
Transportation and Safety Building
Harrisburg, PA 17120

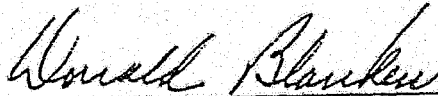
Vivian Piasecki
Chairperson .
Pennsylvania Historical and Museum Commission
P. O. Box 1026
Harrisburg, PA 17120

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Walter C. Evans
Township Planner
Northampton Township
55 Township Road
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DONALD BLANKEN, ESQUIRE
Counsel for
PHILADELPHIA ELECTRIC COMPANY

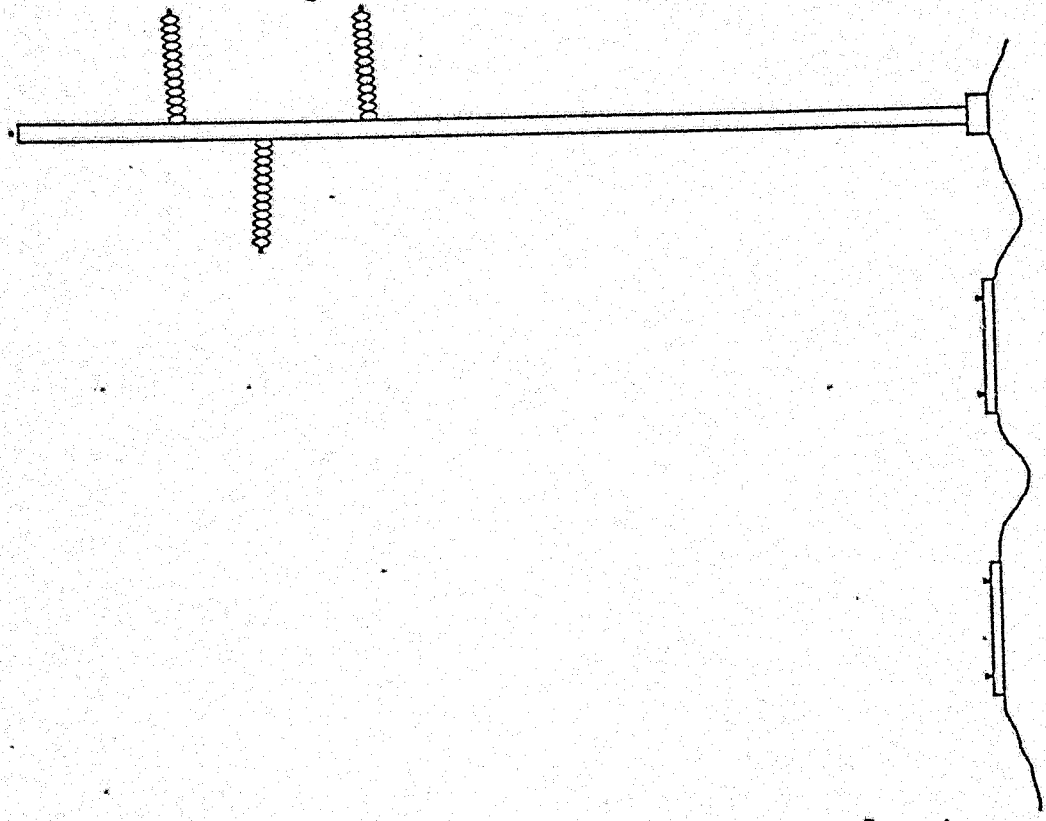
**OVERSIZE
DOCUMENT(S)**

KEY MAP -

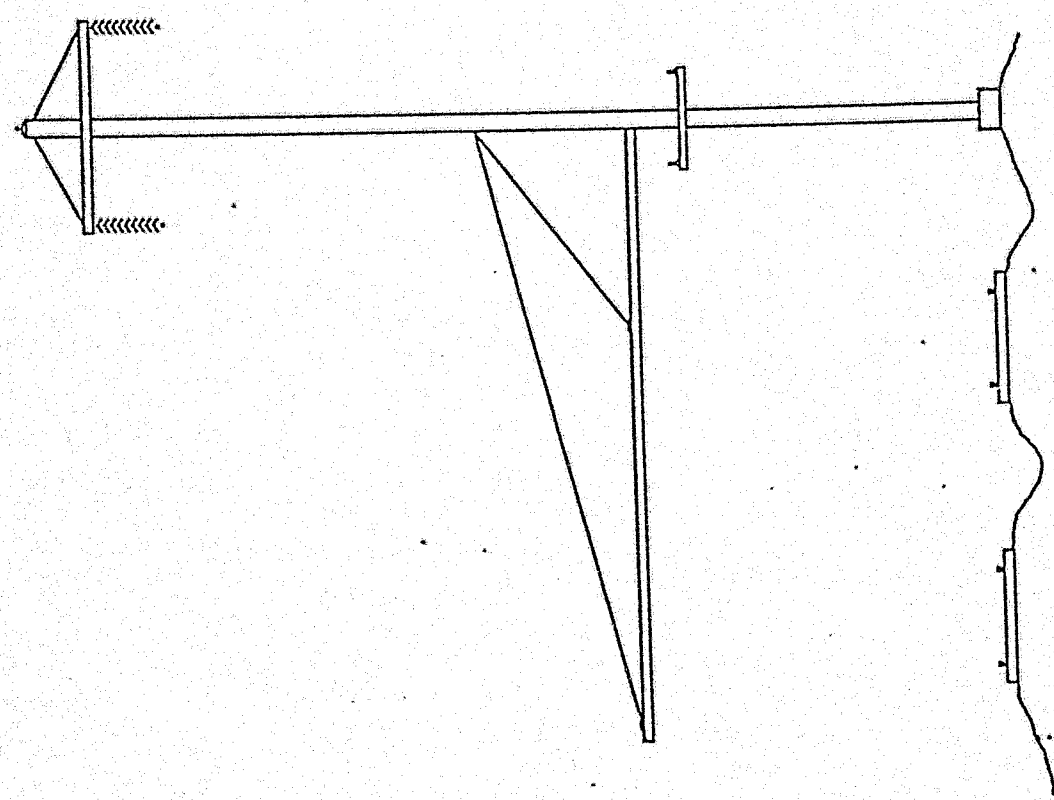
HEATON - WOODBOURNE

**OVERSIZE
DOCUMENT(S)**

KEY MAP —
HEATON-WOODBOURNE



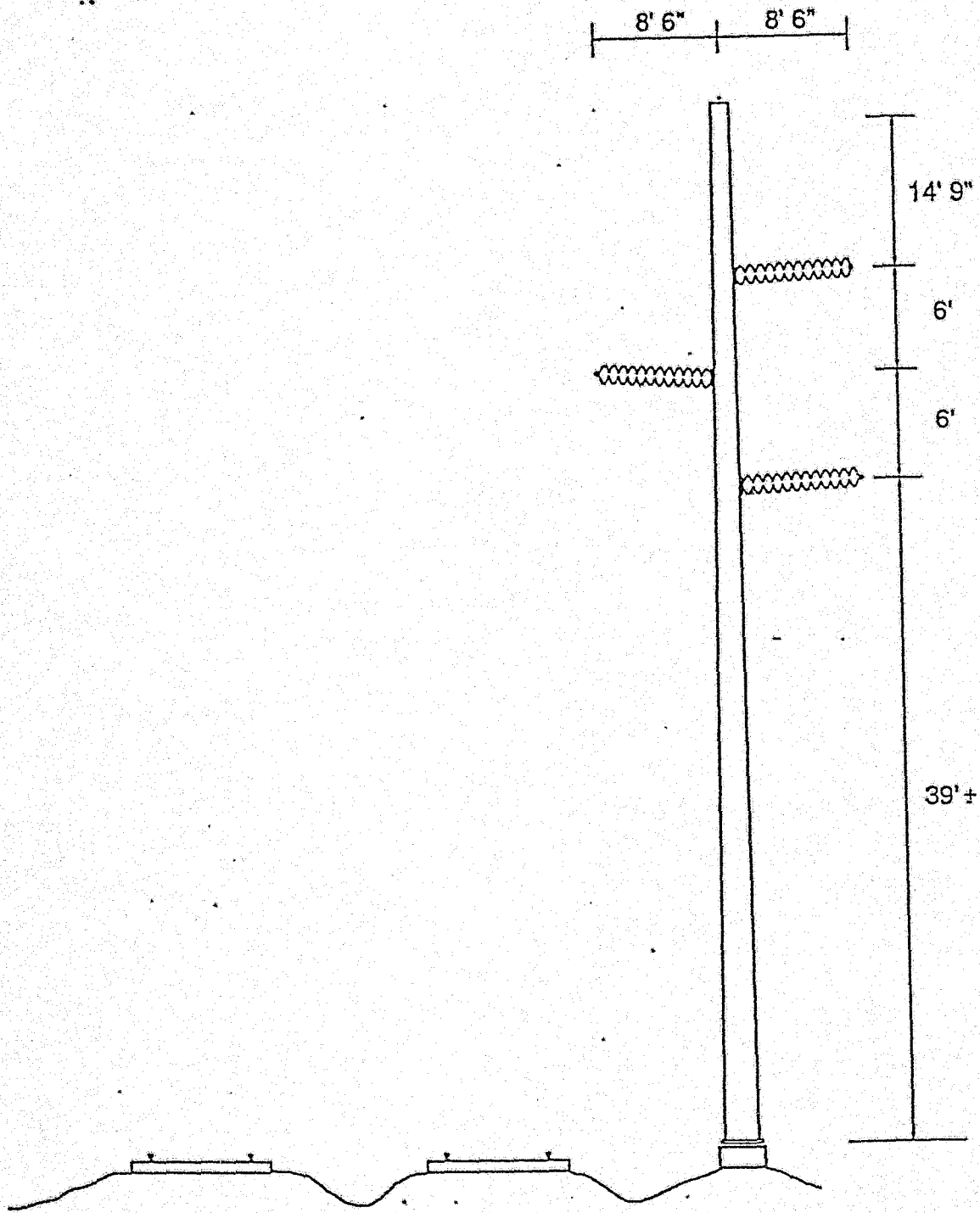
PECO MODIFIED
RAILROAD STRUCTURE



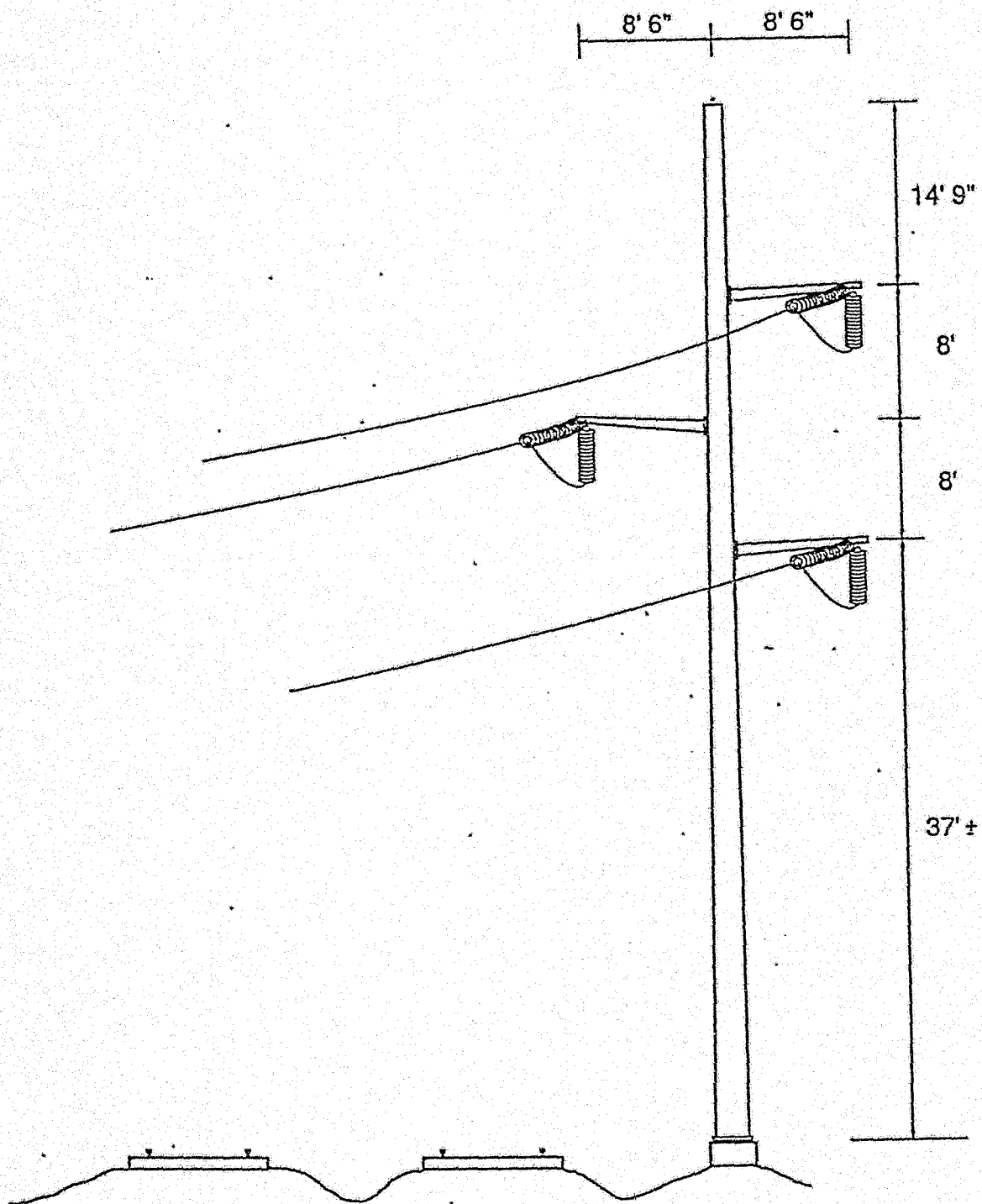
EXISTING RAILROAD
STRUCTURE

SKETCH 407890

EXHIBIT "B"



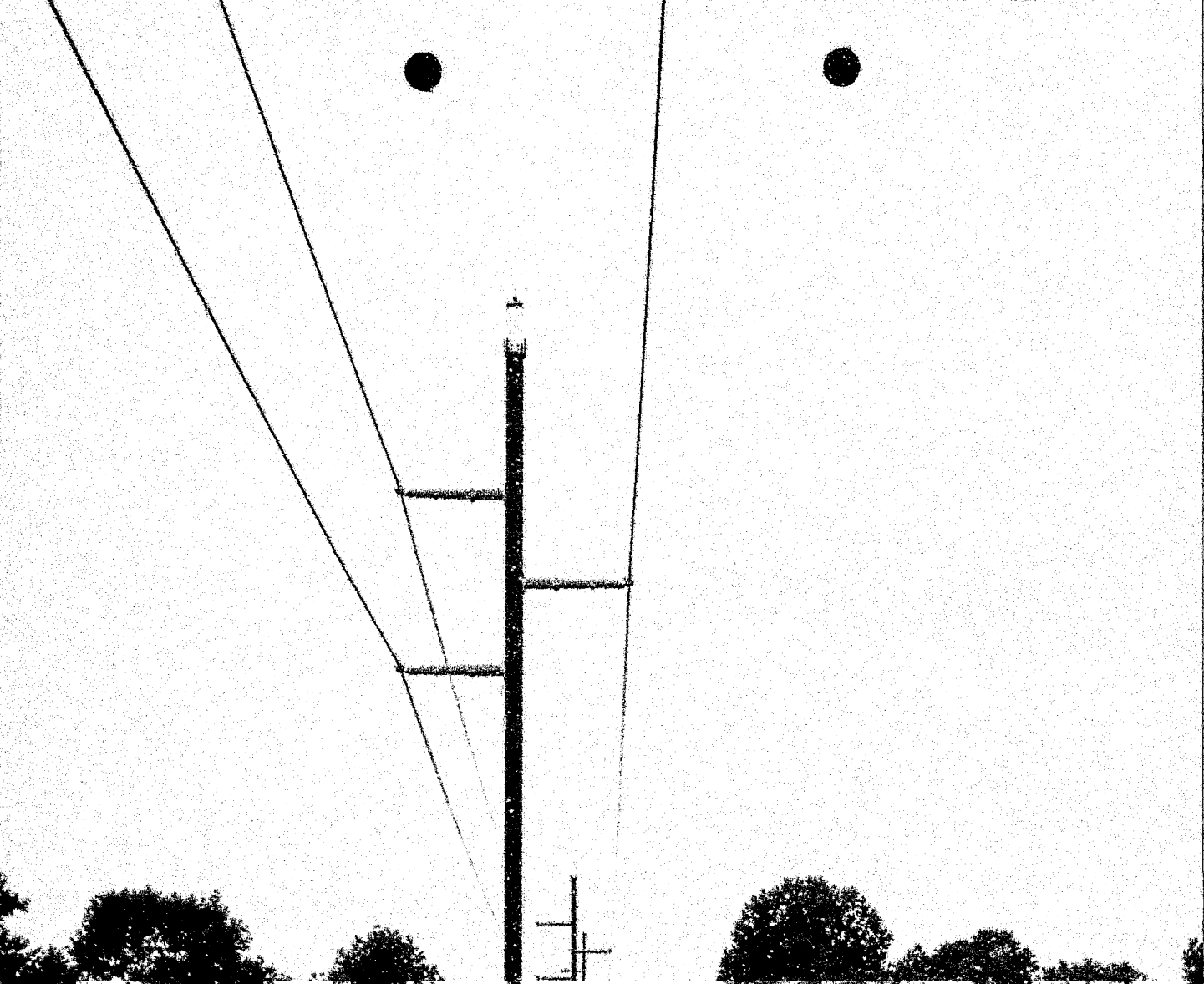
NEW TANGENT AND LIGHT
ANGLE STRUCTURE

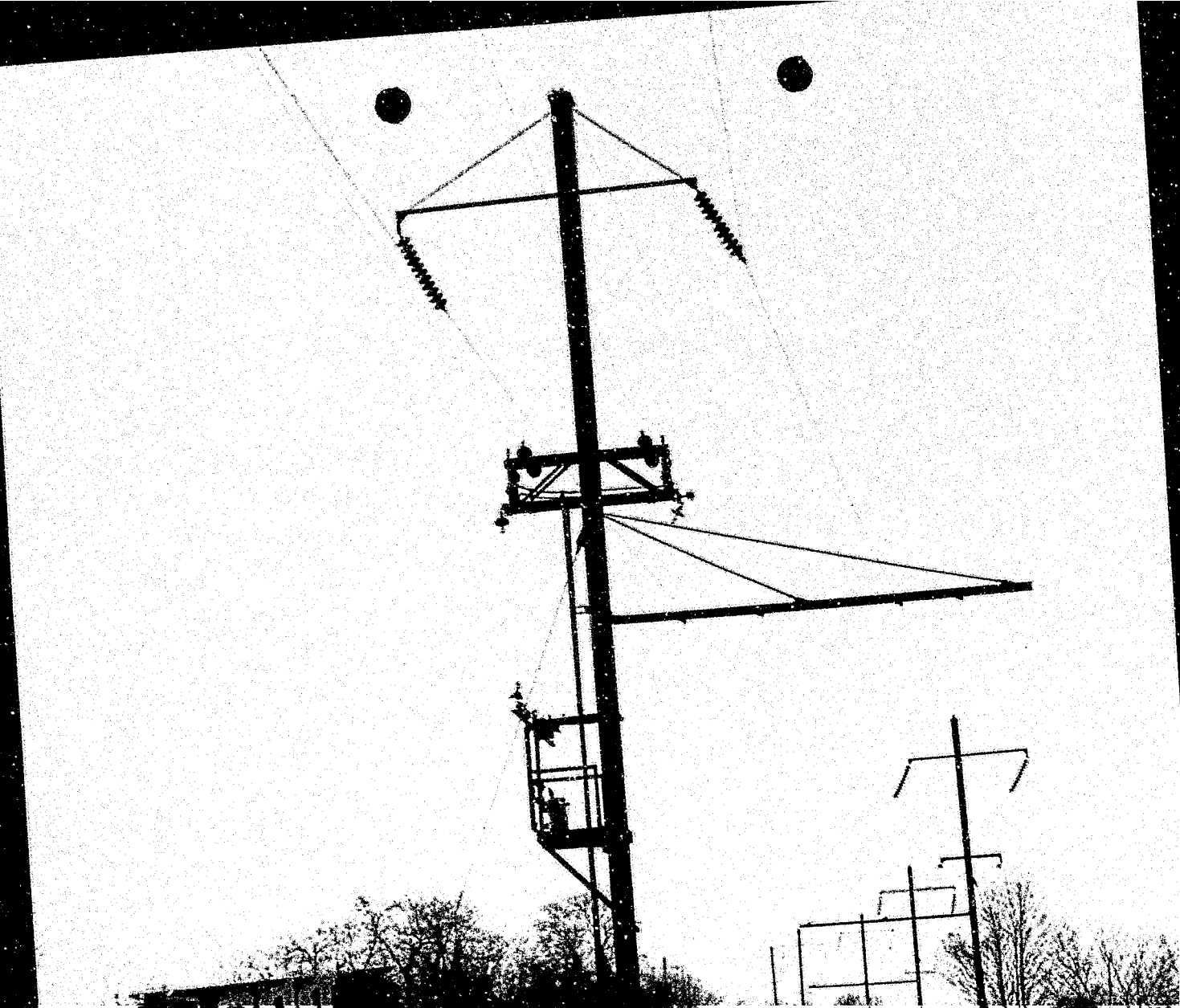


NEW HEAVY ANGLE AND
DEAD END STRUCTURE

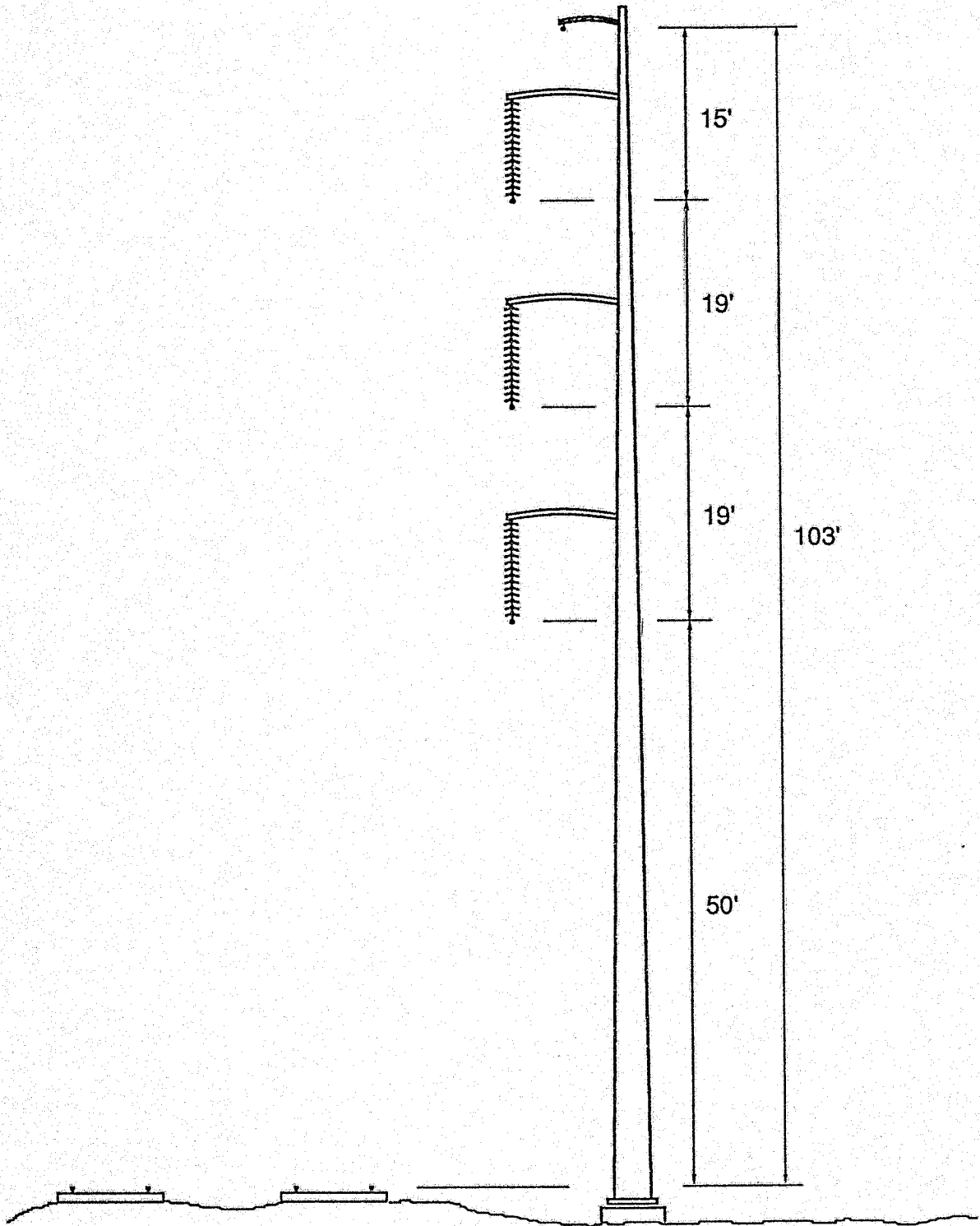


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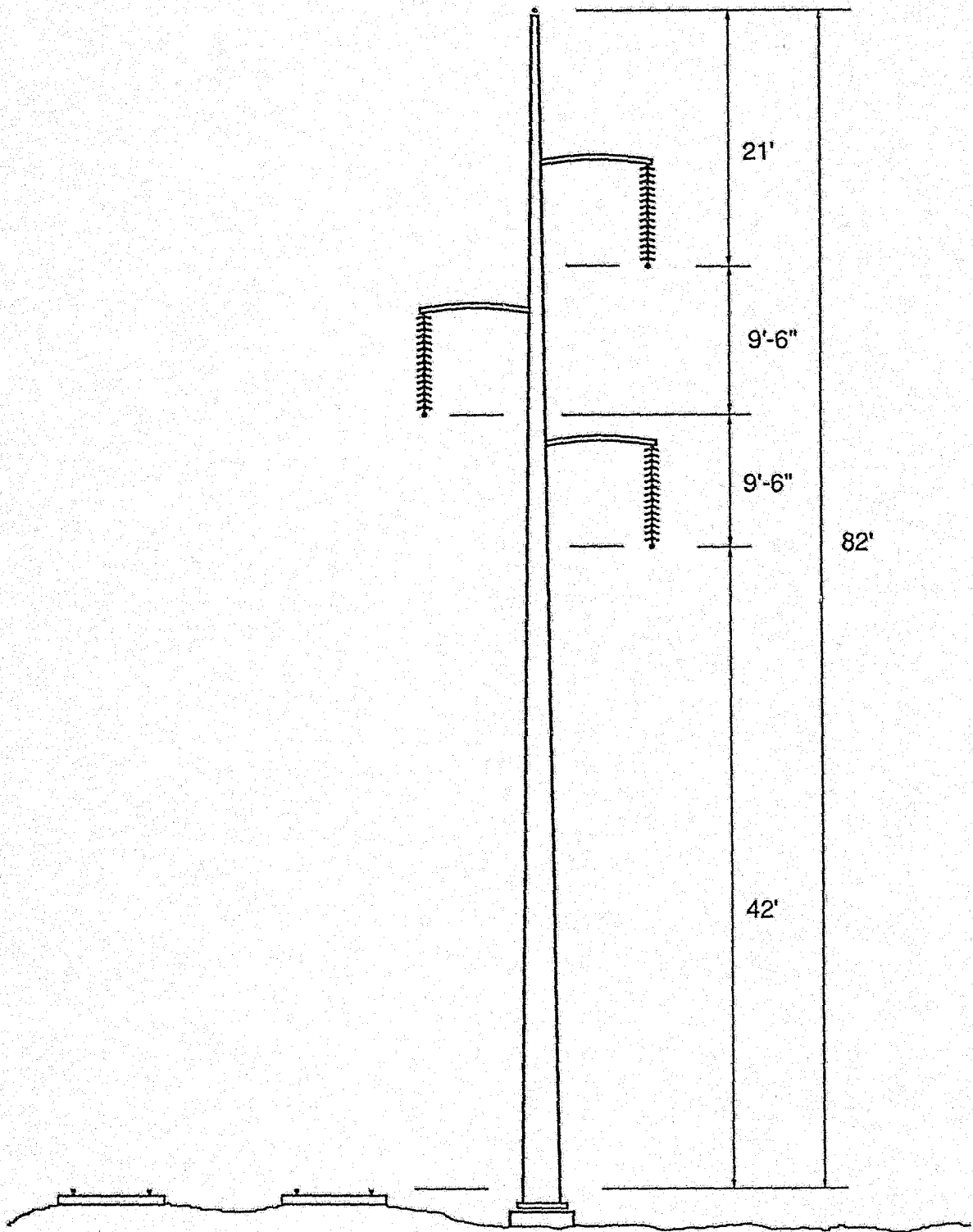




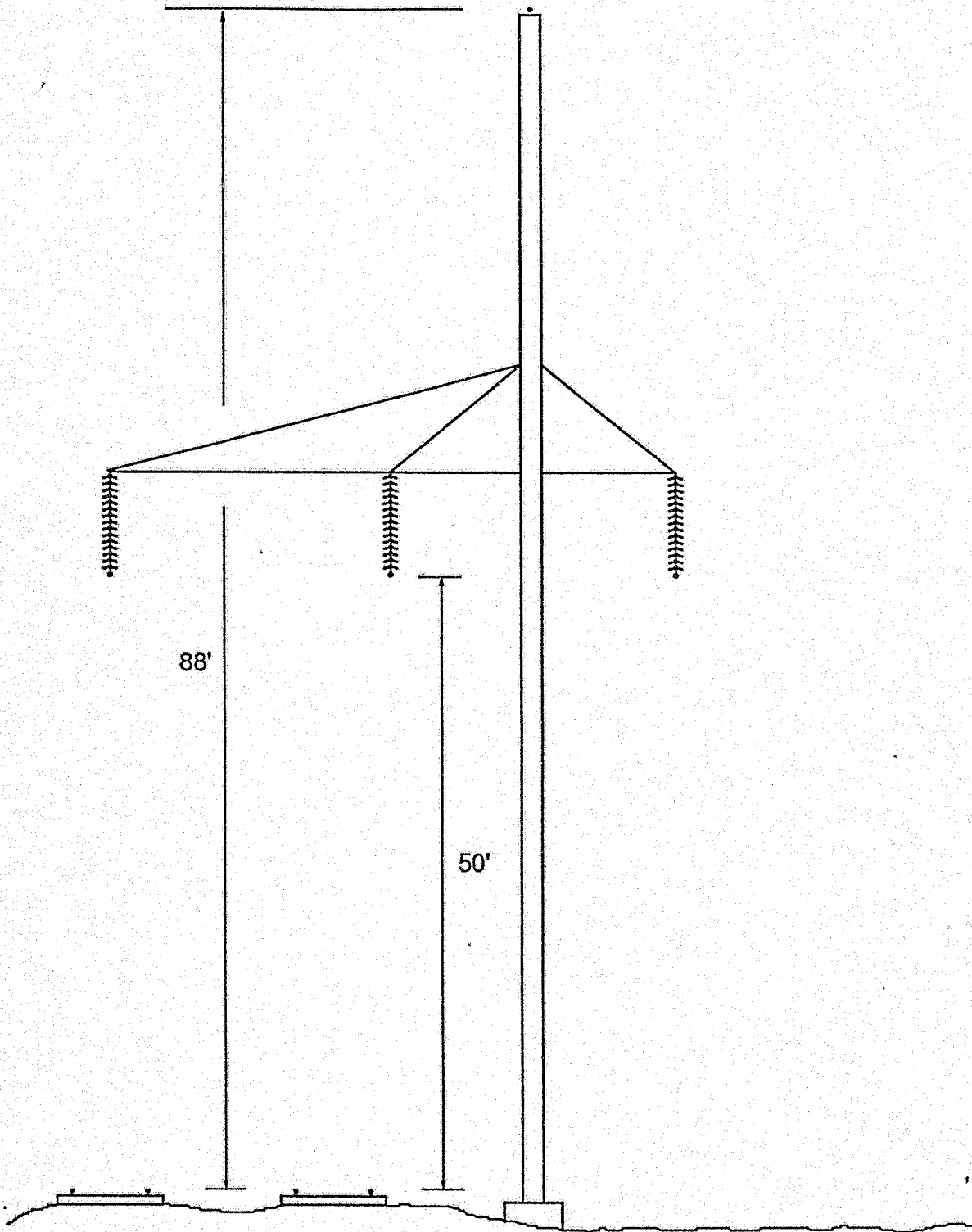




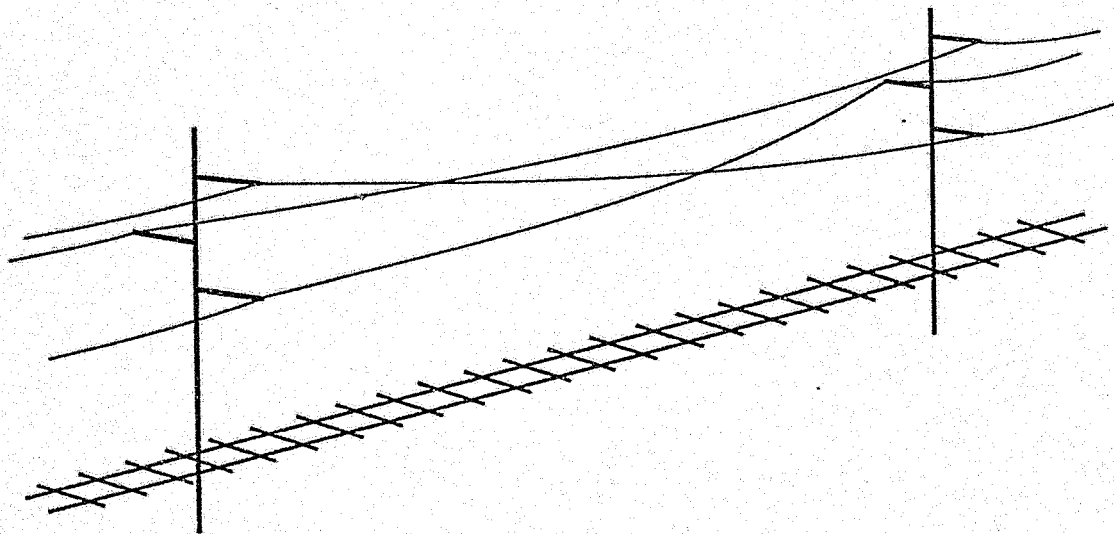
**600' SPAN VERTICAL
Woodbourne - Heaton 230kV Line
Alternative Design**



600' SPAN DELTA
Woodbourne - Heaton 230kV Line
Alternative Design



**600' SPAN HORIZONTAL
Woodbourne - Heaton 230kV Line
Alternative Design**



Woodbourne - Heaton 230kV Line
Typical Phase Roll

PECO EXHIBIT NO. 2

A-170550, F, USS

8/15/91 Plub, PJ
ajs

DOCKETED
AUG 8 1991

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

RECEIVED

AUG 26 1991

DOCUMENT
FOUNDER

EXHIBIT
OF
CHARLES J. BOEGGEMAN
ON BEHALF
OF
PHILADELPHIA ELECTRIC COMPANY

SECRETARY'S OFFICE
Public Utility Commission

AUGUST 1991

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TABLE 1

ELECTRIC FIELD - COMPACT DELTA

| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | COLUMN 1 E-FIELD 12' PHASE SPACING DELTA (kV/m) |
|---|--|
| -300 | 0.013 |
| -295 | 0.014 |
| -290 | 0.014 |
| -285 | 0.015 |
| -280 | 0.015 |
| -275 | 0.016 |
| -270 | 0.017 |
| -265 | 0.017 |
| -260 | 0.018 |
| -255 | 0.019 |
| -250 | 0.020 |
| -245 | 0.021 |
| -240 | 0.021 |
| -235 | 0.023 |
| -230 | 0.024 |
| -225 | 0.025 |
| -220 | 0.026 |
| -215 | 0.028 |
| -210 | 0.029 |
| -205 | 0.031 |
| -200 | 0.033 |
| -195 | 0.034 |
| -190 | 0.037 |
| -185 | 0.039 |
| -180 | 0.041 |
| -175 | 0.044 |
| -170 | 0.047 |
| -165 | 0.051 |
| -160 | 0.055 |
| -155 | 0.059 |
| -150 | 0.064 |
| -145 | 0.069 |
| -140 | 0.075 |

TABLE 1

ELECTRIC FIELD - COMPACT DELTA

| | COLUMN 1 |
|---------------|-----------|
| LATERAL | E-FIELD |
| DISTANCE | 12' PHASE |
| FROM | SPACING |
| CENTER LINE | DELTA |
| R.O.W. (FEET) | (kV/m) |
| -135 | 0.082 |
| -130 | 0.089 |
| -125 | 0.098 |
| -120 | 0.108 |
| -115 | 0.120 |
| -110 | 0.133 |
| -105 | 0.148 |
| -100 | 0.166 |
| -95 | 0.187 |
| -90 | 0.212 |
| -85 | 0.241 |
| -80 | 0.275 |
| -75 | 0.317 |
| -70 | 0.366 |
| -65 | 0.425 |
| -60 | 0.496 |
| -55 | 0.581 |
| -50 | 0.681 |
| -45 | 0.798 |
| -40 | 0.929 |
| -35 | 1.070 |
| -30 | 1.209 |
| -25 | 1.322 |
| -20 | 1.384 |
| -15 | 1.372 |
| -10 | 1.308 |
| -5 | 1.301 |
| 0 | 1.468 |
| 5 | 1.718 |
| 10 | 1.873 |
| 15 | 1.851 |
| 20 | 1.679 |
| 25 | 1.436 |

TABLE 1

ELECTRIC FIELD - COMPACT DELTA

| | COLUMN 1 |
|---|--|
| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | E-FIELD 12° PHASE SPACING DELTA (kV/m) |
| 30 | 1.187 |
| 35 | 0.970 |
| 40 | 0.794 |
| 45 | 0.655 |
| 50 | 0.547 |
| 55 | 0.462 |
| 60 | 0.394 |
| 65 | 0.340 |
| 70 | 0.295 |
| 75 | 0.257 |
| 80 | 0.226 |
| 85 | 0.200 |
| 90 | 0.178 |
| 95 | 0.159 |
| 100 | 0.143 |
| 105 | 0.129 |
| 110 | 0.116 |
| 115 | 0.106 |
| 120 | 0.096 |
| 125 | 0.088 |
| 130 | 0.081 |
| 135 | 0.074 |
| 140 | 0.069 |
| 145 | 0.064 |
| 150 | 0.059 |
| 155 | 0.055 |
| 160 | 0.051 |
| 165 | 0.048 |
| 170 | 0.045 |
| 175 | 0.042 |
| 180 | 0.039 |
| 185 | 0.037 |
| 190 | 0.035 |

TABLE 1

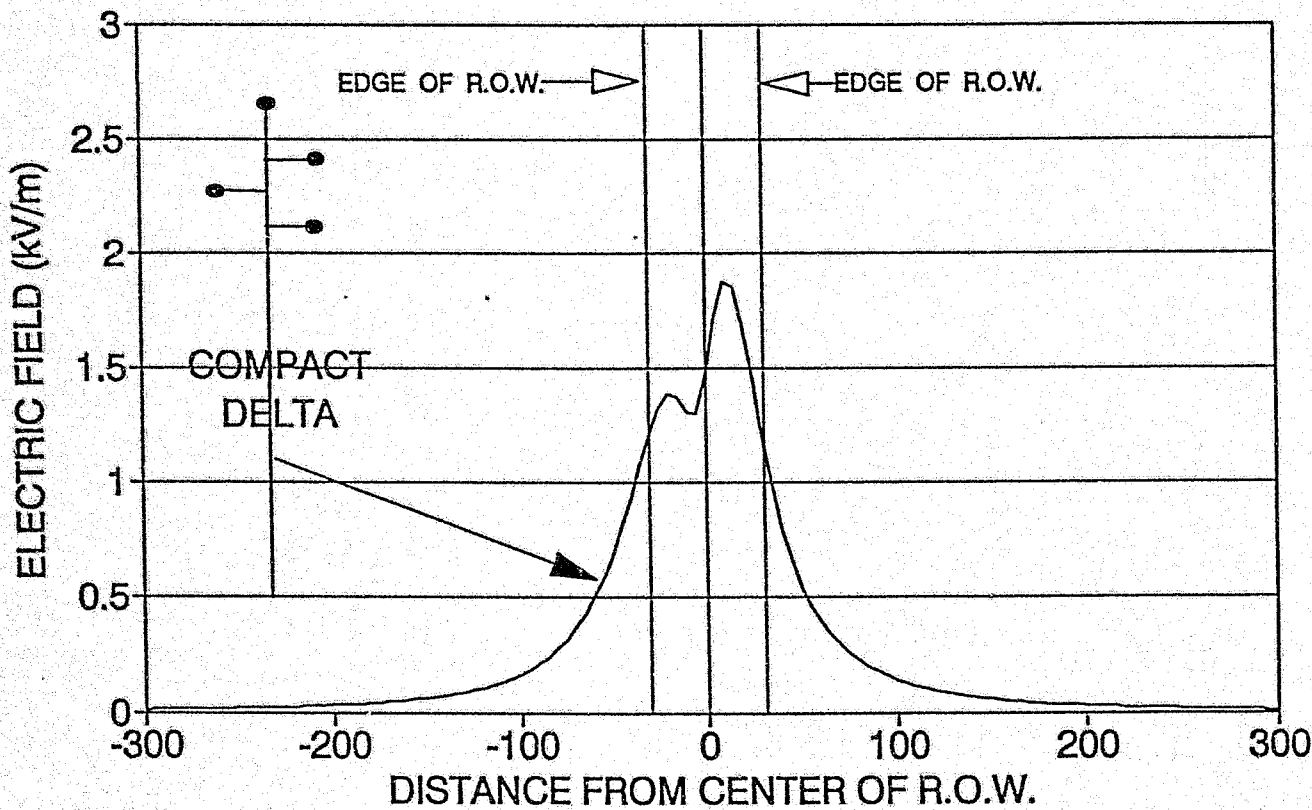
ELECTRIC FIELD - COMPACT DELTA

| | COLUMN 1 |
|---------------|-----------|
| LATERAL | E-FIELD |
| DISTANCE | 12' PHASE |
| FROM | SPACING |
| CENTER LINE | DELTA |
| R.O.W. (FEET) | (kV/m) |
| 195 | 0.033 |
| 200 | 0.031 |
| 205 | 0.030 |
| 210 | 0.028 |
| 215 | 0.027 |
| 220 | 0.025 |
| 225 | 0.024 |
| 230 | 0.023 |
| 235 | 0.022 |
| 240 | 0.021 |
| 245 | 0.020 |
| 250 | 0.019 |
| 255 | 0.018 |
| 260 | 0.018 |
| 265 | 0.017 |
| 270 | 0.016 |
| 275 | 0.016 |
| 280 | 0.015 |
| 285 | 0.014 |
| 290 | 0.014 |
| 295 | 0.013 |
| 300 | 0.013 |

ELECTRIC FIELD STUDY

COMPACT DELTA

FIGURE 1-1



SEE TABLE 1

TABLE 2 - MAGNETIC FIELDS AT VARIOUS LOADS (COMPACT DELTA)

| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 | COLUMN 5 |
|---|--|--|--|--|---|
| | B-FIELD 12' PHASE SPACING DELTA 0 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 180 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 360 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 600 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 1000 AMPS (milligauss) |
| -300 | 0.00 | 0.21 | 0.43 | 0.71 | 1.19 |
| -295 | 0.00 | 0.22 | 0.44 | 0.74 | 1.24 |
| -290 | 0.00 | 0.23 | 0.46 | 0.76 | 1.27 |
| -285 | 0.00 | 0.24 | 0.47 | 0.79 | 1.32 |
| -280 | 0.00 | 0.25 | 0.49 | 0.82 | 1.37 |
| -275 | 0.00 | 0.26 | 0.51 | 0.85 | 1.42 |
| -270 | 0.00 | 0.26 | 0.53 | 0.88 | 1.47 |
| -265 | 0.00 | 0.28 | 0.55 | 0.92 | 1.54 |
| -260 | 0.00 | 0.29 | 0.57 | 0.95 | 1.59 |
| -255 | 0.00 | 0.30 | 0.59 | 0.99 | 1.65 |
| -250 | 0.00 | 0.31 | 0.62 | 1.03 | 1.72 |
| -245 | 0.00 | 0.32 | 0.64 | 1.07 | 1.79 |
| -240 | 0.00 | 0.34 | 0.67 | 1.12 | 1.87 |
| -235 | 0.00 | 0.35 | 0.70 | 1.17 | 1.95 |
| -230 | 0.00 | 0.37 | 0.73 | 1.22 | 2.04 |
| -225 | 0.00 | 0.38 | 0.77 | 1.28 | 2.14 |
| -220 | 0.00 | 0.40 | 0.80 | 1.34 | 2.24 |
| -215 | 0.00 | 0.42 | 0.84 | 1.40 | 2.34 |
| -210 | 0.00 | 0.44 | 0.88 | 1.47 | 2.45 |
| -205 | 0.00 | 0.46 | 0.92 | 1.54 | 2.57 |
| -200 | 0.00 | 0.49 | 0.97 | 1.62 | 2.71 |
| -195 | 0.00 | 0.51 | 1.02 | 1.70 | 2.84 |
| -190 | 0.00 | 0.54 | 1.08 | 1.80 | 3.01 |
| -185 | 0.00 | 0.57 | 1.13 | 1.89 | 3.16 |
| -180 | 0.00 | 0.60 | 1.20 | 2.00 | 3.34 |
| -175 | 0.00 | 0.64 | 1.27 | 2.12 | 3.54 |
| -170 | 0.00 | 0.67 | 1.34 | 2.24 | 3.74 |
| -165 | 0.00 | 0.71 | 1.43 | 2.38 | 3.97 |
| -160 | 0.00 | 0.76 | 1.52 | 2.53 | 4.23 |
| -155 | 0.00 | 0.81 | 1.62 | 2.70 | 4.51 |
| -150 | 0.00 | 0.86 | 1.73 | 2.88 | 4.81 |
| -145 | 0.00 | 0.92 | 1.84 | 3.07 | 5.13 |
| -140 | 0.00 | 0.99 | 1.97 | 3.29 | 5.49 |

TABLE 2 - MAGNETIC FIELDS AT VARIOUS LOADS (COMPACT DELTA)

| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 | COLUMN 5 |
|---|--|--|--|--|---|
| | B-FIELD 12' PHASE SPACING DELTA 0 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 180 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 360 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 600 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 1000 AMPS (milligauss) |
| -135 | 0.00 | 1.06 | 2.12 | 3.54 | 5.91 |
| -130 | 0.00 | 1.14 | 2.28 | 3.80 | 6.35 |
| -125 | 0.00 | 1.23 | 2.46 | 4.10 | 6.85 |
| -120 | 0.00 | 1.33 | 2.66 | 4.44 | 7.41 |
| -115 | 0.00 | 1.44 | 2.89 | 4.81 | 8.03 |
| -110 | 0.00 | 1.57 | 3.14 | 5.24 | 8.75 |
| -105 | 0.00 | 1.72 | 3.43 | 5.72 | 9.55 |
| -100 | 0.00 | 1.88 | 3.76 | 6.26 | 10.45 |
| -95 | 0.00 | 2.06 | 4.13 | 6.88 | 11.49 |
| -90 | 0.00 | 2.28 | 4.55 | 7.59 | 12.68 |
| -85 | 0.00 | 2.52 | 5.05 | 8.41 | 14.04 |
| -80 | 0.00 | 2.81 | 5.62 | 9.36 | 15.63 |
| -75 | 0.00 | 3.14 | 6.28 | 10.47 | 17.48 |
| -70 | 0.00 | 3.53 | 7.06 | 11.77 | 19.66 |
| -65 | 0.00 | 3.99 | 7.98 | 13.30 | 22.21 |
| -60 | 0.00 | 4.53 | 9.07 | 15.11 | 25.23 |
| -55 | 0.00 | 5.18 | 10.36 | 17.27 | 28.84 |
| -50 | 0.00 | 5.96 | 11.92 | 19.86 | 33.17 |
| -45 | 0.00 | 6.89 | 13.77 | 22.95 | 38.33 |
| -40 | 0.00 | 8.00 | 15.99 | 26.65 | 44.51 |
| -35 | 0.00 | 9.32 | 18.63 | 31.05 | 51.85 |
| -30 | 0.00 | 10.86 | 21.73 | 36.21 | 60.47 |
| -25 | 0.00 | 12.63 | 25.27 | 42.11 | 70.32 |
| -20 | 0.00 | 14.58 | 29.15 | 48.59 | 81.15 |
| -15 | 0.00 | 16.59 | 33.18 | 55.30 | 92.35 |
| -10 | 0.00 | 18.48 | 36.97 | 61.61 | 102.89 |
| -5 | 0.00 | 20.02 | 40.03 | 66.72 | 111.42 |
| 0 | 0.00 | 20.93 | 41.86 | 69.76 | 116.50 |
| 5 | 0.00 | 21.02 | 42.04 | 70.06 | 117.00 |
| 10 | 0.00 | 20.23 | 40.45 | 67.42 | 112.59 |
| 15 | 0.00 | 18.70 | 37.40 | 62.33 | 104.09 |
| 20 | 0.00 | 16.74 | 33.47 | 55.79 | 93.17 |
| 25 | 0.00 | 14.65 | 29.30 | 48.84 | 81.56 |

TABLE 2 - MAGNETIC FIELDS AT VARIOUS LOADS (COMPACT DELTA)

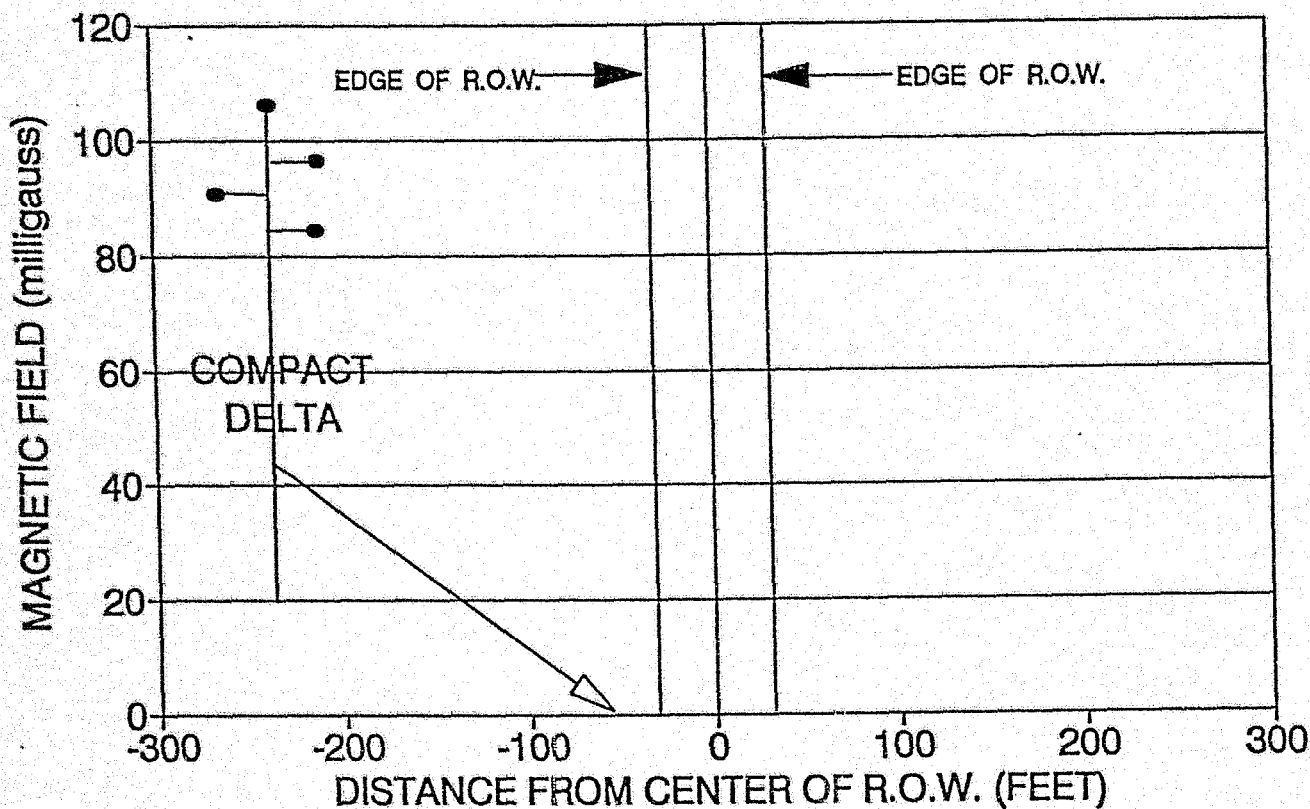
| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 | COLUMN 5 |
|---|--|--|--|--|---|
| | B-FIELD 12' PHASE SPACING DELTA 0 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 180 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 360 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 600 AMPS (milligauss) | B-FIELD 12' PHASE SPACING DELTA 1000 AMPS (milligauss) |
| 30 | 0.00 | 12.66 | 25.33 | 42.21 | 70.49 |
| 35 | 0.00 | 10.89 | 21.78 | 36.30 | 60.62 |
| 40 | 0.00 | 9.36 | 18.72 | 31.20 | 52.10 |
| 45 | 0.00 | 8.07 | 16.14 | 26.90 | 44.92 |
| 50 | 0.00 | 6.99 | 13.98 | 23.30 | 38.91 |
| 55 | 0.00 | 6.09 | 12.18 | 20.30 | 33.90 |
| 60 | 0.00 | 5.34 | 10.67 | 17.79 | 29.71 |
| 65 | 0.00 | 4.71 | 9.41 | 15.69 | 26.20 |
| 70 | 0.00 | 4.17 | 8.35 | 13.91 | 23.23 |
| 75 | 0.00 | 3.72 | 7.45 | 12.41 | 20.72 |
| 80 | 0.00 | 3.34 | 6.68 | 11.13 | 18.59 |
| 85 | 0.00 | 3.01 | 6.02 | 10.03 | 16.75 |
| 90 | 0.00 | 2.72 | 5.45 | 9.08 | 15.16 |
| 95 | 0.00 | 2.48 | 4.96 | 8.26 | 13.79 |
| 100 | 0.00 | 2.26 | 4.52 | 7.54 | 12.59 |
| 105 | 0.00 | 2.08 | 4.15 | 6.92 | 11.56 |
| 110 | 0.00 | 1.91 | 3.82 | 6.36 | 10.62 |
| 115 | 0.00 | 1.76 | 3.52 | 5.87 | 9.80 |
| 120 | 0.00 | 1.63 | 3.26 | 5.44 | 9.08 |
| 125 | 0.00 | 1.52 | 3.03 | 5.05 | 8.43 |
| 130 | 0.00 | 1.41 | 2.82 | 4.70 | 7.85 |
| 135 | 0.00 | 1.32 | 2.63 | 4.39 | 7.33 |
| 140 | 0.00 | 1.23 | 2.47 | 4.11 | 6.86 |
| 145 | 0.00 | 1.16 | 2.31 | 3.85 | 6.43 |
| 150 | 0.00 | 1.09 | 2.17 | 3.62 | 6.05 |
| 155 | 0.00 | 1.02 | 2.05 | 3.41 | 5.69 |
| 160 | 0.00 | 0.97 | 1.93 | 3.22 | 5.38 |
| 165 | 0.00 | 0.91 | 1.82 | 3.04 | 5.08 |
| 170 | 0.00 | 0.86 | 1.73 | 2.88 | 4.81 |
| 175 | 0.00 | 0.82 | 1.64 | 2.73 | 4.56 |
| 180 | 0.00 | 0.78 | 1.55 | 2.59 | 4.33 |
| 185 | 0.00 | 0.74 | 1.48 | 2.46 | 4.11 |
| 190 | 0.00 | 0.71 | 1.41 | 2.35 | 3.92 |

TABLE 2 - MAGNETIC FIELDS AT VARIOUS LOADS (COMPACT DELTA)

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 | COLUMN 5 |
|---------------|--------------|--------------|--------------|--------------|--------------|
| | B-FIELD | B-FIELD | B-FIELD | B-FIELD | B-FIELD |
| LATERAL | 12' PHASE | 12' PHASE | 12' PHASE | 12' PHASE | 12' PHASE |
| DISTANCE | SPACING | SPACING | SPACING | SPACING | SPACING |
| FROM | DELTA | DELTA | DELTA | DELTA | DELTA |
| CENTER LINE | 0 AMPS | 180 AMPS | 360 AMPS | 600 AMPS | 1000 AMPS |
| R.O.W. (FEET) | (milligauss) | (milligauss) | (milligauss) | (milligauss) | (milligauss) |
| 195 | 0.00 | 0.67 | 1.34 | 2.24 | 3.74 |
| 200 | 0.00 | 0.64 | 1.28 | 2.14 | 3.57 |
| 205 | 0.00 | 0.61 | 1.22 | 2.04 | 3.41 |
| 210 | 0.00 | 0.59 | 1.17 | 1.95 | 3.26 |
| 215 | 0.00 | 0.56 | 1.12 | 1.87 | 3.12 |
| 220 | 0.00 | 0.54 | 1.08 | 1.80 | 3.01 |
| 225 | 0.00 | 0.52 | 1.03 | 1.72 | 2.87 |
| 230 | 0.00 | 0.50 | 1.00 | 1.66 | 2.77 |
| 235 | 0.00 | 0.48 | 0.95 | 1.59 | 2.66 |
| 240 | 0.00 | 0.46 | 0.92 | 1.53 | 2.56 |
| 245 | 0.00 | 0.44 | 0.89 | 1.48 | 2.47 |
| 250 | 0.00 | 0.43 | 0.85 | 1.42 | 2.37 |
| 255 | 0.00 | 0.41 | 0.82 | 1.37 | 2.29 |
| 260 | 0.00 | 0.40 | 0.80 | 1.33 | 2.22 |
| 265 | 0.00 | 0.38 | 0.77 | 1.28 | 2.14 |
| 270 | 0.00 | 0.37 | 0.74 | 1.24 | 2.07 |
| 275 | 0.00 | 0.36 | 0.72 | 1.20 | 2.00 |
| 280 | 0.00 | 0.35 | 0.70 | 1.16 | 1.94 |
| 285 | 0.00 | 0.34 | 0.67 | 1.12 | 1.87 |
| 290 | 0.00 | 0.33 | 0.65 | 1.09 | 1.82 |
| 295 | 0.00 | 0.32 | 0.64 | 1.06 | 1.77 |
| 300 | 0.00 | 0.31 | 0.62 | 1.03 | 1.72 |

FIGURE 1-2

MAGNETIC FIELD STUDY COMPACT DELTA



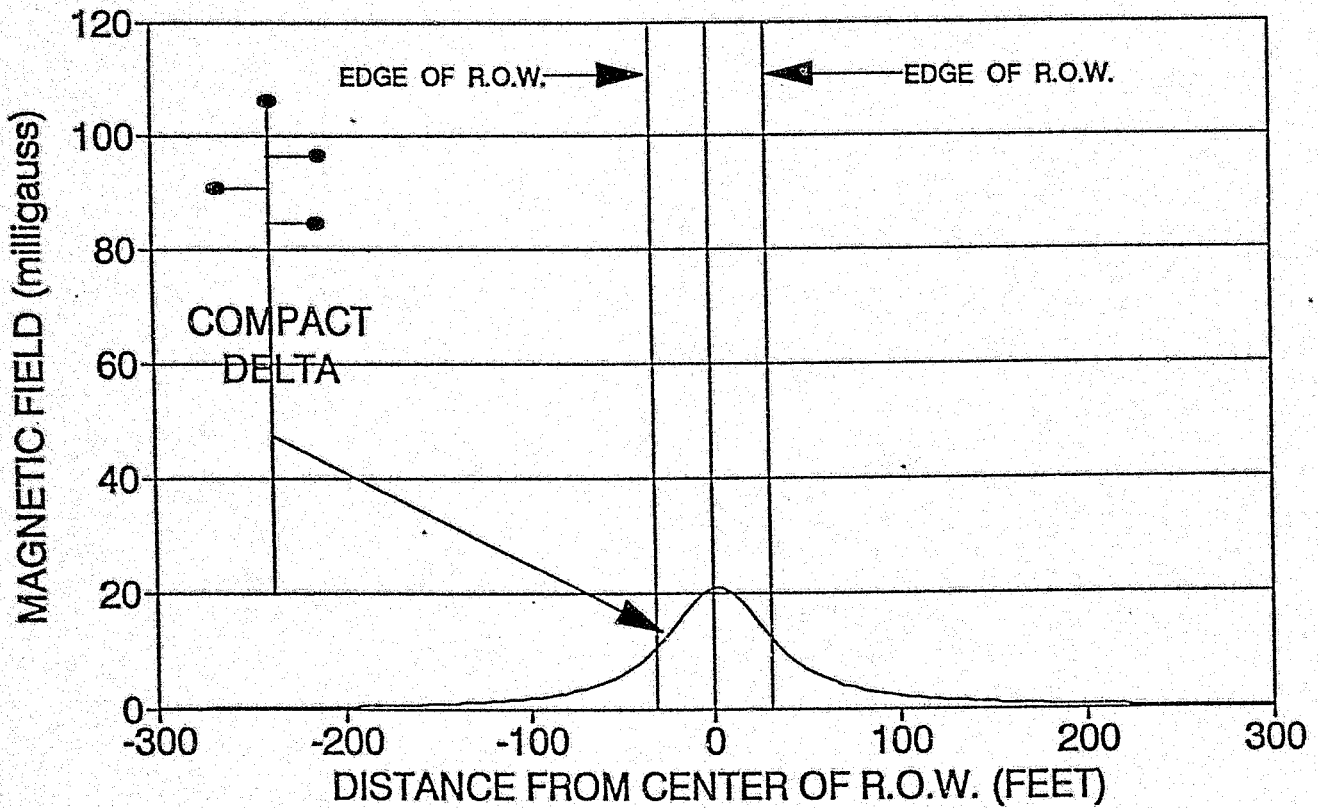
LOAD = 0 AMPERES

SEE TABLE 2 COLUMN 1

MAGNETIC FIELD STUDY

COMPACT DELTA

FIGURE 2-2

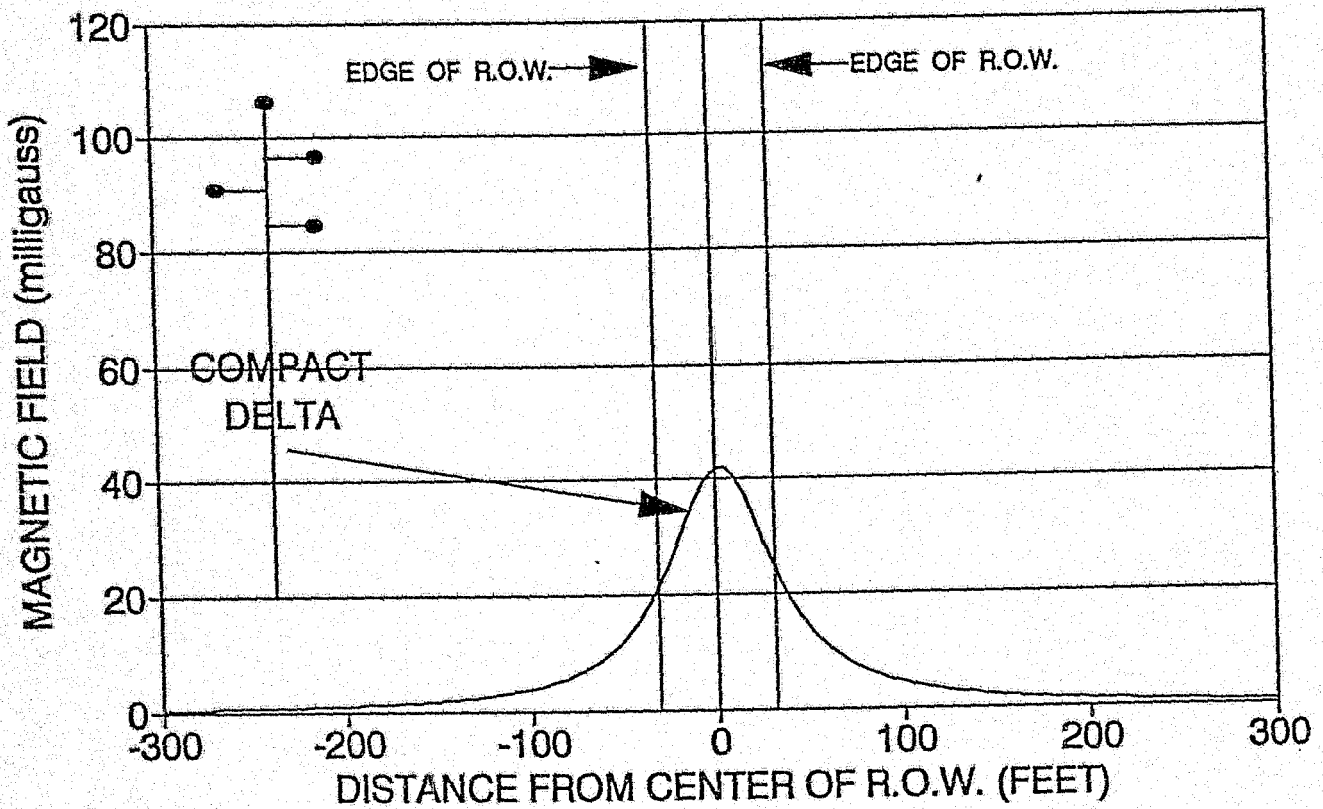


LOAD = 180 AMPERES

SEE TABLE 2 COLUMN 2

FIGURE 3-2

MAGNETIC FIELD STUDY COMPACT DELTA



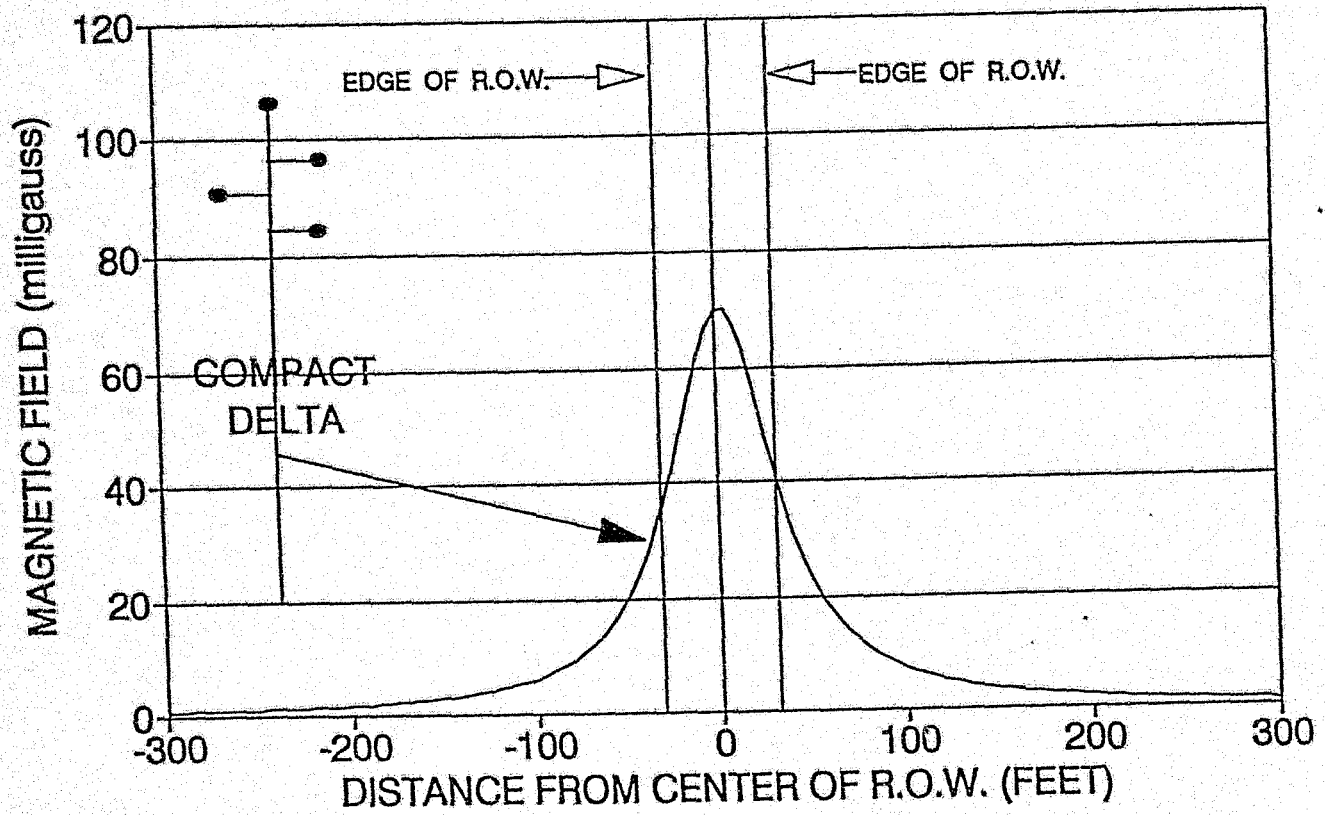
LOAD = 360 AMPERES

SEE TABLE 2 COLUMN 3

FIGURE 4-2

MAGNETIC FIELD STUDY

COMPACT DELTA

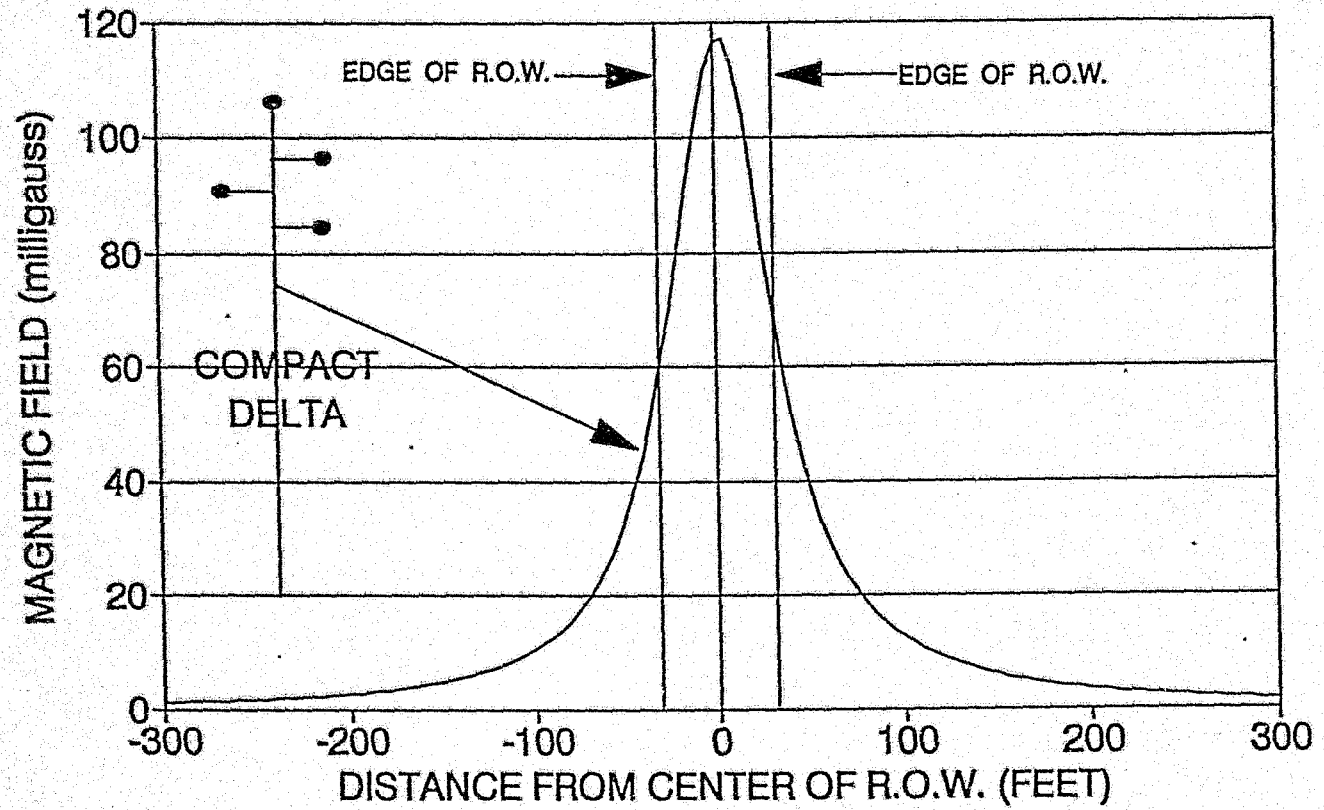


LOAD = 600 AMPERES

SEE TABLE 2 COLUMN 4

FIGURE 5-2

MAGNETIC FIELD STUDY COMPACT DELTA

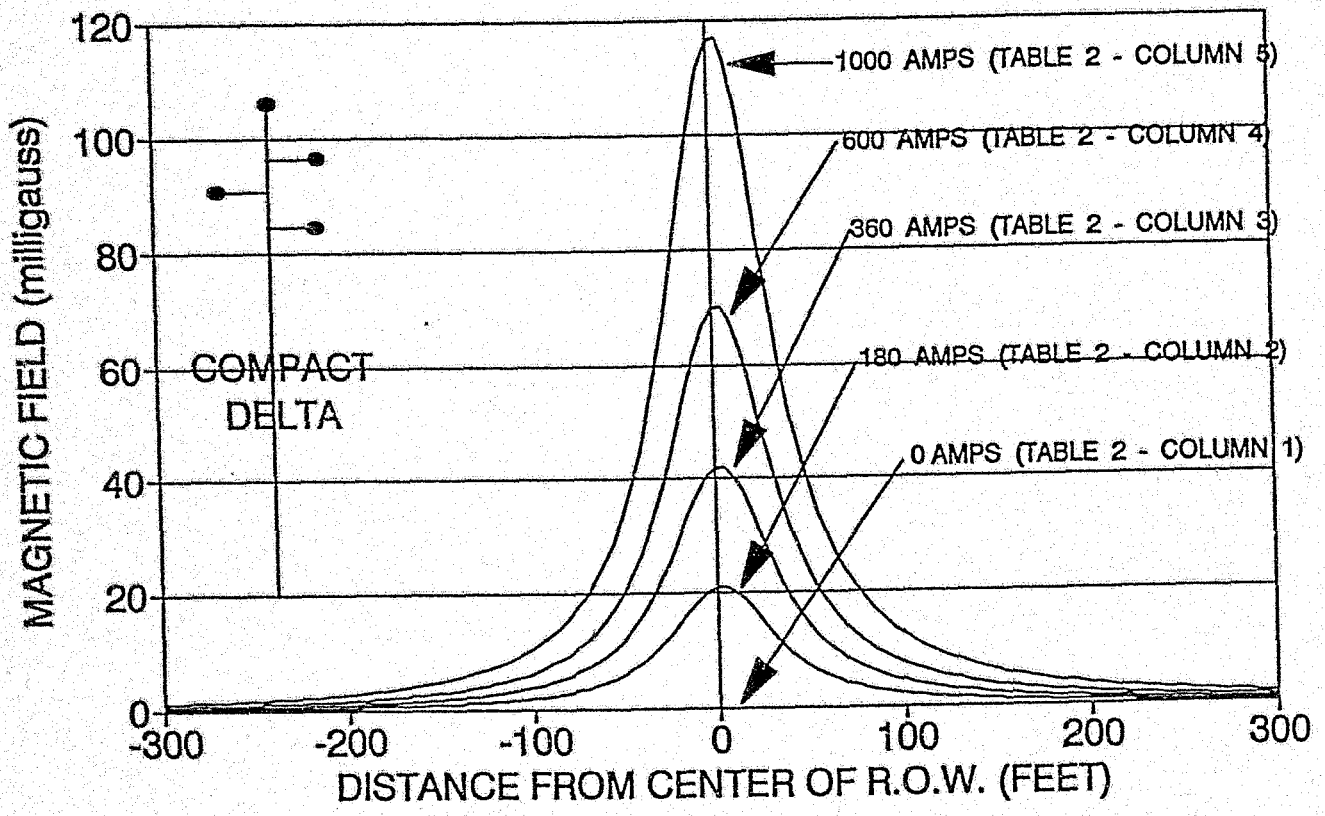


LOAD = 1000 AMPERES

SEE TABLE 2 COLUMN 5

FIGURE 6-2

MAGNETIC FIELD STUDY COMPACT DELTA



SEE TABLE 2

TABLE 3 - ELECTRIC FIELD COMPARISONS

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 |
|---|--|--|---|---|
| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | E-FIELD 12' PHASE SPACING DELTA (kV/m) | E-FIELD 19' PHASE SPACING DELTA (KV/m) | E-FIELD 15' PHASE SPACING FLAT (kV/m) | E-FIELD 19' PHASE SPACING VERTICAL (kV/m) |
| -300 | 0.013 | 0.018 | 0.012 | 0.027 |
| -295 | 0.014 | 0.019 | 0.012 | 0.028 |
| -290 | 0.014 | 0.020 | 0.013 | 0.029 |
| -285 | 0.015 | 0.020 | 0.014 | 0.030 |
| -280 | 0.015 | 0.021 | 0.015 | 0.031 |
| -275 | 0.016 | 0.022 | 0.015 | 0.032 |
| -270 | 0.017 | 0.023 | 0.016 | 0.033 |
| -265 | 0.017 | 0.024 | 0.017 | 0.034 |
| -260 | 0.018 | 0.025 | 0.018 | 0.035 |
| -255 | 0.019 | 0.026 | 0.019 | 0.036 |
| -250 | 0.020 | 0.027 | 0.020 | 0.037 |
| -245 | 0.021 | 0.028 | 0.021 | 0.039 |
| -240 | 0.021 | 0.029 | 0.023 | 0.040 |
| -235 | 0.023 | 0.031 | 0.024 | 0.042 |
| -230 | 0.024 | 0.032 | 0.026 | 0.043 |
| -225 | 0.025 | 0.034 | 0.027 | 0.045 |
| -220 | 0.026 | 0.036 | 0.029 | 0.046 |
| -215 | 0.028 | 0.037 | 0.031 | 0.048 |
| -210 | 0.029 | 0.039 | 0.033 | 0.050 |
| -205 | 0.031 | 0.042 | 0.036 | 0.051 |
| -200 | 0.033 | 0.044 | 0.038 | 0.053 |
| -195 | 0.034 | 0.047 | 0.041 | 0.055 |
| -190 | 0.037 | 0.049 | 0.044 | 0.057 |
| -185 | 0.039 | 0.052 | 0.048 | 0.060 |
| -180 | 0.041 | 0.056 | 0.052 | 0.062 |
| -175 | 0.044 | 0.060 | 0.056 | 0.064 |
| -170 | 0.047 | 0.064 | 0.061 | 0.067 |
| -165 | 0.051 | 0.068 | 0.066 | 0.069 |
| -160 | 0.055 | 0.073 | 0.073 | 0.072 |
| -155 | 0.059 | 0.079 | 0.079 | 0.074 |
| -150 | 0.064 | 0.085 | 0.087 | 0.077 |
| -145 | 0.069 | 0.092 | 0.096 | 0.079 |
| -140 | 0.075 | 0.100 | 0.106 | 0.082 |
| -135 | 0.082 | 0.109 | 0.117 | 0.085 |

TABLE 3 - ELECTRIC FIELD COMPARISONS

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 |
|---------------|-----------|-----------|-----------|-----------|
| LATERAL | E-FIELD | E-FIELD | E-FIELD | E-FIELD |
| DISTANCE | 12' PHASE | 19' PHASE | 15' PHASE | 19' PHASE |
| FROM | SPACING | SPACING | SPACING | SPACING |
| CENTER LINE | DELTA | DELTA | FLAT | VERTICAL |
| R.O.W. (FEET) | (kV/m) | (KV/m) | (kV/m) | (kV/m) |
| -130 | 0.089 | 0.119 | 0.130 | 0.087 |
| -125 | 0.098 | 0.130 | 0.145 | 0.089 |
| -120 | 0.108 | 0.143 | 0.162 | 0.091 |
| -115 | 0.120 | 0.158 | 0.181 | 0.092 |
| -110 | 0.133 | 0.176 | 0.204 | 0.092 |
| -105 | 0.148 | 0.196 | 0.231 | 0.092 |
| -100 | 0.166 | 0.219 | 0.263 | 0.090 |
| -95 | 0.187 | 0.247 | 0.300 | 0.087 |
| -90 | 0.212 | 0.279 | 0.344 | 0.081 |
| -85 | 0.241 | 0.317 | 0.396 | 0.073 |
| -80 | 0.275 | 0.362 | 0.459 | 0.061 |
| -75 | 0.317 | 0.415 | 0.534 | 0.045 |
| -70 | 0.366 | 0.478 | 0.623 | 0.027 |
| -65 | 0.425 | 0.554 | 0.729 | 0.035 |
| -60 | 0.496 | 0.643 | 0.855 | 0.077 |
| -55 | 0.581 | 0.748 | 1.003 | 0.137 |
| -50 | 0.681 | 0.870 | 1.171 | 0.217 |
| -45 | 0.798 | 1.008 | 1.354 | 0.322 |
| -40 | 0.929 | 1.159 | 1.541 | 0.457 |
| -35 | 1.070 | 1.312 | 1.709 | 0.627 |
| -30 | 1.209 | 1.449 | 1.822 | 0.836 |
| -25 | 1.322 | 1.543 | 1.842 | 1.082 |
| -20 | 1.384 | 1.565 | 1.739 | 1.357 |
| -15 | 1.372 | 1.500 | 1.511 | 1.639 |
| -10 | 1.308 | 1.403 | 1.197 | 1.893 |
| -5 | 1.301 | 1.453 | 0.870 | 2.073 |
| 0 | 1.468 | 1.796 | 0.687 | 2.139 |
| 5 | 1.718 | 2.258 | 0.909 | 2.074 |
| 10 | 1.873 | 2.591 | 1.296 | 1.895 |
| 15 | 1.851 | 2.653 | 1.663 | 1.642 |
| 20 | 1.679 | 2.451 | 1.921 | 1.361 |
| 25 | 1.436 | 2.094 | 2.031 | 1.087 |
| 30 | 1.187 | 1.706 | 2.000 | 0.841 |
| 35 | 0.970 | 1.360 | 1.868 | 0.633 |

TABLE 3 - ELECTRIC FIELD COMPARISONS

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 |
|---|--|--|---|---|
| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | E-FIELD 12' PHASE SPACING DELTA (kV/m) | E-FIELD 19' PHASE SPACING DELTA (kV/m) | E-FIELD 15' PHASE SPACING FLAT (kV/m) | E-FIELD 19' PHASE SPACING VERTICAL (kV/m) |
| 40 | 0.794 | 1.085 | 1.679 | 0.464 |
| 45 | 0.655 | 0.877 | 1.472 | 0.329 |
| 50 | 0.547 | 0.723 | 1.271 | 0.224 |
| 55 | 0.462 | 0.608 | 1.087 | 0.144 |
| 60 | 0.394 | 0.520 | 0.927 | 0.084 |
| 65 | 0.340 | 0.452 | 0.790 | 0.041 |
| 70 | 0.295 | 0.396 | 0.675 | 0.023 |
| 75 | 0.257 | 0.350 | 0.578 | 0.039 |
| 80 | 0.226 | 0.312 | 0.497 | 0.055 |
| 85 | 0.200 | 0.279 | 0.430 | 0.067 |
| 90 | 0.178 | 0.251 | 0.373 | 0.076 |
| 95 | 0.159 | 0.226 | 0.325 | 0.081 |
| 100 | 0.143 | 0.205 | 0.285 | 0.085 |
| 105 | 0.129 | 0.186 | 0.251 | 0.087 |
| 110 | 0.116 | 0.170 | 0.222 | 0.088 |
| 115 | 0.106 | 0.155 | 0.197 | 0.088 |
| 120 | 0.096 | 0.143 | 0.175 | 0.087 |
| 125 | 0.088 | 0.131 | 0.157 | 0.085 |
| 130 | 0.081 | 0.121 | 0.141 | 0.083 |
| 135 | 0.074 | 0.112 | 0.127 | 0.081 |
| 140 | 0.069 | 0.104 | 0.115 | 0.079 |
| 145 | 0.064 | 0.096 | 0.104 | 0.076 |
| 150 | 0.059 | 0.090 | 0.095 | 0.074 |
| 155 | 0.055 | 0.084 | 0.086 | 0.071 |
| 160 | 0.051 | 0.078 | 0.079 | 0.069 |
| 165 | 0.048 | 0.073 | 0.072 | 0.067 |
| 170 | 0.045 | 0.069 | 0.067 | 0.064 |
| 175 | 0.042 | 0.064 | 0.061 | 0.062 |
| 180 | 0.039 | 0.061 | 0.057 | 0.060 |
| 185 | 0.037 | 0.057 | 0.052 | 0.058 |
| 190 | 0.035 | 0.054 | 0.049 | 0.056 |
| 195 | 0.033 | 0.051 | 0.045 | 0.054 |
| 200 | 0.031 | 0.048 | 0.042 | 0.052 |
| 205 | 0.030 | 0.046 | 0.039 | 0.050 |

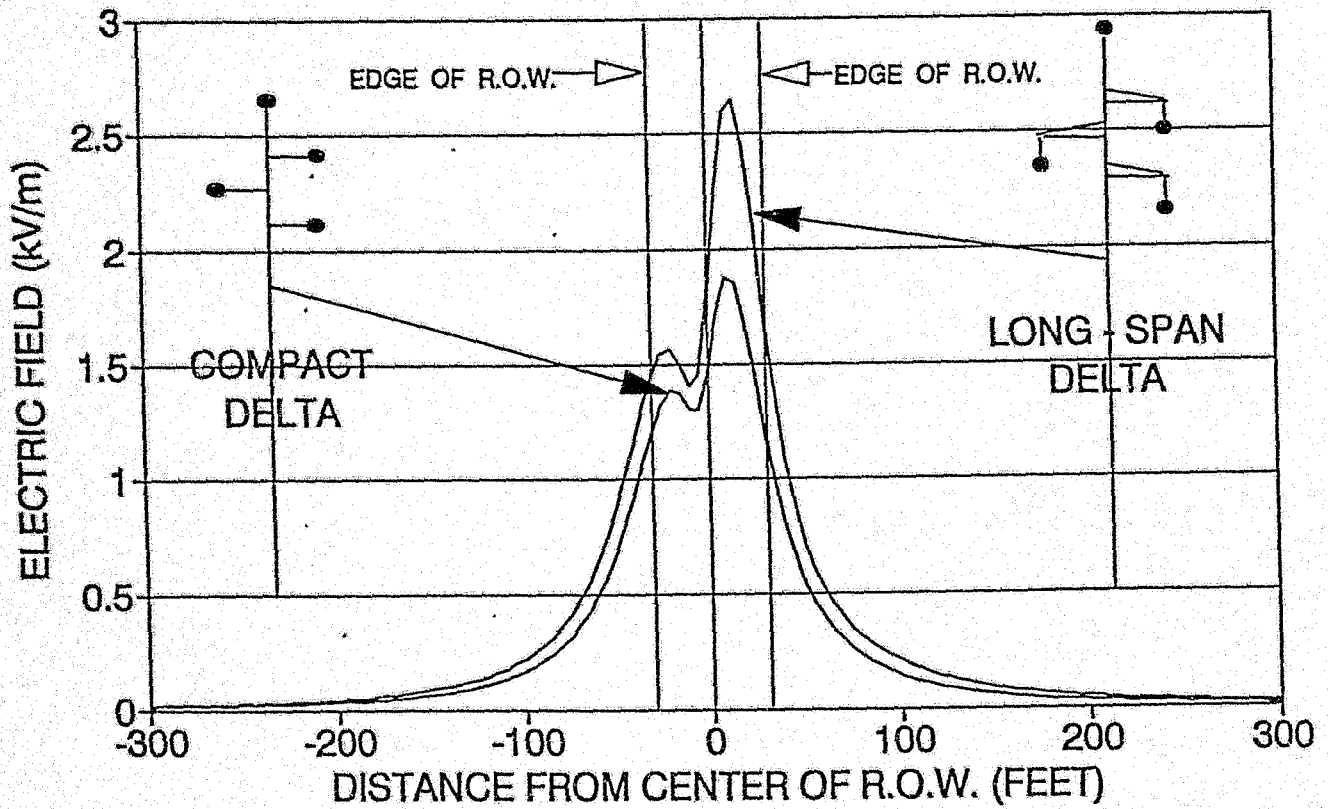
TABLE 3 - ELECTRIC FIELD COMPARISONS

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 |
|---------------|-----------|-----------|-----------|-----------|
| LATERAL | E-FIELD | E-FIELD | E-FIELD | E-FIELD |
| DISTANCE | 12' PHASE | 19' PHASE | 15' PHASE | 19' PHASE |
| FROM | SPACING | SPACING | SPACING | SPACING |
| CENTER LINE | DELTA | DELTA | FLAT | VERTICAL |
| R.O.W. (FEET) | (kV/m) | (kV/m) | (kV/m) | (kV/m) |
| 210 | 0.028 | 0.043 | 0.036 | 0.048 |
| 215 | 0.027 | 0.041 | 0.034 | 0.046 |
| 220 | 0.025 | 0.039 | 0.032 | 0.045 |
| 225 | 0.024 | 0.037 | 0.030 | 0.043 |
| 230 | 0.023 | 0.036 | 0.028 | 0.042 |
| 235 | 0.022 | 0.034 | 0.026 | 0.040 |
| 240 | 0.021 | 0.033 | 0.025 | 0.039 |
| 245 | 0.020 | 0.031 | 0.024 | 0.038 |
| 250 | 0.019 | 0.030 | 0.022 | 0.037 |
| 255 | 0.018 | 0.029 | 0.021 | 0.035 |
| 260 | 0.018 | 0.027 | 0.020 | 0.034 |
| 265 | 0.017 | 0.026 | 0.019 | 0.033 |
| 270 | 0.016 | 0.025 | 0.018 | 0.032 |
| 275 | 0.016 | 0.024 | 0.017 | 0.031 |
| 280 | 0.015 | 0.023 | 0.016 | 0.030 |
| 285 | 0.014 | 0.023 | 0.015 | 0.029 |
| 290 | 0.014 | 0.022 | 0.015 | 0.028 |
| 295 | 0.013 | 0.021 | 0.014 | 0.028 |
| 300 | 0.013 | 0.020 | 0.013 | 0.027 |

FIGURE 1-3

ELECTRIC FIELD STUDY

COMPACT DELTA VERSUS LONG-SPAN DELTA

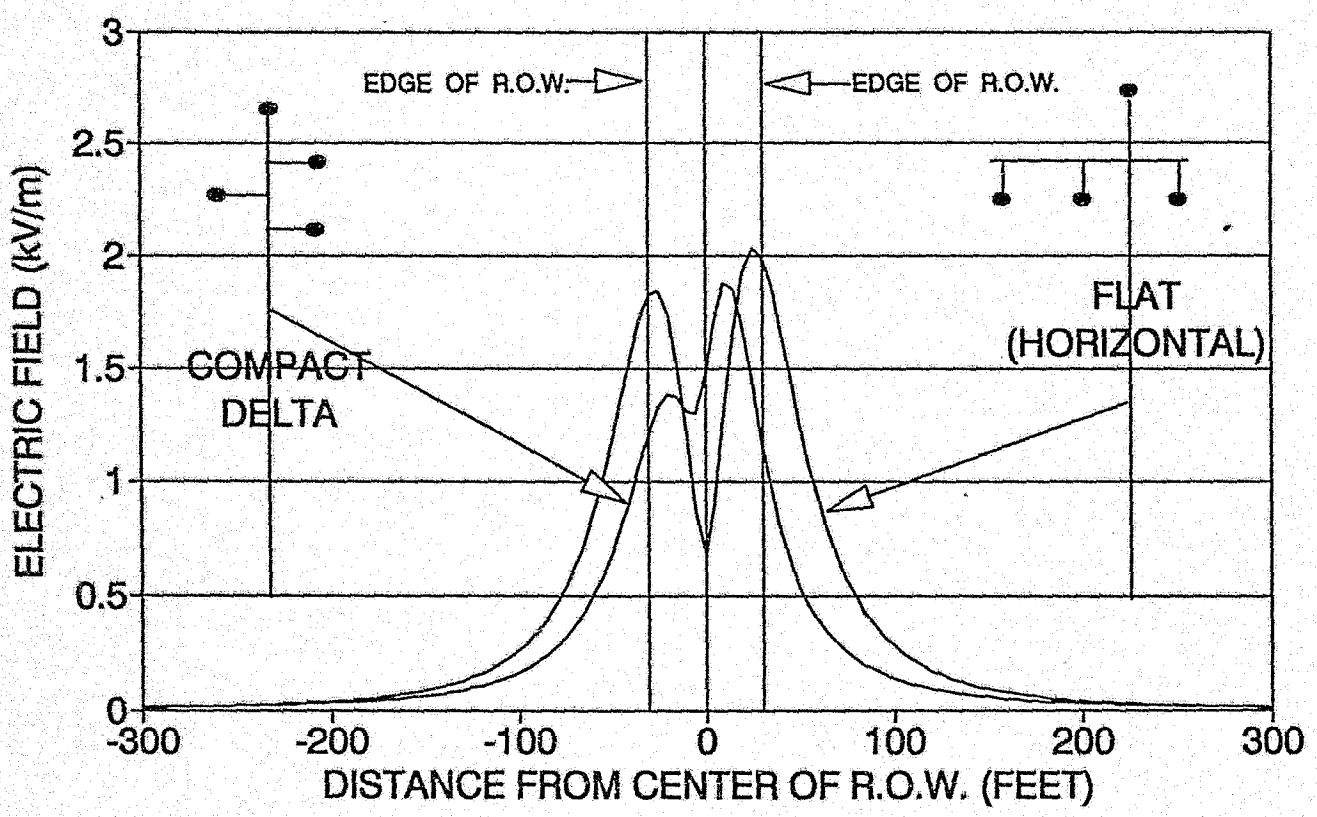


SEE TABLE 3 COLUMNS 1 & 2

FIGURE 2-3

ELECTRIC FIELD STUDY

COMPACT DELTA VERSUS FLAT CONFIGURATION

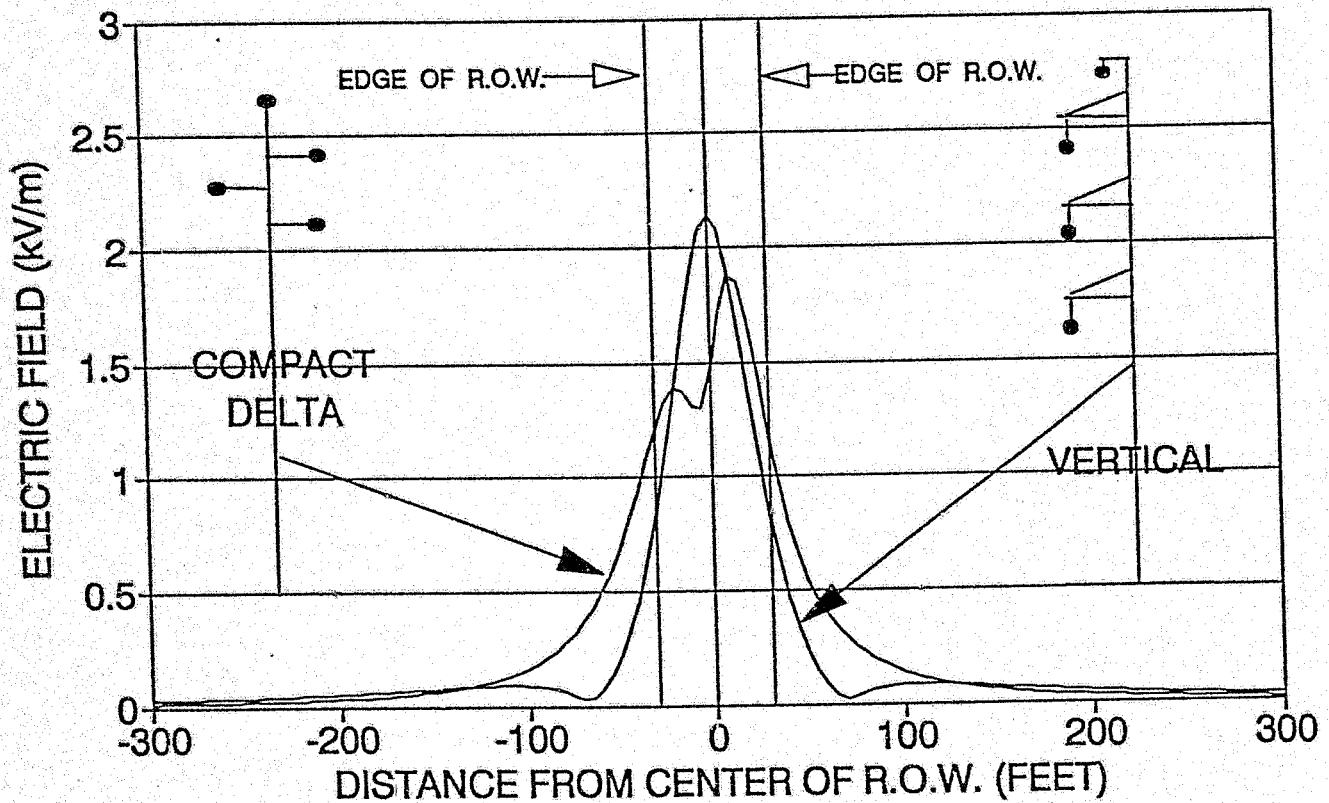


SEE TABLE 3 COLUMNS 1 & 3

FIGURE 3-3

ELECTRIC FIELD STUDY

COMPACT DELTA VERSUS VERTICAL CONFIG.



SEE TABLE 3 COLUMNS 1 & 4

TABLE 4 - MAGNETIC FIELD COMPARISONS

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 |
|---------------|--------------|--------------|--------------|--------------|
| | B-FIELD | B-FIELD | B-FIELD | B-FIELD |
| LATERAL | 12' PHASE | 19' PHASE | 15' PHASE | 19' PHASE |
| DISTANCE | SPACING | SPACING | SPACING | SPACING |
| FROM | DELTA | DELTA | FLAT | VERTICAL |
| CENTER LINE | 600 AMPS | 600 AMPS | 600 AMPS | 600 AMPS |
| R.O.W. (FEET) | (milligauss) | (milligauss) | (milligauss) | (milligauss) |
| -300 | 0.71 | 1.04 | 1.42 | 1.55 |
| -295 | 0.74 | 1.08 | 1.47 | 1.60 |
| -290 | 0.76 | 1.11 | 1.52 | 1.65 |
| -285 | 0.79 | 1.15 | 1.57 | 1.70 |
| -280 | 0.82 | 1.20 | 1.63 | 1.76 |
| -275 | 0.85 | 1.24 | 1.69 | 1.82 |
| -270 | 0.88 | 1.29 | 1.75 | 1.88 |
| -265 | 0.92 | 1.34 | 1.82 | 1.94 |
| -260 | 0.95 | 1.39 | 1.88 | 2.01 |
| -255 | 0.99 | 1.45 | 1.96 | 2.08 |
| -250 | 1.03 | 1.51 | 2.03 | 2.16 |
| -245 | 1.07 | 1.57 | 2.12 | 2.24 |
| -240 | 1.12 | 1.64 | 2.20 | 2.32 |
| -235 | 1.17 | 1.71 | 2.30 | 2.41 |
| -230 | 1.22 | 1.78 | 2.39 | 2.50 |
| -225 | 1.28 | 1.86 | 2.50 | 2.61 |
| -220 | 1.34 | 1.95 | 2.61 | 2.71 |
| -215 | 1.40 | 2.04 | 2.73 | 2.83 |
| -210 | 1.47 | 2.14 | 2.86 | 2.95 |
| -205 | 1.54 | 2.25 | 3.00 | 3.08 |
| -200 | 1.62 | 2.36 | 3.14 | 3.22 |
| -195 | 1.70 | 2.48 | 3.30 | 3.37 |
| -190 | 1.80 | 2.62 | 3.47 | 3.53 |
| -185 | 1.89 | 2.76 | 3.66 | 3.70 |
| -180 | 2.00 | 2.91 | 3.86 | 3.89 |
| -175 | 2.12 | 3.08 | 4.07 | 4.09 |
| -170 | 2.24 | 3.26 | 4.31 | 4.30 |
| -165 | 2.38 | 3.46 | 4.56 | 4.54 |
| -160 | 2.53 | 3.67 | 4.84 | 4.79 |
| -155 | 2.70 | 3.91 | 5.15 | 5.06 |
| -150 | 2.88 | 4.17 | 5.48 | 5.36 |
| -145 | 3.07 | 4.45 | 5.85 | 5.68 |
| -140 | 3.29 | 4.76 | 6.26 | 6.04 |

TABLE 4 - MAGNETIC FIELD COMPARISONS

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 |
|---------------|--------------|--------------|--------------|--------------|
| | B-FIELD | B-FIELD | B-FIELD | B-FIELD |
| LATERAL | 12' PHASE | 19' PHASE | 15' PHASE | 19' PHASE |
| DISTANCE | SPACING | SPACING | SPACING | SPACING |
| FROM | DELTA | DELTA | FLAT | VERTICAL |
| CENTER LINE | 600 AMPS | 600 AMPS | 600 AMPS | 600 AMPS |
| R.O.W. (FEET) | (milligauss) | (milligauss) | (milligauss) | (milligauss) |
| -135 | 3.54 | 5.11 | 6.71 | 6.42 |
| -130 | 3.80 | 5.49 | 7.21 | 6.85 |
| -125 | 4.10 | 5.91 | 7.76 | 7.32 |
| -120 | 4.44 | 6.39 | 8.38 | 7.83 |
| -115 | 4.81 | 6.92 | 9.08 | 8.40 |
| -110 | 5.24 | 7.51 | 9.87 | 9.02 |
| -105 | 5.72 | 8.19 | 10.76 | 9.72 |
| -100 | 6.26 | 8.95 | 11.77 | 10.50 |
| -95 | 6.88 | 9.82 | 12.92 | 11.36 |
| -90 | 7.59 | 10.82 | 14.25 | 12.33 |
| -85 | 8.41 | 11.96 | 15.78 | 13.42 |
| -80 | 9.36 | 13.28 | 17.56 | 14.64 |
| -75 | 10.47 | 14.81 | 19.63 | 16.01 |
| -70 | 11.77 | 16.60 | 22.05 | 17.56 |
| -65 | 13.30 | 18.70 | 24.90 | 19.32 |
| -60 | 15.11 | 21.17 | 28.26 | 21.30 |
| -55 | 17.27 | 24.10 | 32.23 | 23.55 |
| -50 | 19.86 | 27.56 | 36.91 | 26.10 |
| -45 | 22.95 | 31.66 | 42.38 | 28.96 |
| -40 | 26.65 | 36.51 | 48.68 | 32.18 |
| -35 | 31.05 | 42.17 | 55.76 | 35.75 |
| -30 | 36.21 | 48.69 | 63.40 | 39.64 |
| -25 | 42.11 | 56.00 | 71.20 | 43.78 |
| -20 | 48.59 | 63.90 | 78.60 | 47.99 |
| -15 | 55.30 | 72.01 | 84.98 | 51.99 |
| -10 | 61.61 | 79.80 | 89.88 | 55.37 |
| -5 | 66.72 | 86.60 | 93.01 | 57.67 |
| 0 | 69.76 | 91.59 | 94.27 | 58.48 |
| 5 | 70.06 | 93.80 | 93.59 | 57.66 |
| 10 | 67.42 | 92.39 | 90.95 | 55.36 |
| 15 | 62.33 | 87.23 | 86.42 | 51.97 |
| 20 | 55.79 | 79.26 | 80.24 | 47.97 |
| 25 | 48.84 | 69.98 | 72.89 | 43.76 |

TABLE 4 - MAGNETIC FIELD COMPARISONS

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 |
|---------------|--------------|--------------|--------------|--------------|
| | B-FIELD | B-FIELD | B-FIELD | B-FIELD |
| LATERAL | 12' PHASE | 19' PHASE | 15' PHASE | 19' PHASE |
| DISTANCE | SPACING | SPACING | SPACING | SPACING |
| FROM | DELTA | DELTA | FLAT | VERTICAL |
| CENTER LINE | 600 AMPS | 600 AMPS | 600 AMPS | 600 AMPS |
| R.O.W. (FEET) | (milligauss) | (milligauss) | (milligauss) | (milligauss) |
| 30 | 42.21 | 60.74 | 65.00 | 39.62 |
| 35 | 36.30 | 52.31 | 57.20 | 35.72 |
| 40 | 31.20 | 44.97 | 49.94 | 32.15 |
| 45 | 26.90 | 38.75 | 43.45 | 28.94 |
| 50 | 23.30 | 33.53 | 37.80 | 26.07 |
| 55 | 20.30 | 29.17 | 32.97 | 23.53 |
| 60 | 17.79 | 25.53 | 28.87 | 21.28 |
| 65 | 15.69 | 22.47 | 25.40 | 19.29 |
| 70 | 13.91 | 19.90 | 22.46 | 17.54 |
| 75 | 12.41 | 17.72 | 19.96 | 15.99 |
| 80 | 11.13 | 15.86 | 17.83 | 14.62 |
| 85 | 10.03 | 14.27 | 16.00 | 13.40 |
| 90 | 9.08 | 12.90 | 14.43 | 12.32 |
| 95 | 8.26 | 11.71 | 13.07 | 11.35 |
| 100 | 7.54 | 10.68 | 11.89 | 10.49 |
| 105 | 6.92 | 9.77 | 10.85 | 9.71 |
| 110 | 6.36 | 8.97 | 9.94 | 9.02 |
| 115 | 5.87 | 8.27 | 9.14 | 8.39 |
| 120 | 5.44 | 7.64 | 8.42 | 7.82 |
| 125 | 5.05 | 7.09 | 7.79 | 7.31 |
| 130 | 4.70 | 6.59 | 7.23 | 6.85 |
| 135 | 4.39 | 6.14 | 6.72 | 6.42 |
| 140 | 4.11 | 5.73 | 6.26 | 6.04 |
| 145 | 3.85 | 5.37 | 5.85 | 5.68 |
| 150 | 3.62 | 5.04 | 5.47 | 5.36 |
| 155 | 3.41 | 4.74 | 5.14 | 5.06 |
| 160 | 3.22 | 4.46 | 4.83 | 4.79 |
| 165 | 3.04 | 4.21 | 4.54 | 4.54 |
| 170 | 2.88 | 3.98 | 4.28 | 4.30 |
| 175 | 2.73 | 3.77 | 4.05 | 4.09 |
| 180 | 2.59 | 3.57 | 3.83 | 3.89 |
| 185 | 2.46 | 3.39 | 3.63 | 3.70 |
| 190 | 2.35 | 3.22 | 3.44 | 3.53 |

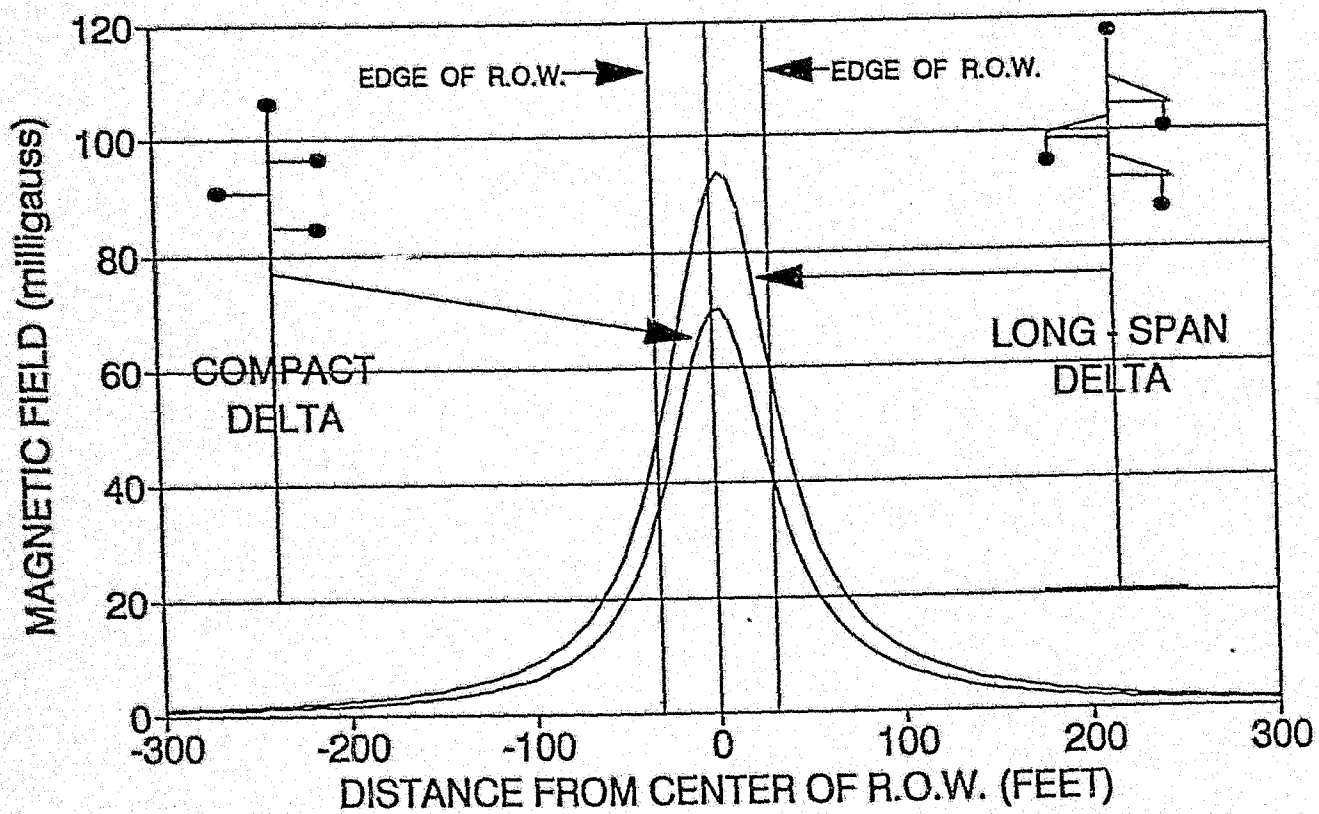
TABLE 4 - MAGNETIC FIELD COMPARISONS

| | COLUMN 1 | COLUMN 2 | COLUMN 3 | COLUMN 4 |
|---------------|--------------|--------------|--------------|--------------|
| | B-FIELD | B-FIELD | B-FIELD | B-FIELD |
| LATERAL | 12' PHASE | 19' PHASE | 15' PHASE | 19' PHASE |
| DISTANCE | SPACING | SPACING | SPACING | SPACING |
| FROM | DELTA | DELTA | FLAT | VERTICAL |
| CENTER LINE | 600 AMPS | 600 AMPS | 600 AMPS | 600 AMPS |
| R.O.W. (FEET) | (milligauss) | (milligauss) | (milligauss) | (milligauss) |
| 195 | 2.24 | 3.07 | 3.27 | 3.37 |
| 200 | 2.14 | 2.93 | 3.11 | 3.22 |
| 205 | 2.04 | 2.79 | 2.96 | 3.08 |
| 210 | 1.95 | 2.67 | 2.82 | 2.95 |
| 215 | 1.87 | 2.55 | 2.69 | 2.83 |
| 220 | 1.80 | 2.44 | 2.57 | 2.72 |
| 225 | 1.72 | 2.34 | 2.46 | 2.61 |
| 230 | 1.66 | 2.25 | 2.36 | 2.51 |
| 235 | 1.59 | 2.16 | 2.26 | 2.41 |
| 240 | 1.53 | 2.07 | 2.16 | 2.32 |
| 245 | 1.48 | 2.00 | 2.08 | 2.24 |
| 250 | 1.42 | 1.92 | 1.99 | 2.16 |
| 255 | 1.37 | 1.85 | 1.92 | 2.08 |
| 260 | 1.33 | 1.78 | 1.84 | 2.01 |
| 265 | 1.28 | 1.72 | 1.78 | 1.94 |
| 270 | 1.24 | 1.66 | 1.71 | 1.88 |
| 275 | 1.20 | 1.61 | 1.65 | 1.82 |
| 280 | 1.16 | 1.55 | 1.59 | 1.76 |
| 285 | 1.12 | 1.50 | 1.53 | 1.71 |
| 290 | 1.09 | 1.45 | 1.48 | 1.66 |
| 295 | 1.06 | 1.41 | 1.43 | 1.61 |
| 300 | 1.03 | 1.36 | 1.38 | 1.56 |

FIGURE 1-4

MAGNETIC FIELD STUDY

COMPACT DELTA VERSUS LONG-SPAN DELTA



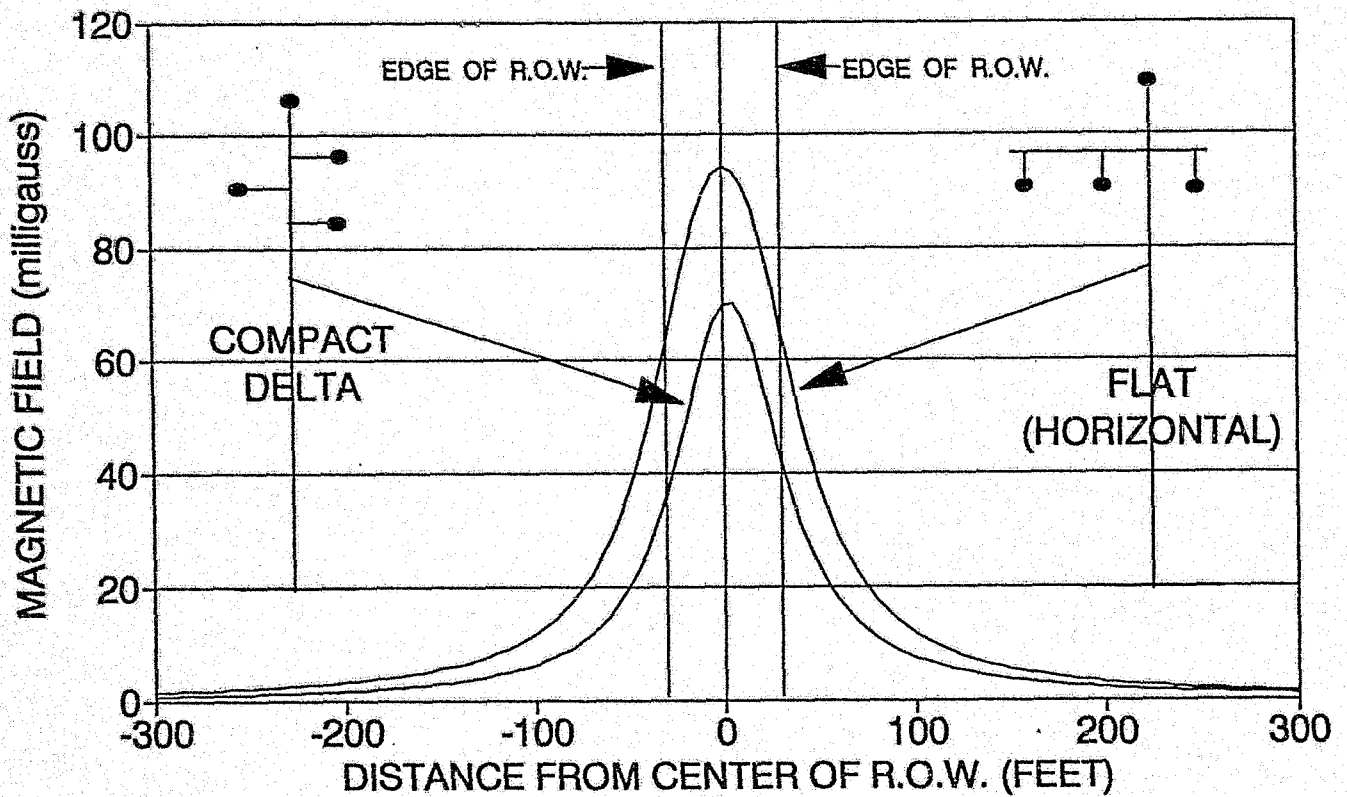
LOAD = 600 AMPERES

SEE TABLE 4 COLUMNS 1 & 2

FIGURE 2-4

MAGNETIC FIELD STUDY

COMPACT DELTA VERSUS FLAT CONFIGURATION



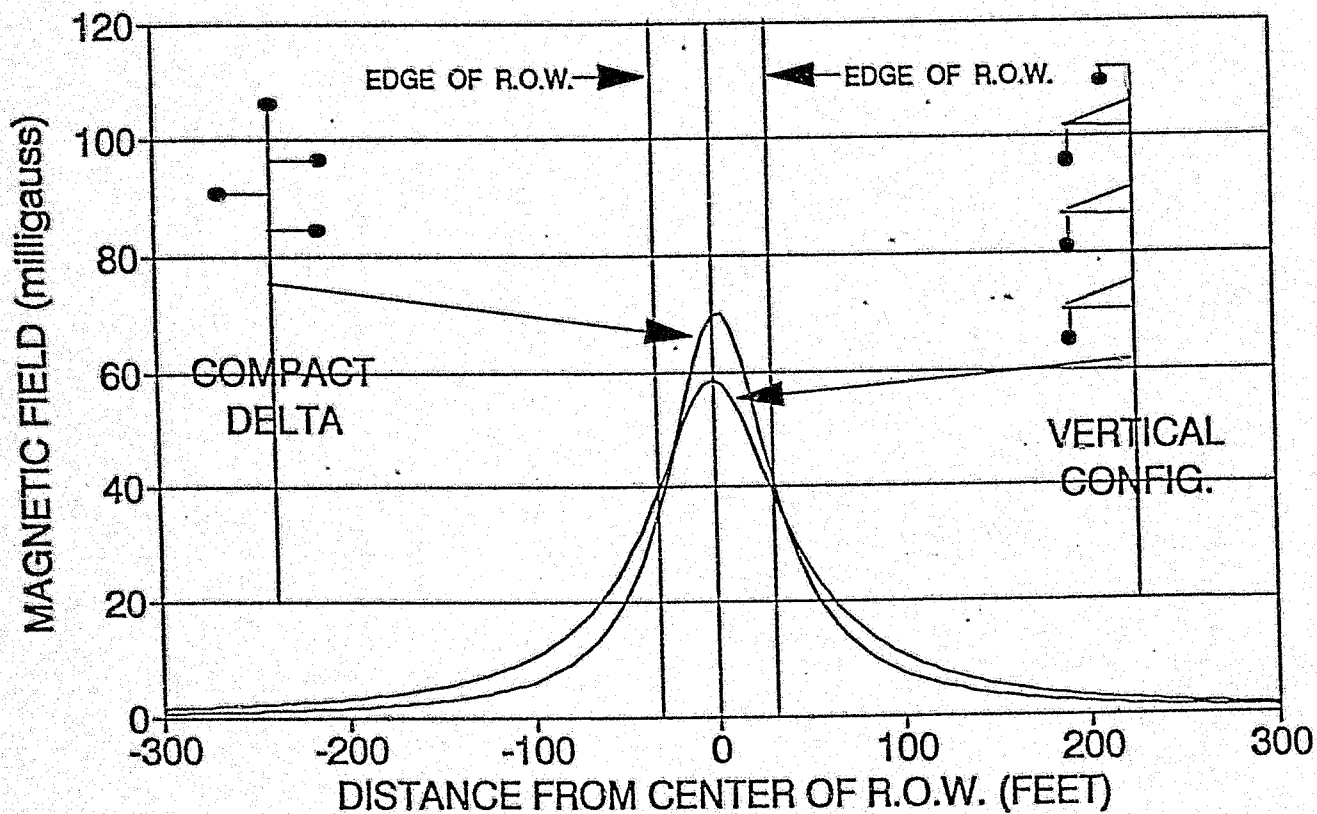
LOAD = 600 AMPERES

SEE TABLE 4 COLUMNS 1 & 3

FIGURE 3-4

MAGNETIC FIELD STUDY

COMPACT DELTA VERSUS VERTICAL CONFIG.



LOAD = 600 AMPERES

SEE TABLE 4 COLUMNS 1 & 4

OCA CROSS EXAMINATION EXHIBIT NO. 1
LETTER OF NOTIFICATION OF PHILADELPHIA
ELECTRIC COMPANY RELATIVE TO
RECONSTRUCTING AND REBUILDING OF THE
EXISTING 138 KV LINE TO OPERATE AS A
WOODBOURNE-HEATON 230 KV LINE IN
MONTGOMERY AND BUCKS COUNTIES
DOCKET NO. A-110550, F.055

DOCKETED
AUG 28 1991

8/15/91 PWB, PJ, RJS

DOCUMENT
FOLDER

RECEIVED

AUG 26 1991

SECRETARY'S OFFICE
Public Utility Commission

Q-IR-OCA-I-8

What consideration has been given to minimizing the electric and magnetic fields at the edge of the right-of-way and beyond? Please provide all documentation regarding the options considered. Please include all cost information and field calculations for each.

A-IR-OCA-I-8

The choices for siting and design for this transmission line were guided by the availability of an existing Conrail right-of-way and its associated structures. This existing right-of-way, which was previously utilized for the transmission of electricity for railroad purposes, provided a direct and established route between Woodbourne and Heaton Substations and required no condemnation of property. The majority of existing structures on the right-of-way, with some modification, are being used for this 230 kV transmission line.

Given the special situation of an existing railroad right-of-way with structures, only minimal consideration was given to alternative routes. In PECO's view, use of the existing right-of-way and structures was obviously superior to any alternatives, and, therefore, no cost information or field calculations were prepared for alternate routes.

In order to use the majority of the existing structures on the railroad right-of-way, the use of a compact triangular conductor configuration was required. This compact triangular, or "delta," configuration provides the benefit of reducing electric and magnetic fields due to cancellation effects. Alternative conductor configurations either were not technically feasible, or would not have allowed use of the existing structures. Therefore, no cost information or field calculations were prepared for alternative designs.

The transmission line will normally be operated at an ampere load considerably lower than the line's capacity. Calculations yielding the expected values of field levels at different ampere loadings are provided in response to Interrogatory 2.

Responsible Witnesses: R. J. Oedemann and C. J. Boeggeman

OCA CROSS EXAMINATION EXHIBIT NO. 2
LETTER OF NOTIFICATION OF PHILADELPHIA
ELECTRIC COMPANY RELATIVE TO
RECONSTRUCTING AND REBUILDING OF THE
EXISTING 138 KV LINE TO OPERATE AS A
WOODBOURNE-HEATON 230 KV LINE IN
MONTGOMERY AND BUCKS COUNTIES
DOCKET NO. A-110550, F.055

8/15/91 PHB, PD OJS

DOCKETED
AUG 8 1991

DOCUMENT
FOLDER

RECEIVED

AUG 26 1991

SECRETARY'S OFFICE
Public Utility Commission

Q-IR-OCA-I-2

Has Philadelphia Electric calculated the electric and magnetic fields that the line is expected to produce on and off the right-of-way? If so, please provide: (1) the results and the assumptions (line voltage, amperage, line design details) used in the calculation, and (2) the method used for the calculation.

A-IR-OCA-I-2

Philadelphia Electric has calculated the electric and magnetic fields that the line is expected to produce on and off the right-of-way, given a variety of loading characteristics, using the EPRI computer program ENVIRO. The parameters that were used for the calculations are as follows:

Circuit Voltage : 230 kV

Circuit Currents:

Light load = 180 amps (estimated 30% of normal maximum)
Normal load = 360 amps (estimated 60% of normal maximum)
Heavy load = 600 amps
Emergency maximum load = 1200 amps

Phase Conductor : 1 - 1590 kcmil ACSR conductor per phase
ACSR = Aluminum Conductor Steel Reinforced

Conductor Diameter : 1.545 inches

Electrical Characteristics:

DC Resistance (25° C @ 60 Hertz) = 0.0578 ohms/mile
AC Resistance (25° C @ 60 Hertz) = 0.0602 ohms/mile
Reactance (1 ft. radius @ 60 Hertz) = 0.358 ohms/mile

Ground Conductor : 1 - 7#5AW conductor

Conductor Diameter : 0.546 inches

Electrical Characteristics:

DC Resistance (25° C @ 60 Hertz) = 1.2170 ohms/mile
AC Resistance (25° C @ 60 Hertz) = 1.2400 ohms/mile
Reactance (1 ft. radius @ 60 Hertz) = 0.707 ohms/mile

Values calculated are for 1 meter (3.28 feet) above ground.

Below are the clearances between phases and ground, given the existing structures, and a compact triangular ("delta") conductor configuration.

| <u>PHASE</u> | <u>ANGLE</u> | <u>Coordinates</u> | | |
|--------------|--------------|--------------------|---------------|---------------|
| | | <u>X (ft)</u> | <u>Y (ft)</u> | |
| A | 0 | -8.0 | 28.0 | Compact Delta |
| B | 240 | 8.0 | 35.0 | |
| C | 120 | -8.0 | 42.0 | |
| SHIELD | * | 0.0 | 57.0 | |

* Given the parameters of the shield wire, magnetic field software calculates the resultant induced shield wire current and angle.

Attached are five (5) graphs and three (3) pages of tables showing the results of the electric and magnetic field calculations. Figure (1) shows the expected electric field strength of the proposed new line, while Figures (2), (3), (4) and (5) show the expected magnetic field strength of the proposed new line, given the ampere loads of 180 amps (expected light load), 360 amps (expected normal load), 600 amps (expected heavy load), and 1200 amps (expected four-hour emergency load to pick up the load of an adjacent transmission line in the event of loss due to a storm or equipment failure) respectfully.

Responsible Witness: C. J. Boeggeman

| | SEE FIGURE 1 | SEE FIGURE 2 | SEE FIGURE 3 | SEE FIGURE 4 | SEE FIGURE 5 |
|---|--|---|---|---|--|
| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | E-FIELD 14' PHASE SPACING DELTA (kV/m) | B-FIELD 14' PHASE SPACING DELTA-180 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-360 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-600 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-1200 AMPS (mG) |
| -300 | 0.02 | 0.33 | 0.65 | 1.09 | 2.18 |
| -295 | 0.02 | 0.34 | 0.67 | 1.12 | 2.24 |
| -290 | 0.02 | 0.35 | 0.69 | 1.16 | 2.31 |
| -285 | 0.02 | 0.36 | 0.72 | 1.19 | 2.39 |
| -280 | 0.02 | 0.37 | 0.74 | 1.23 | 2.46 |
| -275 | 0.02 | 0.38 | 0.76 | 1.27 | 2.54 |
| -270 | 0.02 | 0.39 | 0.79 | 1.31 | 2.63 |
| -265 | 0.02 | 0.41 | 0.82 | 1.36 | 2.72 |
| -260 | 0.02 | 0.42 | 0.84 | 1.41 | 2.81 |
| -255 | 0.02 | 0.44 | 0.87 | 1.46 | 2.91 |
| -250 | 0.02 | 0.45 | 0.91 | 1.51 | 3.02 |
| -245 | 0.02 | 0.47 | 0.94 | 1.57 | 3.13 |
| -240 | 0.02 | 0.49 | 0.98 | 1.63 | 3.25 |
| -235 | 0.03 | 0.51 | 1.01 | 1.69 | 3.38 |
| -230 | 0.03 | 0.53 | 1.05 | 1.76 | 3.51 |
| -225 | 0.03 | 0.55 | 1.10 | 1.83 | 3.65 |
| -220 | 0.03 | 0.57 | 1.14 | 1.90 | 3.81 |
| -215 | 0.03 | 0.60 | 1.19 | 1.99 | 3.97 |
| -210 | 0.03 | 0.62 | 1.24 | 2.07 | 4.14 |
| -205 | 0.03 | 0.65 | 1.30 | 2.17 | 4.33 |
| -200 | 0.04 | 0.68 | 1.36 | 2.27 | 4.53 |
| -195 | 0.04 | 0.71 | 1.42 | 2.37 | 4.75 |
| -190 | 0.04 | 0.75 | 1.49 | 2.49 | 4.98 |
| -185 | 0.04 | 0.78 | 1.57 | 2.61 | 5.23 |
| -180 | 0.04 | 0.82 | 1.65 | 2.75 | 5.50 |
| -175 | 0.05 | 0.87 | 1.74 | 2.89 | 5.79 |
| -170 | 0.05 | 0.92 | 1.83 | 3.05 | 6.10 |
| -165 | 0.05 | 0.97 | 1.93 | 3.22 | 6.45 |
| -160 | 0.06 | 1.02 | 2.05 | 3.41 | 6.82 |
| -155 | 0.06 | 1.09 | 2.17 | 3.62 | 7.23 |
| -150 | 0.07 | 1.15 | 2.30 | 3.84 | 7.68 |
| -145 | 0.07 | 1.23 | 2.45 | 4.09 | 8.18 |
| -140 | 0.08 | 1.31 | 2.62 | 4.36 | 8.72 |
| -135 | 0.08 | 1.40 | 2.80 | 4.66 | 9.32 |
| -130 | 0.09 | 1.50 | 3.00 | 4.99 | 9.99 |
| -125 | 0.10 | 1.61 | 3.22 | 5.37 | 10.73 |
| -120 | 0.10 | 1.73 | 3.47 | 5.78 | 11.56 |
| -115 | 0.11 | 1.87 | 3.75 | 6.25 | 12.49 |
| -110 | 0.13 | 2.03 | 4.06 | 6.77 | 13.54 |
| -105 | 0.14 | 2.21 | 4.42 | 7.36 | 14.73 |

| | SEE FIGURE 1 | SEE FIGURE 2 | SEE FIGURE 3 | SEE FIGURE 4 | SEE FIGURE 5 |
|---|--|---|---|---|--|
| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | E-FIELD 14' PHASE SPACING DELTA (kV/m) | B-FIELD 14' PHASE SPACING DELTA-180 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-360 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-600 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-1200 AMPS (mG) |
| -100 | 0.15 | 2.41 | 4.82 | 8.04 | 16.08 |
| -95 | 0.17 | 2.64 | 5.29 | 8.81 | 17.62 |
| -90 | 0.19 | 2.91 | 5.82 | 9.70 | 19.39 |
| -85 | 0.21 | 3.22 | 6.43 | 10.72 | 21.44 |
| -80 | 0.24 | 3.57 | 7.15 | 11.91 | 23.82 |
| -75 | 0.27 | 3.99 | 7.98 | 13.30 | 26.60 |
| -70 | 0.31 | 4.48 | 8.96 | 14.94 | 29.88 |
| -65 | 0.35 | 5.06 | 10.13 | 16.88 | 33.76 |
| -60 | 0.41 | 5.76 | 11.51 | 19.19 | 38.38 |
| -55 | 0.47 | 6.59 | 13.18 | 21.96 | 43.93 |
| -50 | 0.56 | 7.59 | 15.18 | 25.30 | 50.60 |
| -45 | 0.68 | 8.80 | 17.60 | 29.34 | 58.67 |
| -40 | 0.83 | 10.26 | 20.52 | 34.21 | 68.41 |
| -35 | 1.03 | 12.01 | 24.03 | 40.05 | 80.09 |
| -30 | 1.29 | 14.08 | 28.16 | 46.93 | 93.86 |
| -25 | 1.61 | 16.43 | 32.86 | 54.77 | 109.53 |
| -20 | 1.94 | 18.94 | 37.87 | 63.12 | 126.25 |
| -15 | 2.20 | 21.32 | 42.63 | 71.06 | 142.11 |
| -10 | 2.27 | 23.15 | 46.30 | 77.16 | 154.32 |
| -5 | 2.10 | 24.02 | 48.05 | 80.08 | 160.15 |
| 0 | 1.77 | 23.77 | 47.54 | 79.24 | 158.48 |
| 5 | 1.49 | 22.53 | 45.05 | 75.09 | 150.18 |
| 10 | 1.42 | 20.59 | 41.18 | 68.64 | 137.27 |
| 15 | 1.45 | 18.30 | 36.60 | 61.00 | 122.00 |
| 20 | 1.45 | 15.94 | 31.87 | 53.12 | 106.25 |
| 25 | 1.37 | 13.70 | 27.40 | 45.67 | 91.34 |
| 30 | 1.24 | 11.70 | 23.41 | 39.01 | 78.03 |
| 35 | 1.09 | 9.98 | 19.96 | 33.27 | 66.55 |
| 40 | 0.94 | 8.53 | 17.06 | 28.44 | 56.87 |
| 45 | 0.80 | 7.32 | 14.64 | 24.40 | 48.81 |
| 50 | 0.68 | 6.32 | 12.63 | 21.06 | 42.11 |
| 55 | 0.58 | 5.48 | 10.97 | 18.28 | 36.56 |
| 60 | 0.49 | 4.79 | 9.58 | 15.96 | 31.93 |
| 65 | 0.42 | 4.21 | 8.42 | 14.03 | 28.06 |
| 70 | 0.36 | 3.72 | 7.44 | 12.40 | 24.80 |
| 75 | 0.31 | 3.31 | 6.61 | 11.02 | 22.04 |
| 80 | 0.27 | 2.95 | 5.91 | 9.85 | 19.70 |
| 85 | 0.24 | 2.65 | 5.31 | 8.84 | 17.69 |
| 90 | 0.21 | 2.39 | 4.79 | 7.98 | 15.96 |
| 95 | 0.19 | 2.17 | 4.34 | 7.23 | 14.46 |

| | SEE FIGURE 1 | SEE FIGURE 2 | SEE FIGURE 3 | SEE FIGURE 4 | SEE FIGURE 5 |
|---|--|---|---|---|--|
| LATERAL DISTANCE FROM CENTER LINE R.O.W. (FEET) | E-FIELD 14' PHASE SPACING DELTA (kV/m) | B-FIELD 14' PHASE SPACING DELTA-180 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-360 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-600 AMPS (mG) | B-FIELD 14' PHASE SPACING DELTA-1200 AMPS (mG) |
| 100 | 0.16 | 1.97 | 3.94 | 6.57 | 13.15 |
| 105 | 0.15 | 1.80 | 3.60 | 6.00 | 12.01 |
| 110 | 0.13 | 1.65 | 3.30 | 5.50 | 11.00 |
| 115 | 0.12 | 1.52 | 3.03 | 5.05 | 10.11 |
| 120 | 0.11 | 1.40 | 2.80 | 4.66 | 9.32 |
| 125 | 0.10 | 1.29 | 2.59 | 4.31 | 8.62 |
| 130 | 0.09 | 1.20 | 2.40 | 3.99 | 7.99 |
| 135 | 0.08 | 1.11 | 2.23 | 3.71 | 7.42 |
| 140 | 0.08 | 1.04 | 2.08 | 3.46 | 6.92 |
| 145 | 0.07 | 0.97 | 1.94 | 3.23 | 6.46 |
| 150 | 0.06 | 0.91 | 1.81 | 3.02 | 6.04 |
| 155 | 0.06 | 0.85 | 1.70 | 2.83 | 5.66 |
| 160 | 0.06 | 0.80 | 1.60 | 2.66 | 5.32 |
| 165 | 0.05 | 0.75 | 1.50 | 2.50 | 5.00 |
| 170 | 0.05 | 0.71 | 1.41 | 2.36 | 4.72 |
| 175 | 0.05 | 0.67 | 1.34 | 2.23 | 4.45 |
| 180 | 0.04 | 0.63 | 1.26 | 2.10 | 4.21 |
| 185 | 0.04 | 0.60 | 1.20 | 1.99 | 3.98 |
| 190 | 0.04 | 0.57 | 1.13 | 1.89 | 3.78 |
| 195 | 0.04 | 0.54 | 1.08 | 1.79 | 3.59 |
| 200 | 0.03 | 0.51 | 1.02 | 1.70 | 3.41 |
| 205 | 0.03 | 0.49 | 0.97 | 1.62 | 3.24 |
| 210 | 0.03 | 0.46 | 0.93 | 1.55 | 3.09 |
| 215 | 0.03 | 0.44 | 0.88 | 1.47 | 2.95 |
| 220 | 0.03 | 0.42 | 0.84 | 1.41 | 2.81 |
| 225 | 0.03 | 0.40 | 0.81 | 1.35 | 2.69 |
| 230 | 0.03 | 0.39 | 0.77 | 1.29 | 2.57 |
| 235 | 0.02 | 0.37 | 0.74 | 1.23 | 2.47 |
| 240 | 0.02 | 0.35 | 0.71 | 1.18 | 2.36 |
| 245 | 0.02 | 0.34 | 0.68 | 1.13 | 2.27 |
| 250 | 0.02 | 0.33 | 0.65 | 1.09 | 2.18 |
| 255 | 0.02 | 0.31 | 0.63 | 1.05 | 2.09 |
| 260 | 0.02 | 0.30 | 0.60 | 1.01 | 2.01 |
| 265 | 0.02 | 0.29 | 0.58 | 0.97 | 1.94 |
| 270 | 0.02 | 0.28 | 0.56 | 0.93 | 1.87 |
| 275 | 0.02 | 0.27 | 0.54 | 0.90 | 1.80 |
| 280 | 0.02 | 0.26 | 0.52 | 0.87 | 1.73 |
| 285 | 0.02 | 0.25 | 0.50 | 0.84 | 1.67 |
| 290 | 0.02 | 0.24 | 0.49 | 0.81 | 1.62 |
| 295 | 0.01 | 0.23 | 0.47 | 0.78 | 1.56 |
| 300 | 0.01 | 0.23 | 0.45 | 0.76 | 1.51 |

PROPOSED NEW 230 KV TRANSMISSION LINE WOODBOURNE- HEATON 220-73 LINE

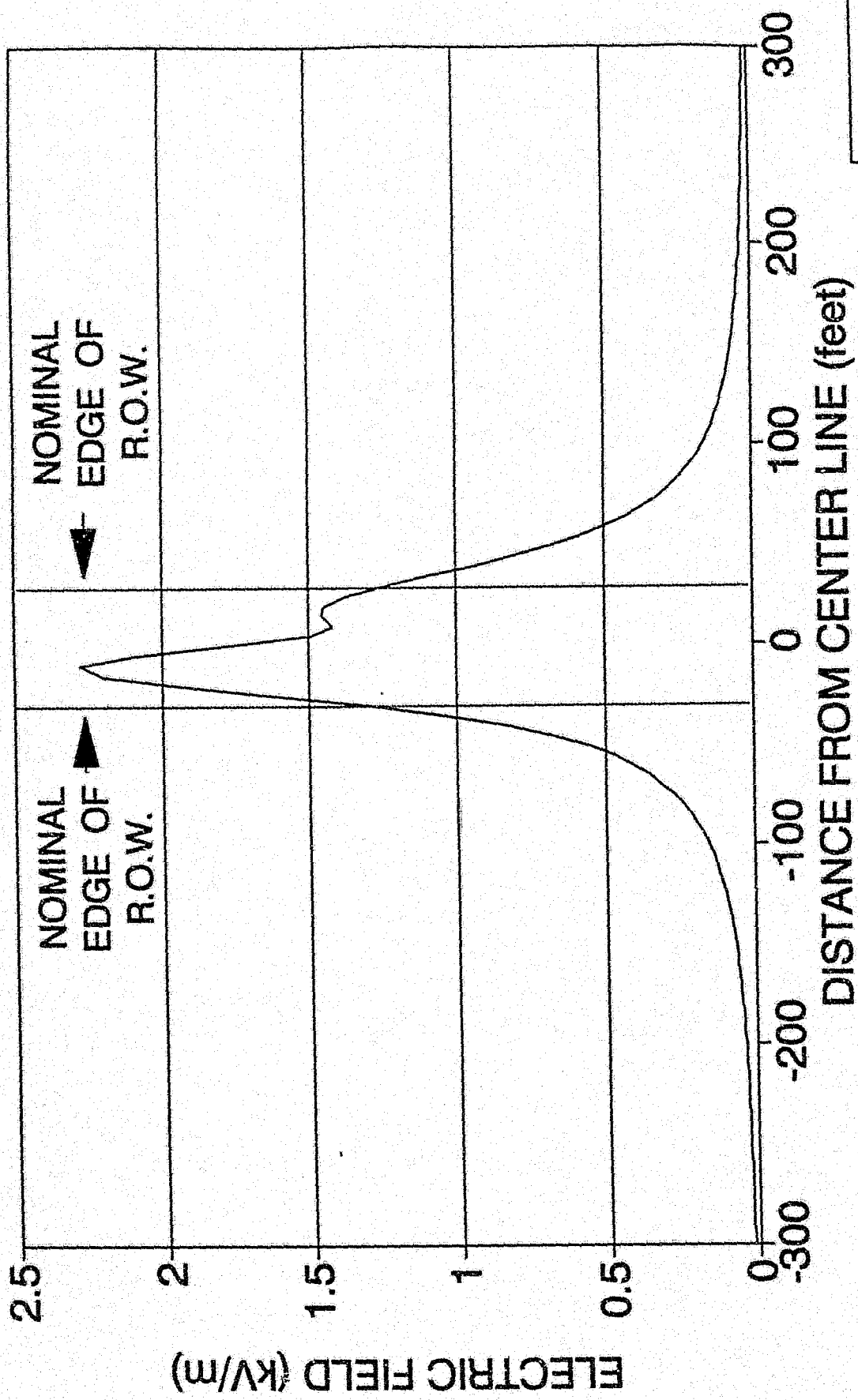
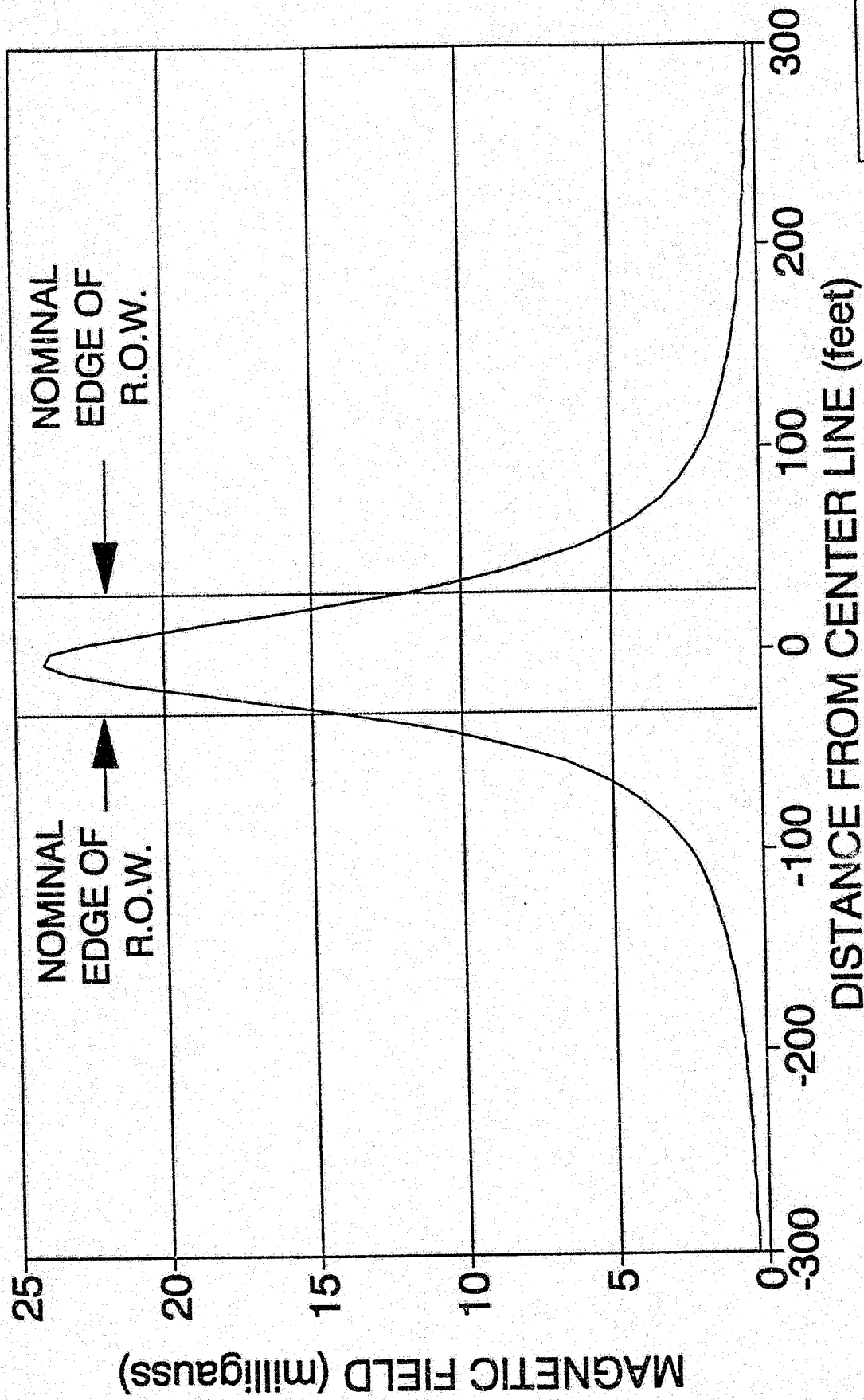


FIGURE 1

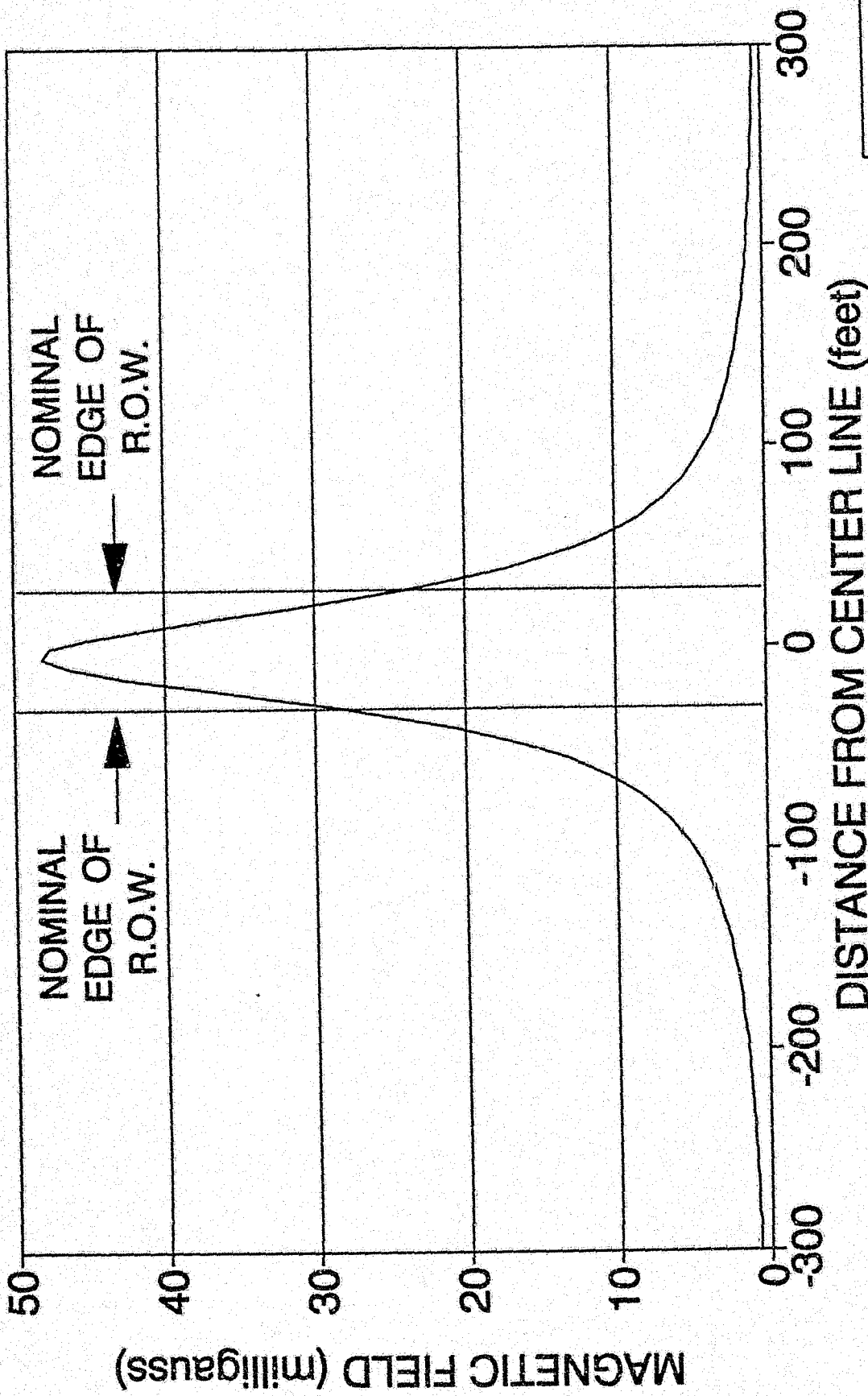
PROPOSED NEW 230 KV TRANSMISSION LINE WOODBOURNE- HEATON 220-73 LINE



LIGHT LOAD CURRENT = 180 AMPS

FIGURE 2

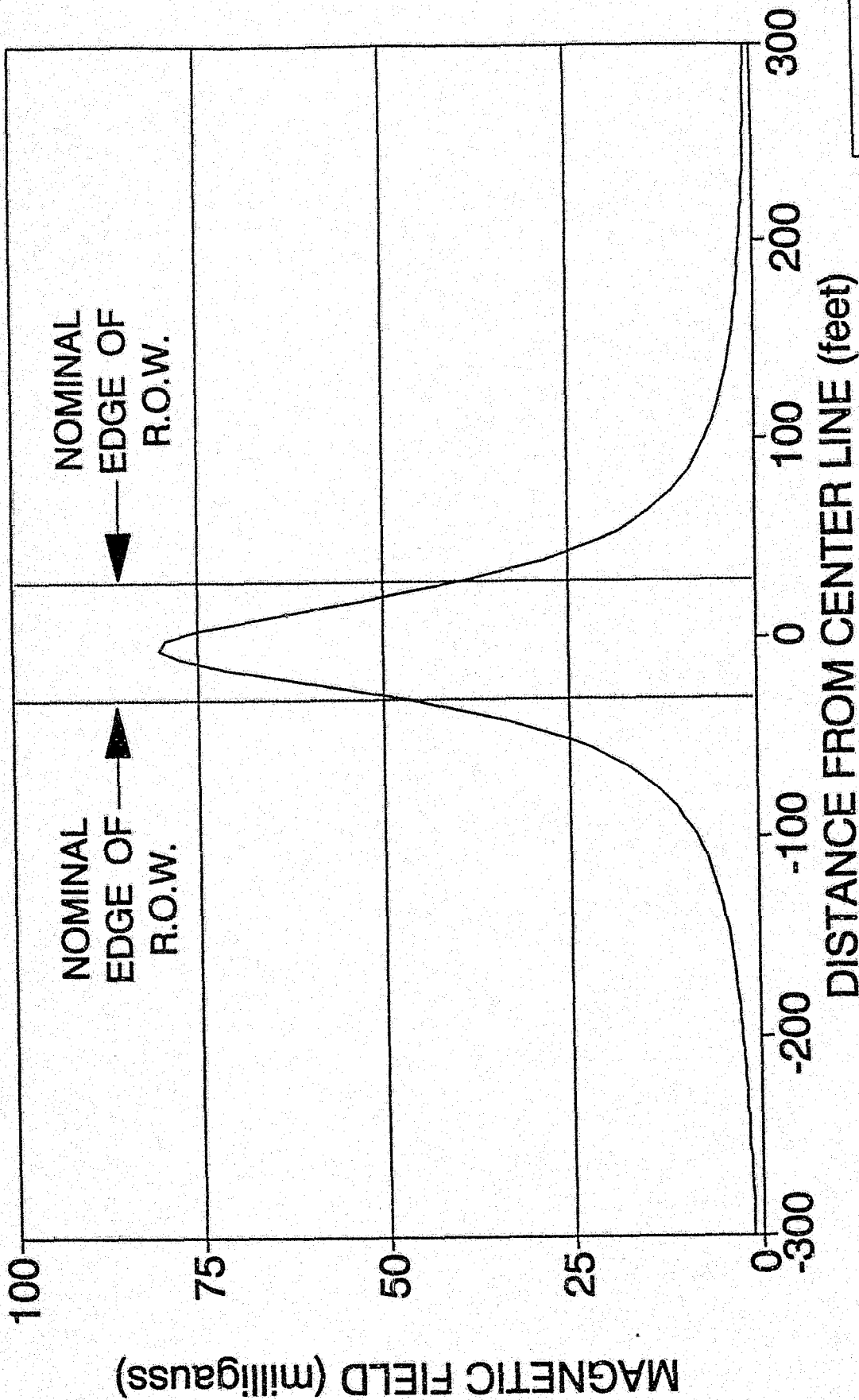
PROPOSED NEW 230 KV TRANSMISSION LINE WOODBOURNE- HEATON 220-73 LINE



NORMAL LOAD CURRENT = 360 AMPS

FIGURE 3

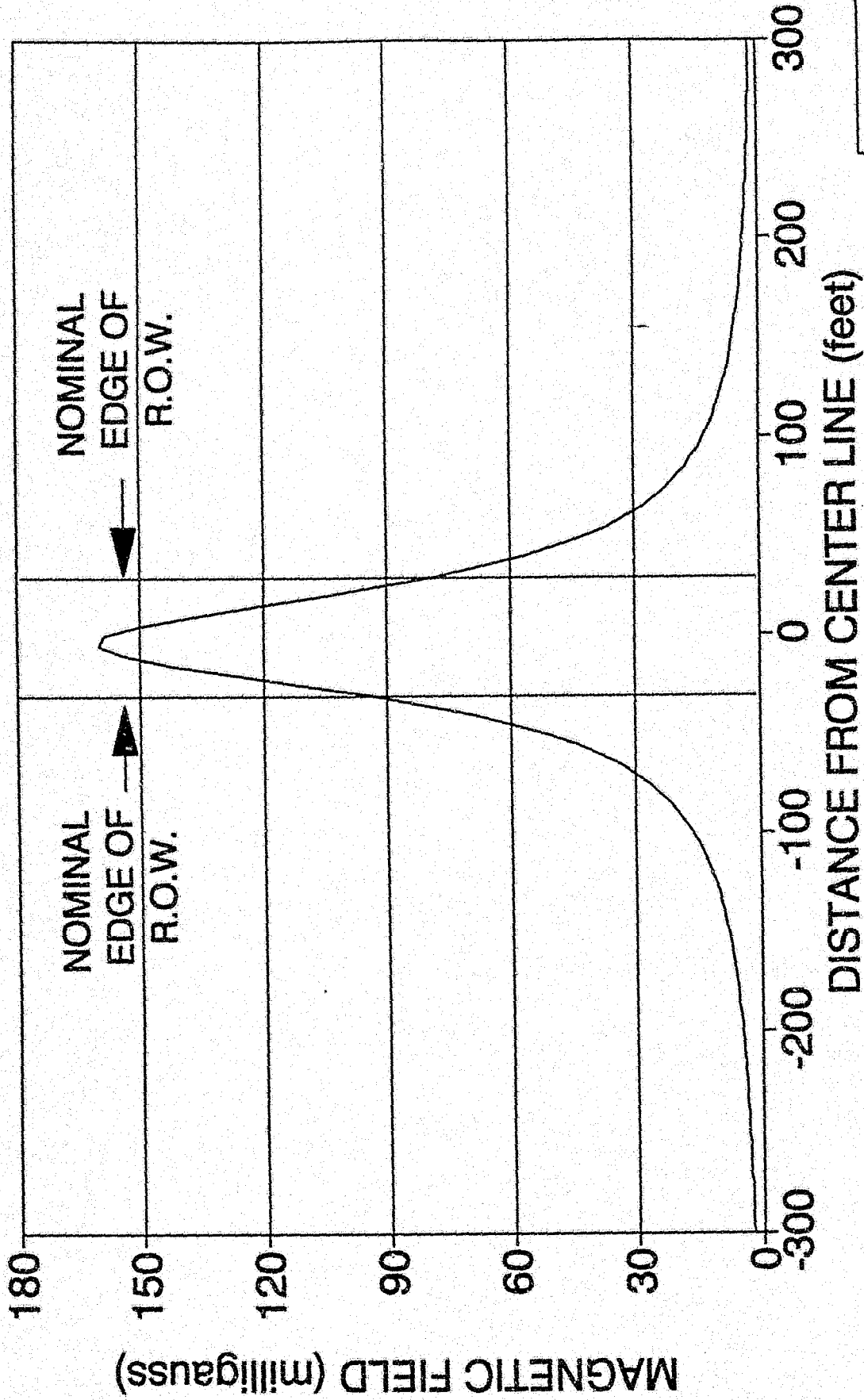
PROPOSED NEW 230 KV TRANSMISSION LINE WOODBOURNE- HEATON 220-73 LINE



HEAVY LOAD CURRENT = 600 AMPS

FIGURE 4

PROPOSED NEW 230 KV TRANSMISSION LINE WOODBOURNE- HEATON 220-73 LINE

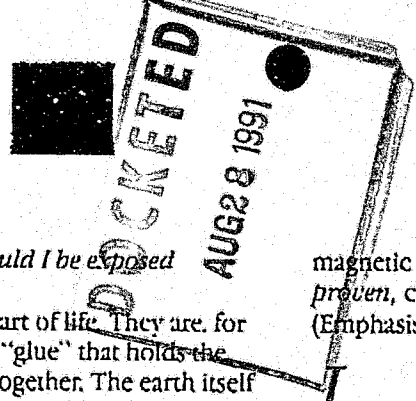


MAXIMUM EMERGENCY LOAD CURRENT = 1200 AMPS

FIGURE 5

Robitons Ex. No. 1
A-110550, F. 55
8/15/91 P.H.B., M.

0205



I have heard about EMFs. What do the letters mean?

Electric and magnetic fields, often referred to as EMFs, are invisible fields of force. These fields are found wherever there's an electrical appliance or a power line of any kind.

How many kinds of fields are there?

There are two kinds of fields. When you plug a light cord into a wall socket, electrical force is in that cord, and an *electric field* is created. When you turn the lamp on, current moves through the cord creating a *magnetic field*. Electric fields are easily shielded by most objects such as a chair, a wall, or a tree. Magnetic fields, on the other hand, pass through most objects.

Where would I be exposed to fields?

Fields are a part of life. They are, for instance, the "glue" that holds the body's cells together. The earth itself is a huge magnet with poles at its ends. More specifically, EMFs surround the appliances and power lines that are essential to our daily lives. There are fields of force around the microwave oven you cook with, the video display terminal you work with, and the power lines you cross under on highways or in the countryside.

Are EMFs a health risk?

There have been reports linking EMFs to certain types of cancer, including leukemia, among children and utility workers. The reports have not been ignored. Many millions of dollars have been spent in many countries to address the question. And today the honest answer is, we just don't know. While some studies report a slightly higher incidence of disease among populations with high exposure to EMFs, other studies have presented conflicting information. In late 1990, the Environmental Protection Agency concluded: Prolonged exposure to

magnetic fields is a "possible, but not proven, cause of cancer in humans." (Emphasis supplied.)

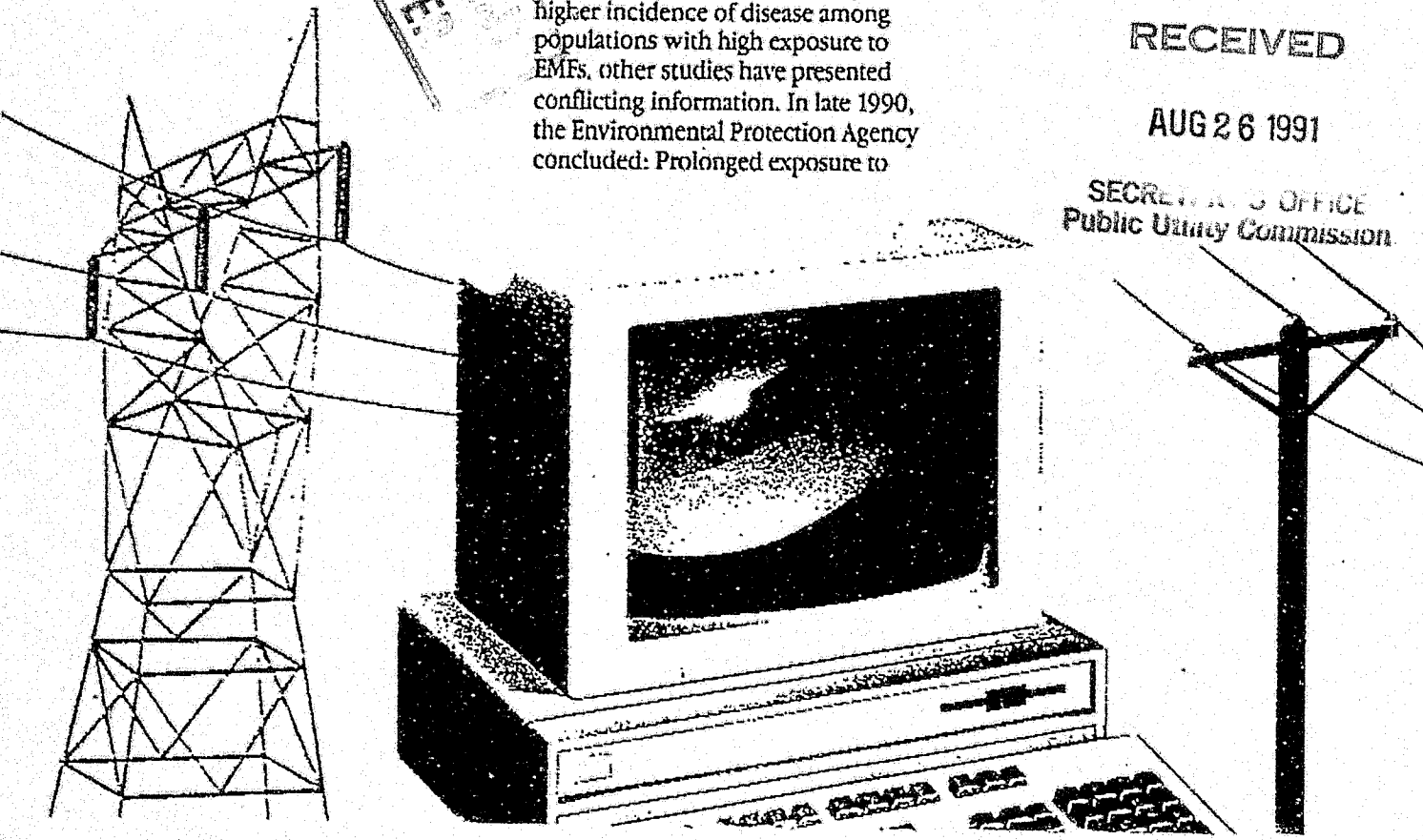
If there is a health risk, how great is it?
Apparently it is very small. For instance, if EMFs are found to be linked to leukemia in children, the chances of developing the disease are increased from one in 20,000 children to 2.5 in 20,000. For all of us, there are far greater cancer-causing concerns: e.g., smoking, improper diet, chemical exposures, too much exposure to the sun, family history, and high stress levels. Consider that worst case risk of childhood cancer in relation to deaths from other causes, as listed in the following chart from an EMF study by Carnegie Mellon University.

DOCKETED
AUG 28 1991

RECEIVED

AUG 26 1991

SECRETARY'S OFFICE
Public Utility Commission



Data on Deaths in the United States

| Cause of death. | Approximate number of Americans who die each year from this cause. | Approximate odds that when the average American dies it will be from this cause. |
|-----------------------|--|--|
| Disease (all kinds) | 2,000,000 | 1 in 1.1 |
| Heart disease | 770,000 | 1 in 2.7 |
| Cancer (all kinds) | 480,000 | 1 in 4.4 |
| Accidents (all kinds) | 95,000 | 1 in 22 |
| Auto accidents | 48,000 | 1 in 44 |
| Diabetes | 37,000 | 1 in 57 |
| Suicide | 31,000 | 1 in 68 |
| Homicide | 21,000 | 1 in 100 |
| Drowning | 5,900 | 1 in 360 |
| Fire | 4,800 | 1 in 440 |
| Asthma | 4,000 | 1 in 530 |
| Firearm accidents | 1,500 | 1 in 1400 |
| Viral hepatitis | 1,000 | 1 in 2100 |
| Electrocution | 850 | 1 in 2500 |
| Car-train accidents | 570 | 1 in 3700 |
| Appendicitis | 510 | 1 in 4100 |
| Pregnancy and related | 470 | 1 in 2200 |
| Lightning | 78 | 1 in 27,000 |
| Floods | 58 | 1 in 36,000 |
| Tornados | 58 | 1 in 36,000 |
| Fireworks | 8 | 1 in 260,000 |
| Botulism | 2 | 1 in 1,100,000 |

Assuming there is a hazard, how much EMF would it take to harm you?

The jury is still out. Laboratory studies have failed to identify any hazardous level. Also, the observable effects of EMF have proven to be unpredictable. To add to the confusion, there are cases in which EMFs are actually good for you. For years, doctors have used small amounts of electricity to speed the healing of broken bones. The use of magnetic resonance imaging (MRI)—an electromagnetic field—is considered to be far safer than the use of x-rays for lengthy examinations of the inner workings of our bodies. The questions are many and complex; the answers for now are few.

What is Philadelphia Electric's role in all this?

As a responsible member of the community, PECO wants to resolve the uncertainty. We are working toward that goal on a variety of fronts.

- PECO is participating in, funding, and monitoring several research efforts ongoing in the scientific community.
- PECO's own EMF task force, established four years ago, is a full-time multi-discipline team dealing with the question on an ongoing basis.

What kind of research is going on?

There are three kinds of studies being performed: (1) laboratory studies on cells and tissues, (2) laboratory experiments using animals such as rats and mice, and (3) statistical research analyzing relationships between exposure to electricity and various diseases in humans and grazing animals near power lines. Among the

groups conducting the studies are the National Cancer Institute, the National Academy of Sciences, the Department of Energy and numerous governments around the world. The Electric Power Research Institute, founded and funded by U.S. utilities, has already spent more than \$30 million researching the impact of electric and magnetic fields.



- PECO is investigating new engineering methods. For example, when we design and build new power lines, we evaluate construction practices designed to reduce EMFs.
- PECO is working with government officials at all levels, as well as school districts and members of the business community.
- PECO is openly communicating with its various publics to increase awareness about EMFs. This booklet is an example.

What can I do about EMF?

First, add a word to your vocabulary: The word is *milligauss*. It's a unit of measurement. Just as you and I measure our height and weight in inches and pounds, scientists measure magnetic field strength in units of milligauss. How much exposure you receive depends on three things:

1. How strong is the field at its source?
2. How far are you from the source?
3. How long is your exposure to the source?

| <i>How many milligauss units?</i> Here are the magnetic field strengths of several household appliances. | |
|---|--------------------------|
| Appliance | Average milligauss level |
| Television | 1-3 |
| Vacuum cleaner | 1-11 |
| Microwave oven | 3-40 |
| Refrigerator | 1-8 |
| Dishwasher | 1-15 |
| Computer | 1-25 |
| Electric alarm clock | 1-12 |
| Blow dryer | 1-75 |
| Electric blanket* | 10-70 |
| Lamp* | 5-20 |
| Toaster* | 0.6-8 |
| Electric coffee pot* | 1-10 |
| High voltage line* (at edge of right of way) | 30-100 |
| Low voltage line* (under line) | 1-50 |

Source: Silva, et. al., "Power Frequency Magnetic Fields in the Home," Institute of Electrical and Electronics Engineers—IEEE Transactions on Power Delivery, Vol. PWRD-4, No. 1, pp. 465-478, January 1989.
*PECO data.

I understand milligauss as a unit of measure. Now what? Consider what one researcher has called Prudent Avoidance. Prudent Avoidance is simply common sense reduction of your exposure to electric and magnetic fields. Some cases in point: Don't stand close to your microwave oven, your dishwasher or your television set while they're on. Move radios, answering machines, electric clocks and other appliances so they're not right next to you. Consider using your electric blanket to preheat your bed to a comfortable temperature, and then turn it off when you climb in for the night. At work, keep your video display terminal at least 18 inches from you.

What's down the road for EMFs? A lot more research is needed. Philadelphia Electric Company is deeply committed to participating in that research, acting upon its findings, and sharing EMFs information with the 3.8 million residents in its service area.

