

NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING APPEAL BOARD

IN THE MATTER OF:

VIRGINIA ELECTRIC AND POWER COMPANY

(North Anna Power Station,
Units 1 and 2)

Docket Nos. 50-338 OL
50-339 OL

(Pump House Settlement
and Turbine Missiles)

Place - Bethesda, Maryland

Date - Tuesday, 19 June 1979

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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5th Floor
 East-West Towers
 4350 East-West Highway
 Bethesda, Maryland

Tuesday, 19 June 1979

The hearing in the above-entitled matter was convened,
 pursuant to adjournment, at 9:00 a.m.

BEFORE:

ALAN S. ROSENTHAL, Chairman, Atomic Safety and
 Licensing Appeal Board

DR. JOHN H. BUCK, Member

MICHAEL C. FARRAR, Member

APPEARANCES:

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On behalf of the Applicant:

JAMES N. CHRISTMAN, ESQ., and MICHAEL W. MAUPIN,
 ESQ., Hunton & Williams, 707 East Main Street,
 Richmond, Virginia 23212.

On behalf of the Nuclear Regulatory Commission:

DANIEL T. SWANSON, ESQ., STUART A. TREBY, ESQ.,
 and HENRY J. MC GURREN, ESQ.

1 APPEARANCES - Continued:

2 On behalf of the Intervenor Geraldine Arnold:

3 RICHARD M. FOSTER, ESQ., Public Interest Law Center
4 of Virginia, 1908A Lewis Mountain Road,
Charlottesville, Virginia 22903.

5 On behalf of the Commonwealth of Virginia:

6 ANTHONY GAMBARDELLA, ESQ., Assistant Attorney General,
7 Office of the Attorney General, Division of Consumer
Counsel, 11 South 12th Street, Suite 308, Richmond,
8 Virginia 23219.

9 On behalf of the North Anna Environmental Coalition:

10 JUNE ALLEN, President, NAEC

11 On behalf of Citizens for Albemarle, Inc.:

12 ALFRED D. SASSANO, SUE R. SASSANO, ELIZABETH A.
13 NOLTING, DR. ROBERT F. MUELLER, and ROY M. PATTERSON.

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C O N T E N T S

	<u>DIRECT</u>	<u>CROSS</u>	<u>REDIRECT</u>	<u>RECROSS</u>	<u>BOARD</u>
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2	<u>WITNESS:</u>				
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C. R. Cartwright,
 Robert B. Bradbury,
 Stanley A. Lucks,
 Bruce N. MacIver,
 (resumed)
 and

Douglas A. Wert

Lyman Heller,
 Richard Kiessel,
 Joseph Lenahan,
 Jared Wermeil, and
 Alexander Dromerick

William S. Bivins

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P R O C E E D I N G S

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CHAIRMAN ROSENTHAL: Good morning. I think it might be noted at the outset for the record that Mr. Gambardella, the counsel for the Commonwealth of Virginia, is not with us this morning. He advised us yesterday afternoon that he is required to attend a hearing in Richmond which, as I understand it, was called on an emergency basis. He may be back with us tomorrow.

I think the staff cross-examination of the applicant's panel, if it's present, if the applicant's panel of witnesses would resume their places at the witness table.

MR. CHRISTMAN: Mister Chairman, as they're doing that, could I mention one administrative detail about witness availability?

CHAIRMAN ROSENTHAL: Yes, Mr. Christman.

MR. CHRISTMAN: Dr. Schaeffer, who is perhaps our most important witness on turbine missiles, will be available tomorrow. That is his last day. He has had another commitment for a long time. The only thing I would suggest is that we interrupt however far we've gotten tomorrow morning and go with our turbine missile panel and go all day.

CHAIRMAN ROSENTHAL: Mr. Christman, it is my hope, indeed my expectation, that we will conclude the evidence on the pump house settlement issue today and, as I understand it,

1 the applicant witnesses will be heard first on the turbine
2 missile issue as they have heard first on the pump house
3 settlement issue. I don't anticipate there will be any problem
4 in that regard. We will certainly bear that in mind.

5 MR. CHRISTMAN: Fine. Thank you.

6 Whereupon,

7 C. R. CARTWRIGHT,

8 ROBERT B. BRADBURY,

9 STANLEY A. LUCKS,

10 and

11 BRUCE N. MAC IVER

12 resumed the stand and, having been previously duly sworn, were
13 examined and testified further as follows:

14 CROSS-EXAMINATION

15 BY MR. MC GURREN:

16 Q Good morning. I take it you can all hear me. I'll
17 start with you, Mr. MacIver.

18 A (Witness MacIver) Yes, sir.

19 Q Didn't you testify yesterday that VEPCO is continuing
20 to monitor settlement of the service water pump house every
21 month and recently has been monitoring weekly?

22 A That is correct, sir.

23 Q Why are you doing this?

24 A The settlement is at approximately 90 percent of the
25 allowable value in the technical specification, and we feel,

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1 VEPCO feels, incumbent to be assured that we would not exceed
2 that value without our knowledge of it, and this is why it is
3 being monitored on such an intense frequency at this point in
4 time.

5 Q Correct me if I'm wrong, but didn't you also say
6 that settlement is not understood at this time?

7 A I'm not aware that I said that the settlement is
8 not understood. The time rate at which the settlement has
9 occurred over the past few years is not understood. Excuse me,
10 sir. The concern which perhaps you're addressing is that with
11 regard to the four service water lines which, since last
12 September, have settled slightly more than the north wall of
13 the pump house -- this additional settlement is not completely
14 understood, and the monitoring on a monthly basis would
15 continue until either we gain an understanding of that
16 additional settlement or we can see that it has been completed.

17 Q Are you aware that it is the staff's position that
18 measurement on settlement markers SM-7, 8, 9, 10, 15, 16, 17,
19 18; H--569; and H-584; should be made at least once every 31
20 days until unit one has been in operation at least five years?

21 A I am familiar with this statement in the staff
22 testimony.

23 Q Are you also familiar with the staff's position that
24 at the end of the five year period an engineering study should
25 be made by VEPCO to determine the need for and frequency of

m_s 1 continued monitoring of settlement ground water and drain
2 flow rates?

3 A I am familiar with that statement in the staff
4 testimony.

5 Q Do you have any objection to that staff position?

6 A From a good common sense engineering point of view,
7 a frequency of once per month is excessive, once we can
8 establish that the rate of settlement is sufficiently slow so
9 that there would not be an opportunity for a significant
10 amount of further settlement to occur between readings. Upon
11 our explanation or indication of cessation of the recent
12 further settlement of the four service water lines, an adequate
13 monitoring program would see the reduction of that frequency
14 perhaps to a quarterly basis and eventually back to the
15 original semi-annual basis, and this would be adequate from the
16 standpoint of verifying compliance with the technical
17 specifications.

18 Q But right now with respect to the four service water
19 lines, you do not feel that you fully understand the
20 settlement. Is that correct?

21 A That is correct.

22 Q Mr. Cartwright, early during your cross-examination,
23 I believe you indicated that in certain instances you might
24 wish to verify survey measurements before reporting on them.
25 Is that correct?

m₂ 1 A (Witness Cartwright) Well, the tech spec allows
2 60 days reporting when you get to 75 percent of spec allowable,
3 and so, yes, we would reverify once we had these readings in.
4 If there's any reason at all to doubt their correctness, yes,
5 we would reverify those, which still gives you plenty of time
6 to report within the 60 day period.

7 Q I think in your answer you may have answered my next
8 question, but I'll ask it any way. What would happen if one
9 of your survey reports indicated that the settlement of the
10 service water pump house exceeded the tech spec for a total
11 allowable settlement? Would you, in that circumstance, attempt
12 to verify before complying with the present tech spec
13 requirement?

14 A No, under those circumstances, we could not do that.
15 We must abide by the tech spec unless it was a completely far
16 out or ridiculous type of survey reading. But under normal
17 circumstances, we would have to abide by the tech spec at the
18 100 percent level.

19 Q And what would that require you to do?

20 A That requires shutdown of the unit -- to go into
21 mode five cold shutdown.

22 MR. MC GURREN: Thank you. That's all I have,
23 Mister Chairman.

24 MR. FARRAR: Mr. McGurren, let me follow that one
25 up just quickly. Mr. Cartwright, let me make sure I

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m 1 understand. You're saying that the instant the readings hit
2 your desk, it's not you but whoever in VEPCO is responsible.
3 The instant they hit that person's desk, they go to cold
4 shutdown without calling surveyors down from Boston or
5 wherever they're from and asking them to take another look at
6 it just to make sure. And I'm talking now of something that
7 was, you know, 100 percent plus a little tiny bit, they
8 wouldn't call them right back down and say take another look
9 at it, because maybe we get lucky, and the little error we
10 talked about yesterday will prove to be in our favor and we
11 won't have a shutdown. Is that what you're saying?

12 WITNESS CARTWRIGHT: I was just checking the actual
13 statement in tech specs which, when you exceed the 100 percent
14 of allowable, you have six hours to get to hot standby and
15 another 30 hours to get to cold shutdown. It is the time to
16 make a telephone call and get some advice and to get some other
17 experts like Mr. MacIver and some of our people in Richmond.
18 But the decision has to be made, and you can see there's not a
19 lot of time -- there's surely not time to resurvey.

20 MR. FARRAR: I guess what I'm concerned about is
21 from what you've just said, in the tech spec, it says to
22 exceed 100 percent. Well, someone in your company might say,
23 well, I've got this figure on my desk which reads over 100
24 percent, but I'm not sure at this point if, in fact, we exceed
25 100 percent because maybe that survey is wrong. I'm asking

m. 1 what your position as the station manager is in that situation,
2 whether you're prepared to start the six hours and 30 hours
3 running at that point or whether someone down there is going
4 to say, well, I'm not sure yet; call my team back and take a
5 couple days before I go on record?

6 WITNESS CARTWRIGHT: No, sir. We would not do that.
7 If the survey was over the 100 percent, the unit would be
8 shut down for tech spec.

9 MR. FARRAR: Thank you.

10 CHAIRMAN ROSENTHAL: I think that before we provide
11 Mr. Christman the opportunity to undertake whatever re-direct
12 examination he might have in mind, I'll call for questions on
13 the part of the members of the board. Dr. Buck?

14 EXAMINATION BY THE BOARD

15 BY DR. BUCK:

16 Q While we're on the tech spec, I might ask the
17 following question on that. You have a measurement of over 100
18 percent of your allowable under the tech spec. You then have
19 to go to cold shutdown. What happens then?

20 A (Witness Cartwright) You asked what happens when
21 we go --

22 Q Yes. What's the procedure? What happens? Do you
23 just sit there at cold shutdown, or what is the staff supposed
24 to do, or what are you supposed to do?

25 A We would have to rectify that by an engineering

m 1 study. The tech spec itself, which I do have here in front
2 of me, does not give any direction. It does give direction
3 when you hit the 75 percent allowable that an engineering
4 evaluation would have to be made. Once you go to cold shutdown
5 mode five, you would have to evaluate the circumstance, and
6 I can't really predict at this time what would happen, but
7 we would have to call in the other people who are experts in
8 this field and evaluate the situation and, of course, talk to
9 I & E as well.

10 Q You're in, say, the 90 percent range now. Right?

11 A That's correct.

12 Q And you have an engineering study going on, and you
13 ask for modification of the tech spec. Is that where the
14 situation presently stands?

15 A That's correct.

16 Q Has the staff, well, I'll ask the staff I guess, but
17 what has your reply been so far from the staff on your
18 application for modification of the tech specs?

19 (Pause.)

20 A Could you repeat the question again, please?

21 Q I want to know if you know what the staff's reply is
22 to your present request for modification of the tech specs.

23 CHAIRMAN ROSENTHAL: If you don't know, you can
24 simply say so.

25 WITNESS MAC IVER: No, we certainly do, sir. The

1 staff does not wish to accept the VEPCO proposed change to
2 the technical specification which would increase the allowable
3 average settlement. Instead, they wish to impose several
4 limiting conditions which would have to do with the
5 settlement of the exposed ends of the service water lines which
6 would have to do with the differential settlement across the
7 expansion joints and would have to do with the settlement of
8 the pump house with respect to the spray piping.

9 BY DR. BUCK:

10 Q All right. Can you very quickly tell me exactly what
11 your proposal for the new tech spec is?

12 A (Witness MacIver) The VEPCO proposed tech spec
13 would have the average allowable settlement of the pump house
14 be placed at .33 foot since December, 1975, based upon the
15 analysis of the average settlement which would cause the
16 tolerable movement of the expansion joint to be exceeded.

17 Q Then you are taking into account the differential
18 settlement between the pump house and the pipes?

19 A The differential settlement between the pump house
20 and --

21 Q And the pipes at the far end of the joint.

22 A And the pipes to the north of the expansion joints
23 is already addressed in the technical specifications.

24 Q So what you're saying is your .33 takes into account
25 any settlement of the pipes that may go in the same direction

m. 1 as the pump house or they in some way change from the
2 settlement of the pump house. You see what I'm concerned about
3 here, and I don't quite understand what your asking for, this
4 .33 in the tech specs, because the amount of settlement of
5 the pump house, it seems to me, depends upon how much the
6 pipes also settle -- the allowables of the pump house. Is that
7 not correct?

8 A Yes, sir.

9 Q How do you mesh that into your tech spec on an
10 absolute settlement of the pump house? That's what I'm asking.

11 A (Witness Bradbury). Perhaps I can clarify that, sir.
12 Our method of arriving at the .33 foot request was based on an
13 analysis that conformed, using as an input to our mathematical
14 model of the piping system of the expansion joint, settlement
15 at the point where the pipes are connected to the pump house.
16 One of the assumptions we made in that analysis was that that
17 settlement would be the same as the settlement on the other
18 end of the expansion joint.

19 Q You assume it's the same. The pipes, in other words,
20 drop the same amount as the pump house.

21 A Yes, sir. And the .33 foot represents the maximum
22 settlement for which we reach one of the limits of expansion
23 joint motion. That certainly is nowhere near the allowables
24 of the expansion joint, however.

25 Q Well now, we've gotten into the expansion joint.

1 I was going to do some things on saprolite first, but let's
2 continue on this line.

3 I would like to ask some questions on the expansion joint
4 first of all, and I think perhaps the best way to go at it is
5 to ask exactly how this expansion joint operates.

6 A Figure 15 is the figure of the expansion joint.

7 Q Now on Figure 15 to the left side, if I understand
8 it, is over toward the pump house wall. Is that correct?

9 A That is correct.

10 Q And there you show your pipe coming out, going
11 through a bellows, a piece of pipe, another bellows, and then
12 slanting down so that it goes down to the bottom where the
13 pipe goes out under the earth. Is that correct?

14 A Yes.

15 Q Okay. Now the piece of pipe in the middle is just
16 to give you an amplified motion or a small motion of the
17 bellows. Is that correct? When you have two bellows like
18 that separated by a piece of pipe, does that not allow you to
19 have a much wider motion?

20 A Yes.

21 Q And I presume that's the purpose of that.

22 A Yes.

23 Q Okay. Now what confuses me about this drawing,
24 what's the third bellows off to the right hand side?

25 A That is called the balancing bellows.

m 1 Q How does it fit in, and how does it work, and
2 so on?

3 A The motion, the prior motion that occurs in this
4 joint, is one of the compression which results when the pipe
5 shown on the right of the expansion joint compresses the joint
6 to the left. If it were not for this balancing bellows on
7 the end, in order to compress the joint, this pipe motion
8 would have to overcome the static force exerted towards the
9 right by the system pressure times the area of the pipe, which is a
10 three-foot diameter pipe, which is a significant force. With the balancing bel-
11 lows, this allows motion of the two lefthand bellows to compress, and the
12 balancing bellows will expand. The overall joint dimension
13 is maintained essentially constant by the use of the four
14 large --

15 Q Oh, I understand. Now the pressure exerted by the
16 pipe was explained yesterday as due to thermal changes.

17 A Primarily, yes.

18 Q What is the total range of temperatures of the
19 water in that pipe? Do you happen to know?

20 A The total range of temperatures we have analyzed,
21 from approximately 35 degrees to approximately 180 degrees
22 on the highest pipe which is the return line to the reservoir
23 which would only be reached during the worst design basis of
24 the station.

25 Q That would not apply to the intake pipes, or do you

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i analyze them all from the same temperature?

2 A We analyze, essentially, them all from the worst
3 temperature. We analyze the worst case.

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1 Q 35 degrees would be your winter temperature, I
2 presume, your intake temperature. And your 100 and, let's
3 say, 80 degrees would be the pipe temperature of the hottest
4 outgoing water that you'd be likely to have.

5 A Yes.

6 Q I hope you don't get that high.

7 A That would be as the result of a LOCA. That would
8 be removing heat from the containment. That was the only time
9 we reached that 180-degree temperature.

10 Q Okay. Now, what do you anticipate in the way of
11 bellows movement? I'm asking this: How often do you get a
12 real thermal change in the operation of the pump house or the
13 operation of the pipeline?

14 A The only significant thermal changes that the system
15 sees are those that would occur during system shutdown. The
16 thermal change from summer to winter would obviously occur once
17 a year, but that's very slow, and that would not be considered
18 a significant change nor a significant cycle.

19 Q So in other words, as long as you're in normal
20 operation you essentially are in one cycle. It doesn't
21 recycle or do anything like that, as long as you're in basically
22 full-power operation?

23 A Yes, sir.

24 Q Every time you shut down you go through a cycle in
25 your analysis; is that correct?

1 A. Every time you shut down one of these headers, which
2 is very infrequent. We've assumed the number of cycles in the
3 plant as 1,000 cycles, which includes --

4 Q. Total lifetime cycles?

5 A. Of the power station life, yes.

6 Q. And the same number of cycles for this pipeline;
7 is that what you're talking about?

8 A. Yes.

9 Q. All right. Going through the full range of the
10 temperature, what is your expansion, or what expansion do you
11 feel you have to allow for in the bellows?

12 A. The motion of the bellows, of course, is a combina-
13 tion of temperature effect and settlement effect.

14 Q. Just take the temperature effect. That's all I'm
15 asking about. I'll get into the others in a moment. ... But let's
16 just take that first thing.

17 A. I do not have the number solely due to the
18 temperature effect. What I can say is that the number at our
19 proposed tech spec limit is about 40 percent of the allowable
20 compression and a minimum of two-thirds of that motion is due
21 to the thermal effect.

22 Q. What others are in the compression?

23 A. The settlement of the dike also induces essentially
24 some of the compression, as the pipe tends to pull part of the
25 dike a little bit more, if you can look at it that way.

1 Q. That doesn't cause a lateral motion?

2 A. Very slight, since the pump house is, as I said,
3 essentially settling the same amount.

4 Q. Supposing they don't settle at the same amount.
5 Then it causes a lateral offset?

6 A. Then it causes a lateral offset, yes, sir.

7 Q. Now how does it cause a compressional motion; just
8 settlement, now?

9 A. If you consider that the piping system is locked
10 into the soil well past the toe of the dike towards the north,
11 and the dike essentially tries to settle around the pipe. In
12 other words, the pipe doesn't get any shorter. If the dike
13 settles a slight amount, the pipe will do a couple of things.

14 . It will try to rotate downward around the elbows
15 near the toe of the dike, and it will try to extend through the
16 dike a slight amount.

17 Q. I'm afraid I don't follow the "extending through
18 the dike." I can see, the lower the dike sinking, it would
19 tend to bow the pipe downward. But that would seem to me, on
20 offhand analysis, that would tend to pull it away from the
21 pump house rather than push it into the pump house.

22 A. Perhaps it might be clearer to refer to Figure 26
23 of our testimony.

24 Q. Okay.

25 A. If you rotate that pipe vertically downward around

1 the 47-degree elbow, then the dimensions, so to speak, of the
2 angle will decrease, and the horizontal direction will increase
3 slightly. As I say, it's a very small effect.

4 Q All right. At the same time, then, you're also
5 twisting your bellows joint.

6 A The twist is, as I say, very slight. The primary
7 effect is compression.

8 Q All right. What other things cause compression
9 besides the thermal and the twisted pipe?

10 A Seismic motion would cause a very slight amount
11 of compression.

12 Q On what assumption?

13 A This is due to the slight relative motion between
14 the pump house and the pipe.

15 Q So it might go either way, compression or expansion?

16 A Yes. That's so small it's almost negligible. But
17 it is there.

18 Q Okay. Anything else that causes compression?

19 A No.

20 Q All right.

21 Now, I'm concerned about the lateral motion of the
22 bellows. Have you looked at the forces that may cause lateral
23 motion? Not twisting, but just plain lateral motion?

24 A Our analysis includes forces due to settlement,
25 forces due to friction. And yes, we have considered all the

1 forces that act on the pipe.

2 Q Including the twist of the pump house itself, the
3 tilt?

4 A Including -- yes, that's correct. We have considered
5 that.

6 Q All right. Now, you say you combine all of these
7 motions, all of these forces, into a code to analyze the
8 expansion joint; is that correct?

9 A The mathematical model that we construct essentially
10 includes the expansion joint as well as the pipe, yes.

11 Q All right. Now, getting away from the motions for
12 a moment, what in the construction of the bellows leads you
13 to believe that any initial leak would be a pinhole?

14 A We've had a number of discussions with the expansion
15 joint manufacturer on how he would expect this bellows to
16 perform under the conditions that we see outside of our pump
17 house.

18 Q Why does he come up with the pinhole? I'm very
19 puzzled by just "pinhole leaks." Do you know the bases for
20 his conclusion on that?

21 A He has actually taken a similar joint, compressed
22 it axially to its limit -- in other words, until the convolutions
23 are essentially hard up -- and cycled it. It was during this
24 cyclic testing that the first phase occurred, which was
25 pinhole leaks.

1 Q When you call it a pinhole leak, is this the
2 beginning of a crack?

3 A Essentially, you could interpret it as being that,
4 yes.

5 Q How does that crack expand? Around the circum-
6 ference of the bellows?

7 A I don't know. In my opinion, that would be the
8 most likely direction.

9 Q Do you have any data from the manufacturer as to
10 how long it took them, after he got initial leakage, the
11 pinhole leak or leaks, after he got those initial leaks, for
12 the crack to expand or propagate?

13 A I don't know of any. However, we do have data that
14 it took in excess of 2,500 cycles for the pinhole to appear.

15 Q This is only on one bellows. Did you have any
16 other experience on these things?

17 A I'm not aware of any.

18 Q Do you know how many of this type of bellows are
19 in operation anywhere in the country?

20 A No, I don't. But it's not an unusual design.

21 Q Is it the same size -- the question I'm asking is:
22 Is this an unusually large bellows, unusually long or large
23 diameter, unusual construction in any way from others that are
24 in operation around the country?

25 A I wouldn't think so. But I don't know just how many

1 he has furnished.

2 Q And you don't know the history of operation of any
3 of these?

4 A No, I don't.

5 Q If you did get a rapidly propagating crack in a
6 bellows, what instrumentation do you now have that would detect
7 such a leak and how big a leak would it have to be before you
8 could detect it?

9 A Should we reach, for some reason, such an event as
10 you postulated, if we could go back to the Figure 15, I
11 believe, Figure 15.

12 Q 18?

13 A '15, which shows the expansion joint. And if one
14 were to postulate one of those convolutions experienced a
15 circumferential crack, the water would certainly still flow
16 through the expansion joint.

17 Q I'm not worried about the water flowing through the
18 expansion joint to begin with. I want to know how soon you
19 can detect the leak and how big a leak it would have to be
20 before you can detect it.

21 A We would, first of all, not anticipate getting a
22 large amount of leakage during this event, primarily because
23 there are four large tie rods that hold this joint together
24 that would prevent transference deflection. You would need
25 to have substantial transference deflection to have a leak

1 of sufficient magnitude to affect the system. We estimate
2 that it would take in excess of 3,000 gallons per minute to
3 have appreciable effect on system operation.

4 Q All right. Now, let's go back to my question. What
5 size leak can you detect and how do you detect it? Any
6 instrumentation? Do you have flow meters? Do you have
7 pressure indicators? Do you have water droplet indicators?
8 What do you have?

9 A We have both flow indicators on the header, pump
10 discharge pressure indicators on the pumps. The exact size of
11 the leak that you would detect to affect system operation
12 would, again, be greater than this 3,000 gallons per minute
13 to see an effect on these instruments. However, a leak of
14 that magnitude or even a lesser magnitude would fill up that
15 expansion joint enclosure pretty fast, and it would overflow.
16 And the operator making his rounds would observe it that way.

17 Q How often do they make the rounds?

18 A Twice a shift.

19 Q Twice a shift. Once every four hours, I would
20 imagine?

21 A Yes.

22 Q Okay. Does it really fill up the enclosure? Is
23 there any way for it to come out? Does it come out into the
24 top, in other words, or is there a way out at the bottom, so
25 that all that you do is -- see, it would be in your drain

1 pipes underneath?

2 A. The enclosure essentially has no floor, so certain
3 amounts of water could seep into the bottom. But at the flow
4 rates that we're talking about, it would certainly come out
5 the top.

6 Q. And you don't think it's likely that if water ever
7 came out the top, it would wash out enough so that it would
8 just proceed to fill the drains underneath?

9 A. (Witness Lucks) In my opinion --

10 Q. If the answer is no, I'd like to have the reason
11 for its being no.

12 A. In my judgment no. Before it would get to the
13 drains beneath the pump house, it would have to go through the
14 foundation saprolite, which has a relatively low permeability.

15 Q. It would have to go through what?

16 A. The foundation saprolite.

17 I assume you're meaning the horizontal drains?

18 Q. That's right.

19 A. There's a much easier path for it to get out the top
20 of the enclosure.

21 Q. You think the permeability of the saprolite is such
22 that not much would go down into the drain level?

23 A. Yes.

24 Q. My problem here is, in a bellows like this, frankly,
25 I've only used much smaller bellows before. But once you start

1 getting cracks, they propagate pretty rapidly. And I'm a little
2 disturbed by the fact that you're relying on the pinhole leak
3 and the lack of propagation, on the one experiment by the
4 manufacturer. I'd like to see a lot more history of that,
5 frankly.

6 But it would seem to me that you could alleviate
7 this a great deal by having some form of instrumentation in
8 that pump house that would detect water levels, before it had
9 to come busting out through the manhole.

10 A (Witness Bradbury) My only response to that is to
11 emphasize that leakages of significant magnitude that could
12 affect system performance, it's our opinion that it would be
13 detected in a timely fashion by other means.

14 Q But you said just a moment ago that you didn't think
15 you could detect a decrease of the order of 3,000 gallons per
16 minute in the flow. And by that time, your pump house enclosure
17 would be filled up.

18 Can you detect a lot less change in flow than that?

19 A That number of 3,000 gallons per minute is --
20 essentially, we still would retain proper system flow, because
21 that postulates again a separation of the joint, and therefore
22 a flow path up there which would be a low heat loss path. So
23 we anticipate the pumps would run out on that curve, providing
24 more water at the pump discharge and still providing system-
25 required flow by pumping some extra water up the expansion

ite 11
1 joint.

2 Q Does that mean a change in the header pressure?

3 A That would change the pump discharge pressure
4 slightly, yes.

5 Q Would that be detectible? I mean, is that instru-
6 mented back on your panel?

7 A Yes, that is instrumented in the control room.

8 Q Have you any idea how sensitive that is, as to what
9 change in flow you would require to make a change in the
10 header pressure?

11 A I don't know exactly. The pump has a relatively
12 flat curve in that range.

13 Q I would think it would, at a flow of 2,000 gallons
14 on each side at that range.

15 Okay. Mr. Farrar, did you have any questions on
16 this?

17 BY MR. FARRAR:

18 Q At one point, in answering Dr. Buck, his questions
19 seemed concerned about this pinhole leak propagating or the
20 3,000-gallon leak propagating. And your answer was, well,
21 your only concern was as long as there's still flow going
22 through the plant. You know, you're happy everything's still
23 being cooled.

24 I think he was concerned that, okay, great, the
25 plant's still being cooled; meanwhile, off in the enclosure --

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1 DR. BUCK: That's right, I wanted to know what
2 instrumentation they had to detect this.

3 MR. FARRAR: I saw your answer being responsive to
4 the concern of the operator that there's still water getting
5 through. His concern is that, while water is still getting
6 through, his pinhole leak is busily propagating itself, leading
7 to the event that you told us was incredible yesterday.

8 WITNESS BRADBURY: If we think about the scenario
9 we postulated and how we got there, we got there by, first of
10 all, exceeding our proposed tech spec limit, which represents
11 on the order of 40 percent of the allowable limit.

12 BY DR. BUCK:

13 Q I'm not talking about you exceeding the tech spec
14 limits. I'm talking about something happening to the bellows
15 long before the proposed life cycle of the bellows. Okay? I'm
16 talking about a bellows that may be slightly imperfect. It may
17 have a thin spot and after 100 cycles it gets cracked. That's
18 all I'm proposing.

19 I'm not proposing anything about your tech spec or
20 anything else. I propose to get you running along. You're
21 well below 90 percent of your tech spec on the settlement
22 situation, and you're way below anything that you expect in the
23 way of thermal cycling on this bellows. So you think you're
24 perfectly safe. Okay.

25 All I'm proposing here is that, okay, we've got a

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1 weak bellows. We didn't know about it. It suddenly cracks.
2 And the answer we got yesterday, well, this would be a pinhole
3 crack.

4 Now, my question again is: If you have a pinhole
5 crack, pinhole cracks have a habit of propagating. So I'm
6 trying to find out at what level of leakage would your people
7 be able to detect it, and how soon. Forget about tech specs
8 or anything else. I'm just giving you a scenario of a faulty
9 bellows. Let's put it that way. And lord knows, we don't know
10 when we're going to have a faulty bellows.

11 A. (Witness Bradbury) Detecting this leakage by
12 observing water essentially coming out the top of the
13 enclosure would be possible with leakages significantly less
14 than the 3,000 gallons a minute we've spoken of. It's a very
15 small enclosure. I don't have an absolute number of gallons
16 per minute versus fill time of the enclosure box, essentially.
17 But certainly, if the leakage is down on the order of less than
18 a thousand gallons a minute, it would cause those things the
19 operator would be sure to note while he made his runs, while
20 still maintaining --

21 Q. I'm not arguing about the fact that you've got loss
22 of water. Nobody's worrying about that at the moment. All
23 I'm asking here is, do you have instrumentation on the plant,
24 other than a man walking around every four hours, that would
25 indicate that you have a leak and a chance of further

1 propagation of cracks on the bellows. That's all I'm asking.
2 I think your answer is that under 3,000 gallons per minute or
3 something like that, you doubt that any of your instrumentation
4 would do it. Am I right in saying that?

5 A Yes.

6 Q Okay, thank you.

7 BY CHAIRMAN ROSENTHAL:

8 Q Let me ask you this question: Is it fair to say
9 that most of the responses that you've given to the line of
10 questions that have been provided to you are really based upon
11 what the manufacturer has informed you, based upon its own
12 testing, rather than upon your own independent knowledge and
13 experience?

14 A Yes.

15 Q So this really comes down, then, to reliance on
16 information supplied to you by the manufacturer?

17 A Yes.

18 Q You're satisfied that the manufacturer has put a
19 joint of this size through sufficient analysis and testing,
20 has sufficient experience with which to provide an informed
21 judgment as to what would happen?

22 A Yes, I am.

23 Q Do you know the extent to which the manufacturer
24 has tested or observed the performance of joints of this
25 particular character under these particular circumstances?

1 A Other than that we've represented in our testimony,
2 no, we don't.

3 Q On what basis do you offer this confidence?

4 A The manufacturer of the joint is a recognized
5 manufacturer of these type of components. Stone & Webster
6 has no evidence of bad components being supplied by this
7 manufacturer.

8 We routinely review manufacturers for improper
9 performance. This joint was inspected during and after by the
10 manufacturer, to ensure it conformed with the specifications
11 and drawings.

12 BY DR. BUCK:

13 Q One of the reasons that I'm digging into this, I
14 am a little disturbed by relying on a surveyor's measurement
15 or specification in plant. I've seen too many surveyor's
16 measurements that go awry, and it seems to me that a surveyor's
17 measurement is nothing more than a symptom of something else
18 happening. And it seems to me that you can ease up on your
19 reliance on surveyors if you have other means of detecting
20 possible flows in the joint.

21 It seems to be a lot simpler and more straightforward
22 to rely on some more precise measurements than it does on
23 monthly surveyors. Now, I know the staff has put a spec on
24 you. But that doesn't mean we can't talk about other ways of
25 providing protection against such a break.

1 I had another thought when I was talking, and now
2 I've forgotten. I'll have to come back to it.

3 Oh, is there any way of detecting a motion, either
4 a compression or expansion motion or a twist, on the expansion
5 joint itself? In other words, let's think of a big micrometer
6 sitting across there, where you could tell within a thousandth
7 of an inch by making a reading. Maybe that's impossible in
8 cases like this. I don't know. I'm just asking the question.

9 A. Certainly you could measure the joint compared
10 against the dimensions that it had when it was installed.

11 Q. Isn't that a lot simpler than surveying?

12 A. I don't believe so. These joints are covered with
13 a protective cover also that we did not show in our figure,
14 to protect the bellows from incidental damage.

15 Q. That's the point I'm asking: Is there some covering
16 or protection that prohibits you from measuring the bellows
17 itself?

18 A. This protective shield is around the bellows them-
19 selves to protect them from damage due to external causes.

20 Q. I've finished on that particular item. I want to
21 go on to sapolite in a moment.

22 BY CHAIRMAN ROSENTHAL:

23 Q. I would just like, before turning it over to
24 Mr. Farrar, to pursue the answer to the question that I asked
25 a few minutes ago. I asked a question as to what was the basis

1 for confidence in the manufacturer's representations as to
2 what would happen in a particular set of circumstances if
3 you were not aware of just how much experience or testing the
4 manufacturer may have engaged in. And I thought the response
5 was that this is a manufacturer which you're satisfied produces
6 a quality product.

7 Was that it, or did I misunderstand the response?

8 A. That's essentially correct, yes.

9 Q. Well, I'm not certain that the answer is totally
10 responsive. The manufacturer may produce a quality product.
11 But I would suppose that the possibility exists with any
12 manufacturer -- I mean, given the occasion, a particular item
13 which it supplies will have some kind of defects. And the
14 question I was really getting at is, you have hypothesized a
15 whole series of events -- the pinhole leaks and the like --
16 and all of this, you tell me, is based upon what you've been
17 told by the manufacturer.

18 And I still am uncertain as to the basis upon
19 which you can express this enormous confidence in the manufac-
20 turer's representations as to what the scenario would be,
21 without having a better idea than you seem to have regarding
22 just precisely what the manufacturer's experience has been.

23 Mr. Christman?

24 MR. CHRISTMAN: I can make an offer of proof. We
25 have another witness here who is more intimately familiar

1 with these expansion joints, these particular ones. Mr. Wert
2 is his name. I can have him come up here, if you'd like, since
3 the questions seem to be going in that direction.

4 CHAIRMAN ROSENTHAL: Where is Mr. Wert?

5 MR. CHRISTMAN: Mr. Wert is right here. *

6 CHAIRMAN ROSENTHAL: Is he employed by Vepco?

7 MR. CHRISTMAN: He's a Stone & Webster engineer.

8 CHAIRMAN ROSENTHAL: Yes, will you have him join
9 the panel.

10 MR. CHRISTMAN: Mr. Chairman, will you call
11 Mr. Douglas A. Wert to the stand.

12 CHAIRMAN ROSENTHAL: That's W-e-r-t?

13 MR. CHRISTMAN: Yes.

14 CHAIRMAN ROSENTHAL: Mr. Wert, if you'd remain
15 standing for just a moment and raise your right hand.

16 (Witness sworn.)

17 MR. CHRISTMAN: Mr. Wert, you may sit down.

18 Whereupon,

19 DOUGLAS A. WERT

20 was called as a witness and, having been first duly sworn, was
21 examined and testified as follows:

22 MR. CHRISTMAN: May I qualify the witness?

23 CHAIRMAN ROSENTHAL: Yes, you might.

24 BY MR. CHRISTMAN:

25 Q Mr. Wert, would you state your name one more time

1 for the reporter?

2 A (Witness Wert) Douglas A. Wert, W-e-r-t.

3 Q I'll ask you two questions. First, your professional
4 qualifications; and then I'll ask you your familiarity with
5 the expansion joints that we've been talking about here this
6 morning.

7 First, can you give us your professional qualifica-
8 tions, that is, your degrees, your experience, your position
9 at Stone & Webster?

10 A Yes, I'm an engineer in the Power Division for
11 Stone & Webster, with nuclear experience, three years in the
12 Navy on nuclear submarines and five years design experience in
13 the Stone & Webster Power Division.

14 I was graduated last year from Northeastern
15 University with a degree in mechanical engineering. And my
16 familiarity with the expansion joints particularly is that I
17 interface directly with the manufacturer in the development of
18 the testimony regarding the expansion joints and in the discus-
19 sions regarding testing and the development or the instigation
20 of the design movements that were given to the expansion joint
21 manufacturer to analyze, the particular case that we're dis-
22 cussing.

23 MR. FARRAR: Could I ask about the qualifications?

24 I lost track there. Mr. Wert, you said you got your
25 degree last year?

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1 WITNESS WERT: That's correct.

2 MR. FARRAR: You said you had a lot of years of
3 experience prior to that?

4 WITNESS WERT: That is correct.

5 MR. FARRAR: How did you manage that?

6 WITNESS WERT: I attended college in the 1960s and
7 entered the Navy. I was a nuclear reactor operator for six
8 years. And subsequent to my discharge, I jointed Stone &
9 Webster without a degree and attended night school for the
10 last five years to get a degree in mechanical engineering.

11 MR. FARRAR: Okay. Thank yo .

12 BY CHAIRMAN ROSENTHAL:

13 Q Mr. Wert, I take it that, from your seat in the
14 audience, you've been following this line of questions directed
15 to the expansion joint. Dr. Buck or Mr. Farrar, one or the
16 other, may have questions for you. But I was wondering whether
17 you might provide a response to the question which I had just
18 presented Mr. Bradbury. Do you recall the question?

19 A Would you please repeat the question?

20 Q The question was, in essence, what is the basis for
21 the confidence that Stone & Webster and, through it, Vepco,
22 has in the manufacturer's representation respecting the scenario
23 of events that would occur, the pinhole leak and the rest?

24 A I think in answer to that question, there's a dual
25 focus here. Number one, I think it might be of assistance if

1 I explain in a little more detail the testing that the
2 expansion joint manufacturer has done.

3 DR. BUCK: I wish you would, because that is one of
4 the questions that we have. We don't know anything about the
5 testing at the moment.

6 WITNESS WERT: I'd like to point out one thing, that
7 at the Vepco-proposed technical specification limit, these
8 expansion joints that are installed in service water lines are
9 designed for in excess of 40,000 cycles at the technical
10 specification limit. And what we asked the manufacturer to
11 do -- what we did was to give him a set of movements at the
12 expansion joint that would be representative of the condition
13 of the piping system under the technical specification limit
14 settlement for the pump house.

15 What he did was to analyze his expansion joints
16 using computer codes which are proprietary to the Expansion
17 Joint Manufacturers Association, but have been accepted by
18 ASME.

19 BY DR. BUCK:

20 Q Before you go on, could you give us the extent of
21 the motions that you postulated here, both compression and
22 lateral and twist? Do you know what size of motions you
23 projected?

24 A I don't have those specific numbers with me. They're
25 back on my seat. But the motions are on the order of

1 one-half inch lateral and 1.4 inches in compression, and a very
2 small amount of rotation, extremely small.

3 Q. But you do have a half inch of lateral motion?

4 A. That's correct. The expansion joints are designed
5 for three inches of lateral motion.

6 When we gave these numbers to the expansion joint
7 manufacturer, he used his codes to analyze them and found that
8 at this point the expansion joints would take only about
9 40 percent of the capacity, of their elastic limit. The elastic
10 limit is the point at which these convolutions -- let me
11 refer to Figure 15.

12 If we take and assume that we have compressed this
13 expansion joint in such a way that these convolutions are now
14 solids up against one another, the expansion joint manufac-
15 turer, as we discussed in our testimony, calls this an allowable
16 equivalent axial compression. What he does is to take all the
17 motions that occur on this expansion joint and, by virtue of
18 these ASME-approved codes, applies these and forms an equivalent
19 axial compression.

20 Then the ratio between this equivalent axial
21 compression and the design allowable is then a factor of safety,
22 if you will, that these expansion joints are designed for.
23 Now, since the numbers that we used at the technical specifica-
24 tion limit were far lower than the total allowables, even
25 though we had used the proposed technical specification limit

1 in the design parameters for this expansion joint, the
2 manufacturer gave us an expansion joint and assumed that all
3 the motions at one point are maximized.

4 Now, this resulted in us getting a very conservatively
5 designed expansion joint for this piping system.

6 What we further asked him to do was to assume that
7 this expansion joint was set up completely solid. We inputted
8 a design basis that said that the allowable equivalent axial
9 compression was reached on the joint, and then we continued to
10 cycle the joint. And under that capacity, this joint was
11 capable of taking in excess of 2500 cycles, or more than the
12 design life of the plant.

13 Furthermore, we went into the failure mechanism.
14 The expansion joint manufacturer has done numerous tests on
15 these expansion joints. The method of failure involves what
16 he calls the cycled lifetime. Now a cycle, as defined by the
17 Expansion Joint Manufacturers Association is a complete cycling
18 of this bellows assembly.

19 In this case, we have a very static condition,
20 because the settlement is very slow, of long-time duration,
21 and therefore the movements are extremely slow at any point
22 in time. So we really don't have cycles per se, as most
23 expansion joints are designed; especially in view of the fact
24 that the pressure-balancing bellows eliminates the thrust
25 component that would be associated with starting pumps and

1 this type of thing.

2 So we have basically a static device here. What
3 the expansion joint manufacturer does is to apply a design
4 load to his expansion joints, design pressure, and then he
5 continues to cycle these expansion joints.

6 Now, during his testing program he found that this
7 design, this basic design of metal expansion joints with
8 convolutions of this type went at least ten times the design
9 number of cycles beyond its elastic limit before the beginning
10 of some fatigue cracks. Now, these fatigue cracks are what
11 are referred to as the pinhole leaks, and that is that you
12 take this metal portion, compress it all the way up solid,
13 you open the thing out again and you bring it back in again.

14 When that happens, you form small fatigue cracks
15 around the circumference of these convolutions. These will
16 in time, and under additional cycles, begin to propagate into
17 a continuous circumferential crack.

18 Now, the expansion joint manufacturer indicated
19 that in their testing they didn't have any joints that had
20 circumferentially failed at 25 percent cycles over the design
21 lifetime. As a standard, they designed these expansion joints
22 for 40,000 cycles.

23 Q Do you know what their tests were, how many tests
24 were there, and what size of bellows they ran their tests at?

25 A In our discussions, I asked them whether or not they

1 had run tests on expansion joints similar to those installed
2 in our piping system. He indicated they had, that this was
3 pretty much a standard design. The angle of the pipe that
4 it's attached to may change, but the concept of using a
5 pressure-balanced expansion joint is not uncommon in a large
6 piping system, a large diameter pipe, as this is.

7 Q The materials you were using here are not unusual?

8 A That's correct.

9 BY CHAIRMAN ROSENTHAL:

10 Q When you said "he", I take it this was someone in
11 the manufacturer's employ who was directly involved in the
12 testing program?

13 A That's correct.

14 BY DR. BUCK:

15 Q What do you know about their quality assurance
16 program?

17 A I know they're a qualified Category 1 vendor.
18 This is a Category 1 piping system and they met all the
19 requirements.

20 Q Now, if I understand what you told me, it is that
21 under the definition of "cycle" such as a complete cycle,
22 open to closed, the expansion joint in this particular case
23 never goes through such a cycle. Is that right?

24 A I never said that it could never go through such
25 a cycle.

1 Q But under the conditions, on the assumption that
 2 we've got at the plant at the present moment the thermal cycle,
 3 particularly -- let's take the thermal cycle. That does not
 4 operate the bellows to its full capacity length?

5 A That's correct.

6 Q So it's only a partial cycle, under your definition,
 7 is that correct?

8 A That's correct. That is the expansion joint
 9 manufacturers' definition.

10 DR. BUCK: Okay.

11 BY MR. FARRAR:

12 Q Why do we keep referring to this person as "the
 13 manufacturer"? Does he have a company name?

14 A This is Tube-Turns Company.

15 Q At one point, Mr. Wert, you said you told the
 16 manufacturer to put into his code a half-inch of lateral.

17 A Roughly, what we did was to take the proposed
 18 technical specification limit and determine what the movements
 19 were going to be at the expansion joint. We then gave this
 20 information in a coordinate system that the expansion joint
 21 manufacturer could use, to him and asked him to analyze it.
 22 It was necessary to do this.

23 Q My question is: How does the half-inch compare
 24 with the three inches of settlement? How did you get from one
 25 to the other?

1 A The three inches or the .33 feet, whatever it is,
2 of settlement at the pump house results in a motion at the
3 expansion joint, as Mr. Bradbury explained on Figure 26, I
4 believe. With the settling of the pump house and the settling
5 of the dike, the pipe flexes and rotates at a 47-degree elbow
6 toward the right-hand side of the page, and the pump house
7 settles down.

8 A So in effect, what you have is a cantilever, if you
9 will, that then impinges upon the other end of the expansion
10 joint, resulting in a certain amount of compression and a
11 certain lateral offset.

12 Q All right. Assume the pump house settled four
13 inches, and since your tech spec is set up -- and I wanted to
14 get back to this later in terms not of differential settlement --
15 let's assume -- Mr. Cartwright?

16 A (Witness Cartwright) I don't think we're clear on
17 the tech spec.

18 Q I'm not clear, either, because I have a letter from
19 Mr. Christman dated June 11th, which says something entirely
20 different from what I heard you people say, I think. Maybe
21 not entirely different.

22 MR. CHRISTMAN: You're right. I planned to bring
23 that up. So if Mr. Cartwright can do that in advance, that's
24 fine.

1 BY MR. FARRAR:

2 Q We all may be concerned about the same thing. So
3 why don't you go ahead, Mr. Cartwright?

4 A The existing tech spec now compares the existing
5 service water pump house to the piping on the north side of
6 the expansion joint, and the allowable differential is .25 feet.
7 Then it also has the service water pump house, with the
8 allowable total settlement of .15. So there are two specifica-
9 tions.

10 Q You have them in both?

11 A Yes.

12 Q Then we have -- that is the three inches. There's
13 the .25 differential settlement, right? That's the three inches,
14 then. You're telling me, with that amount of differential
15 settlement, you're only going to see a half-inch on the joint?

16 A (Witness Wert) That's correct.

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1 Q And that's what you gave the manufacturer?

2 A That's correct.

3 Q When he told you about, well, Mr. Foster has been
4 quiet about hearsay here, and I know we're in a scientific
5 thing, and we don't have real hearsay rules, but I'd like a
6 little more detail about how this happened. In other words,
7 did he do these tests at your request, you know, you and he
8 sat down together and you said, "Here's what I'd like you to
9 do," and he came back and told you the results? Or did he
10 tell you that, you know, a year ago I did a bunch of tests?
11 In other words, what was the relationship between you -- what
12 was your ability to make your own judgement about the validity
13 of what he was doing? I guess that's the question that I'm
14 asking you.

15 A (Witness Wert) Let me attempt that by explaining
16 basically how this came about.

17 When we looked at the pump house settlement issue and the
18 amount of the tech specs and its affect on the expansion joint,
19 we determined to find out how much individual design margin
20 we had in the expansion joint, since it's standard for a
21 manufacturer to put some additional conservatism of his own
22 in, especially when he's providing items for category one
23 system, et cetera. We wanted to find out how much design
24 margin we had over and above what the numbers were we had given
25 him to design the joint originally. What I requested was that

n 1 he provide access to the computer codes so that we could
2 analyze a series of cases and determine exactly what would
3 happen under various operating conditions, what results the
4 initial settlement ever postulated.

5 The result of that was that he indicated that these codes
6 were proprietary, and we would not have access to them, and
7 I subsequently checked with our specialist on expansion joint,
8 the company, Stone & Webster specialist, and discussed this
9 with him. He verified that this was indeed the case.

10 However, under the purchase order, they agreed to go back
11 and reanalyze these joints at whatever point we deemed
12 necessary, whereupon we developed the deflections at the
13 expansion joints, recently went back to him and asked him to
14 analyze these to find out what the effect was on the expansion
15 joint and how much additional capacity we would have even at
16 the technical specification limit. That is what led to this
17 scenario and the things going back and forth.

18 What we did was request in writing from him to perform
19 these tests, give him these motions. He responded likewise
20 verbally and in writing. We discussed it to some extent as to
21 precisely what we were looking for, but nevertheless his
22 computer output and his computer program was run using inputs
23 from us, and the results were transmitted to us directly.

24 I'm not sure I answered your question.
25

1 BY DR. BUCK:

2 Q You did accept for experimental testing. I think
3 you had mentioned previously that you had some statements
4 about the experimental testing they'd done on previous bellows
5 and so on.

6 A I had asked him in his letter transmitting the
7 results of his investigation and analysis to include the
8 failure mechanism. We had discussed this along the way to
9 find out what would happen if additional things took place, and
10 I wanted to have some basis for the consideration of the
11 catastrophic failure mechanisms as discussed in our testimony,
12 and I asked him to include those results when he transmitted it
13 to us, which he did.

14 Q And he gave you some results of testing — to
15 destruction of some bellows, apparently.

16 A He didn't give us the actual test results. These
17 are the results of generic tests. These were not run
18 specifically for this case, but in order for them to design
19 an expansion joint of this type, which is a relatively complex
20 type of expansion joint, he had to run a significant number of
21 tests in order to investigate the use. The codes in this case
22 were relatively slow in accepting the use of metal expansion
23 joints over the years, and it's only been within the last
24 decade that the codes have recognized the acceptability of the
25 metal expansion joints. And that's as a result of this intense

1 testing program that was done.

2 Q So what he did was give you the results of the
3 generic testing program. Right?

4 A That's correct.

5 Q Okay. I'm sorry.

6 BY MR. FARRAR:

7 Q You wouldn't happen to have any small models of
8 these expansion joints in your briefcase, would you?

9 (Laughter.)

10 A I'm afraid I don't. No.

11 Q I won't take the time now, but I'll ask you later on
12 to take me through some of these drawings and explain it in a
13 little more detail, but I don't think we need to do that now.

14 There was one question I had before Dr. Buck gets on to
15 another subject. This operator who's wandering around every
16 four hours making his rounds, is he going to see this puddle
17 if we get one of these days of heavy rainfall that is shown on
18 some of your graphs? And are we talking about enough water on
19 the ground so that a fellow walking around in a driving rain
20 storm -- there's a psychological question -- is he going to
21 bother looking for it? But, too, is he going to see it? Are
22 we talking about enough water that you wouldn't confuse it with
23 just natural runoff from a rain storm.

24 A (Witness Cartwright) Well, first of all, let me
25 clarify that he does have to make these rounds. There's an

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1 approved procedure which forces him to go there twice a shift.

2 To get into the service water pump house, he walks either
3 over this concrete enclosure or adjacent to that, depending
4 on which door he goes in.. If there's a minor leakage, just a
5 minor leakage, he may not detect that.

6 Q If I recall your testimony from yesterday, it's not
7 on his checklist to poke his head down in the manhole cover.

8 A Not at this time. No, it's not. And minor leakage
9 may be very difficult to detect. But anything approaching
10 1000 gpm or so, I'm certain, would be detectable. Again, it's
11 a small enclosure.

12 Q Rainstorm or not?

13 A I think so.

14 BY DR. BUCK:

15 Q All right. Let's go back to saprolite, if we may,
16 please. And I'll have to admit that my questions here are
17 partly educational for myself, but I want to understand a
18 little bit more about saprolite.

19 I'd like to refer to your testimony on page 37 and 38.
20 It's the carryover paragraph beginning: "Saprolite at North
21 Anna..." It's not a transported soil. (On page 37, it goes
22 on over to page 38.

23 This paragraph has alot of explanation here about rain
24 and bonding and so on, and I always tend to get confused with
25 geologic and mineralogy terms, because every time I look in the

1 dictionary, they lead me around in a circle. I found the
2 most famous one in this case. I happened to look up what I
3 hoped would be a scientific definition of "silt." The first
4 one I got was "silt" is defined as "any soil which contains
5 80 percent or more silt."

6 (Laughter.)

7 I began to feel that this is sort of typical of the
8 definitions that one finds. But let me ask you, what do you
9 mean by a "grain"? Is this a crystal form of rock? What is
10 your technical definition of a grain?

11 A (Witness MacIver) Grain is merely a single,
12 individual particle of the material.

13 Q Okay. Now when you talk about chemical alterations
14 of some minerals, I presume here — let's start out from the
15 beginning here. You said that this saprolite was once rock.
16 Now this granite gneiss that you're talking about, does it
17 normally contain clay particles in its original form, in the
18 rock form?

19 A No, sir. It contains feldspar minerals as well as
20 quartz and mica.

21 Q All right. Your feldspar minerals are what?
22 Potassium, sodium, this sort of thing?

23 A Yes, sir.

24 Q Mostly the chemically active, primarily chemically
25 active types of elements?

1 A Yes, sir.

2 Q Now in the chemical alteration of these minerals,
3 what are you talking about here, in the term "chemical
4 alteration"? Is this oxidation? Hydrogenation? What do you
5 mean?

6 A It is the sodium feldspars, the plagioclase, which
7 have been altered into plain minerals. I feel very hesitant
8 to get into the weathering phenomenon, as I'm not a
9 mineralogist or geologist.

10 Q Your not a chemist, and I'm not a chemist. With
11 whatever your expertise is and my physics, we can get somewhere
12 on it. I don't know.

13 A It results in alteration.

14 Q Let me look at it this way. The rock itself starts
15 out as, I guess what one would call, primarily call crystal
16 formation. Is that correct?

17 A It is a metamorphized rock which has a crystal
18 structure. When found in a sand condition at depth, it is a
19 relatively competent crystalline rock.

20 Q Now in the process of weathering, leaching, all this
21 sort of thing, some of those crystal particles are removed. Is
22 that right? That's how you allow water to go through. Isn't
23 basically how you get your saprolite? Part of the rock is
24 removed?

25 A There's some loss of material but more, I'd say, of a

47 14.8
m. 1 breakdown of the bonds amongst the individual grains of
2 different material.

3 Q Well then, is it true that in forming clay, what
4 happens is that what you get is a rebonding, but you get sort
5 of an amorphous material rather than a crystalline material
6 out of it?

7 A That would be true, sir.

8 Q Okay. So that when we talk about -- and normally
9 clay in the process of this tends to add water. Is that
10 correct? Depending upon the type of clay?

11 A I'm not sure in my answer to this.

12 Q I admit I'm getting into something that maybe isn't
13 necessary here, but I'm trying to get one thing. When you get
14 your saprolite, and you put a load on it, you, shall we say,
15 remold, as we use it here. You tend to break down some of
16 the bonds of the saprolite in compressing it. Is that correct?
17 When you start compressing the saprolite itself, do you not
18 break down some of the crystal bonds?

19 A No, I don't believe that is a correct representation
20 of the mechanism by which --

21 Q Can you give me the correct one?

22 A There has been created within this decomposed rock
23 void spaces that did not exist in the parent rock. Upon the
24 application of a load to this material now, we can reduce that
25 void space. That doesn't mean that we're necessarily breaking

1 Bonds between particles. Rather the weathering process itself
2 has eliminated the bonds between the particles that existed
3 in the parent rock. This material is such that if you were
4 to take an undisturbed sample of it, you could readily with
5 your fingertips reduce this to, in effect, a pile of sand.
6 There is no bonding amongst the particles, though each one
7 exists in the same relationship to its neighbor as it did in
8 the parent rock.

9 Q All right. Then, how does clay form? You've got
10 these particles in the rock, and you say you found lumps of
11 clay in this particular saprolite, how is clay formed from
12 these crystalline particles?

13 A If you look at the fabric of the material, you will
14 find there are interlocked grains of quartz, other grains of
15 feldspar, and still others of mica. Again, the material is
16 an altered granite, which has been altered into a gneiss and
17 is now composed into a soil like material. The weathering
18 has not affected the quartz grains although it has eliminated
19 the bonding amongst them. The individual grains of the sodium
20 feldspar, the plagioclase, still retaining their same
21 dimensions, still locked into this network of quartz particles,
22 have been chemically altered into clay minerals.

23 Q It's this chemical alteration to clay minerals that's
24 bothering me. What is the alteration? What happens? What
25 changes between a group of crystalline particles and this

1 alteration into clay?

2 A All of the clay minerals that we would find in soils
3 are essentially derived from the alteration of rock. Some of
4 the less active clay minerals result from the chemical
5 alteration of feldspars — the illite clays, not terribly
6 active clay. From mica, we can produce the more active clay
7 minerals.

8 Q Let me point out what I'm getting at here. I'm
9 talking about — you say you can separate saprolite with your
10 fingers sometimes. You put a load on it, and you break down
11 some of these particles. Now these are mineral particles
12 which have been and still are in crystalline form. But when
13 you get the same particles in the form of clay, that clay
14 can cement itself into a hard block or with water, it can be
15 a very slippery mess. It can almost be a fluid.

16 Now I'm trying to find out whether in the process of
17 breaking down the remains of the rock, the saprolite, you put
18 minerals into a form such that they can become clay minerals
19 more easily.

20 A (Witness Lucks) If I may back up?

21 Q Sure, back up to the beginning.

22 A The clay particles in the saprolite are formed from
23 the plagioclase feldspars. The plagioclase feldspars,
24 initially crystal in structure — the weathering will lead to
25 decomposition of the clay resulting in very many small clay

1 particles forming where that plagioclase feldspar was in the
2 unweathered rock, so when we talk about clumps of clay
3 particles, these clumps represent part of the fresh rock that
4 used to be the plagioclase feldspar.

5 When we apply a load to saprolite, the loads certainly
6 that we are applying, the pressures we are obtaining in the
7 field, I think, do not approach anything that would break the
8 individual grains that make up the saprolite -- break it up
9 into smaller grains. In fact we ran one lab test where we
10 conducted a consolidation and compression test of loading on
11 a sample of the saprolite. And comparing the gradation after
12 loading with that before loading for an adjacent sampling,
13 we could detect essentially no change.

14 So I don't think it's correct to look at the loading of
15 the Saprolite breaking up grains, reducing the large space
16 slightly by pressure. But certainly the stresses would not
17 be sufficient —

18 Q You're not breaking up bonds, is what you're talking
19 about.

20 A Yes.

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1 A (Witness MacIver) Sir, could I add a bit more to
2 that. We want to be sure that the Board does not confuse
3 the fact that we have clay minerals present here with their
4 notion of a clayey soil which, in general, would be amongst
5 what is addressed in the testimony as a transported soil.

6 Once you erode the products of weathering and rock and
7 collect at some point of deposition a large number of clay
8 minerals, perhaps of the more active types, you can produce
9 a soil which would be justly termed a clay.

10 The fact that within the saprolite we have clumps of clay
11 minerals should not be allowed to justify any consideration
12 that this soil would behave like a clay. There is no
13 stickiness.

14 Q I understand that. My question was really based on
15 the supposition that in the compression, you would break
16 crystalline bonds and therefore make the production of a clay
17 more likely or make it available, shall we say, for rebonding
18 into clay. Your answer is that, no, you do not break down
19 the bonds, the crystalline bonds.

20 A (Witness Lucks) That's correct.

21 DR. BUCK: That's all I have.

22 CHAIRMAN ROSENTHAL: I think we'll take a midmorning
23 break at this point and resume in 15 minutes at quarter of
24 eleven.

25 (Brief recess.)

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1 CHAIRMAN ROSENTHALL: Mr. Farrar?

2 MR. FARRAR: Gentlemen, I have a series of questions
3 which I'll try to put in some sort of order.

4 Mr. Christman, some of them deal with the tech spec. I
5 can do it, or you can do it. Would you like to? Let me tell
6 you what I'd like to get on the record at one place, and you
7 may be able to do it better than I could.

8 I'd like the record to show what the tech spec was, what
9 you initially proposed as a change, what the staff came back
10 with, and what you are now proposing. These appear in several
11 different documents, and you can either do it by way of a
12 statement of your own -- simply get counsel to stipulate to
13 it -- or you can ask Mr. Cartwright, or do it any way you'd
14 like to do it.

15 I may not even have any questions, if that all gets
16 straightened out.

17 MR. CHRISTMAN: Let me have a shot at it and we'll
18 combine what the witnesses can tell us with what I can say
19 and see how it all falls out.

20 Mr. Cartwright, there is now a technical specification
21 regarding settlement for North Anna Unit 1. Is that right?

22 WITNESS CARTWRIGHT: That's right.

23 MR. CHRISTMAN: You're operating under that tech
24 spec right now?

25 WITNESS CARTWRIGHT: Correct.

1 MR. CHRISTMAN: There is not in effect a tech spec
2 for Unit 2 because Unit 2 is not an operating unit right now.
3 Is that correct?

4 WITNESS CARTWRIGHT: That's right.

5 MR. CHRISTMAN: Can you tell us what the settlement
6 limits in the presently effective tech spec for Unit 1 are?
7 That is, as they relate at least to the pump house which we
8 are addressing in this proceeding.

9 WITNESS CARTWRIGHT: The four points on the service
10 water pump house, the total allowable settlement of .15 feet
11 averaged from December of 1975.

12 MR. CHRISTMAN: Now, it's that 0.15 foot average
13 settlement that we are approaching now at this station. Is
14 that correct?

15 WITNESS CARTWRIGHT: That's correct.

16 MR. CHRISTMAN: That 0.15 is that number we have
17 discussed in the past as our tech spec limit?

18 WITNESS CARTWRIGHT: That's true.

19 MR. CHRISTMAN: Now VEPCO has requested --

20 MR. FARRAR: Mr. Christman, can we also get what the
21 differential? Go ahead, if you want to take it this way,
22 either way.

23 MR. CHRISTMAN: Is there a limit on differential
24 settlement in the currently effective tech spec for Unit 1?

25 WITNESS CARTWRIGHT: Yes, there is.

1 MR. CHRISTMAN: Would you state what that limit is?

2 WITNESS CARTWRIGHT: .7 on the pump house as compared
3 to all four pipes on the north side of the expansion joint
4 for a differential settlement of .25 feet of the allowable.

5 MR. CHRISTMAN: Are there any other currently
6 effective limits on settlement that we should be concerned
7 with relating to the pump house?

8 WITNESS CARTWRIGHT: No, there are not.

9 MR. CHRISTMAN: Now, VEPCO originally requested a
10 change in the current tech spec that you've just described
11 to set new settlement limits for Unit 1. What did VEPCO
12 request? What kind of change?

13 WITNESS CARTWRIGHT: I do not have the original
14 request in front of me. We've requested a total settlement
15 of .33 feet average settlement on the pump house.

16 MR. CHRISTMAN: It seems to me that that is the
17 important number then. That 0.33 average settlement is the
18 number we have talked about in the past and in the testimony,
19 is it not, as VEPCO's requested proposed tech spec limit?
20 Mr. MacIver? Is that correct?

21 WITNESS MAC IVER: Yes, that would be the average
22 settlement since December of 1975.

23 MR. CHRISTMAN: Since December of 1975, did we also
24 request a change in any of the other numbers in the tech spec?

25 WITNESS MAC IVER: We've requested a change in

1 quite a few of the numbers for several purposes: (a) to
2 eliminate typographical errors in the technical specification
3 as it was issued, (b) to clarify the dates from which
4 allowable settlement is to be measured, and (c) to adjust
5 settlement values from "as built" conditions to May of 1976
6 when the monitoring of Class I structures began.

7 MR. CHRISTMAN: Good. Now as a result of the staff's
8 review of your request for a change --

9 MR. FARRAR: Wait, Mr. Christman. Can I make sure
10 that as far as this proceeding and what we're concerned about
11 in this proceeding is concerned, your original request was to
12 change the .15 to .33 on the average settlement? You didn't
13 have in mind at that point a change in the differential
14 settlement, the .25 figure being the differential settlement
15 between the measurement .7 and the four pipes. You were not
16 planning a change in that.

17 MR. CHRISTMAN: Perhaps Mr. MacIver could explain.
18 While the company has been considering the change from 0.15
19 to 0.33, simultaneously they have been reviewing the tech spec
20 as regards many other points in the plan which are also being
21 monitored, and as a result of this and the staff's review,
22 what has come out of all of this is a complete tech spec on
23 the settlement for both Unit 1 and Unit 2 which are proposed
24 and which are attached to VEPCO's testimony in this
25 proceeding. Can Mr. MacIver add anything to what I've just

1 said?

2 WITNESS MAC IVER: Not beyond what I've just said
3 that the intent of many of the revisions here is to clarify
4 the bases of the tech spec and permit precise compliance by
5 the operating personnel.

6 BY MR. FARRAR:

7 Q What about the .25? That didn't change in what's
8 attached to your testimony, did it?

9 A (Witness MacIver) There is no recommendation that
10 that allowable be changed.

11 Q At least in your testimony for the differential
12 settlement, we're still talking about three inches.

13 A Yes, sir.

14 A (Witness Cartwright) In Revision 1 there is a slight
15 change.

16 MR. CHRISTMAN: Is Revision 1 the testimony, the
17 proposed tech spec that's attached to VEPCO's testimony in
18 this proceeding?

19 WITNESS CARTWRIGHT: That's my understanding, yes.

20 MR. CHRISTMAN: Do you have a question, Mr. Farrar?

21 MR. FARRAR: Let me ask you, before I ask Mr.
22 Cartwright about Revision 1. What's the thing attached to
23 your June 11 letter going to be called?

24 MR. CHRISTMAN: That is a proposed technical
25 specification on settlement, one for Unit 1 and one for Unit 2,

1 that has been reviewed by the NRC technical staff and found
2 to be acceptable, except insofar as it may be changed by the
3 testimony in this proceeding. Those two tech specs have also
4 been reviewed by the appropriate committees within VEPCO and
5 found to be acceptable, or at least they have passed through
6 the review process.

7 MR. FARRAR: But that's not Revision 1.

8 MR. CHRISTMAN: I'll ask Mr. Cartwright what he
9 means by Revision 1.

10 WITNESS CARTWRIGHT: Revision 1 includes the staff's
11 comments to our original, proposed tech specs.

12 BY MR. FARRAR:

13 Q Could we stick with your original proposal. I'm
14 trying to trace this historically, because different people
15 filed testimony at different times, and I want to be able to
16 relate their testimony to what the tech spec was.

17 A (Witness MacIver) Please let me try to clarify
18 this point. Upon receipt of VEPCO's requested change in the
19 allowable settlement of the pump house, the staff proposed
20 instead a number of allowable total differential settlements
21 that would be applicable to the pump house instead of granting
22 VEPCO an increase in the allowable average settlement.

23 A draft of the technical specification containing these
24 staff proposals has been distributed, marked Revision 1. The
25 draft which is attached to VEPCO's testimony of a possible

1 future technical specification not only embodies the several
2 clarifications of initial dates of surveys and correct many
3 of the allowable settlements of Class I structures, but it
4 also incorporates the staff-requested allowable settlement
5 values for the pump house that were contained in the draft
6 marked Revision 1.

7 Q Now when you say attached to the testimony, you
8 mean that's what Mr. Christman sent me on June 11. Maybe
9 you could answer that, Mr. Christman?

10 A I believe that that is correct.

11 Q Okay. Let me see if I can summarize and somebody
12 tell me if I'm wrong. And maybe I can leave out a couple of
13 the intervening steps.

14 It's clear that we started with a 0.15 average settlement
15 of the pump house, 0.25 differential settlement between the
16 pump house and the pipes. Essentially, VEPCO's initial
17 Proposal was to change the 0.15 to 0.33 and leave the
18 differential settlement alone.

19 A That is correct.

20 Q Since then there's been some negotiations with the
21 staff, and what we now have -- oh, and your testimony was
22 written really in terms of the 0.33 figure.

23 A That is correct.

24 Q The written portion of your testimony was attempting
25 to justify that particular change, and at the same time as that

1 was going on, you were talking to the staff about a more
2 comprehensive change.

3 A Yes, sir.

4 Q Okay. Now we have in front of us Mr. Christman's
5 letter, which has the comprehensive change which, in theory,
6 although we're not sure yet, is acceptable to you people and
7 the staff.

8 A That is correct, sir.

9 Q I think that eliminates the questions I had. I was
10 concerned yesterday that we seemed to be talking that your
11 testimony was in terms of the key thing being no differential
12 settlement, and I wondered why you were so interested in
13 differential settlement. All your testimony had been written
14 in terms of total settlement of the pump house, and it seemed
15 not to be logically consistent, but I think the way it's come
16 out this morning, I can understand where you're going.

17 Is there anybody else inside the bar here who wants to
18 follow this? In other words, is it now clear to everybody
19 exactly what's involved. Maybe I was the only one of us who
20 was confused.

21 MR. FARRAR: Mr. Foster?

22 MR. FOSTER: Did I understand your final statement
23 to be that you see the final VEPCO proposal and the final
24 staff proposal to be the same? I don't believe they are.
25 You didn't put it in precisely those terms. You said that you

1 had a proposal acceptable to both you and the staff.

2 MR. FARRAR: That's what Mr. Christman's letter,
3 I think, represented. Now that may come out that that's not
4 quite acceptable, or the two proposals were slightly different,
5 but at this point, I can leave that to pursue later. I just
6 wanted to make sure that we had this straight. Mr. McGurren?

7 MR. MC GURREN: Mr. Farrar, I was just going to say,
8 as pointed out in the letter that Mr. Christman filed, he did
9 indicate that there was still an area of difference. I believe
10 he cited our testimony on page 42. That difference that we
11 note on page 42 deals with the 31 day versus the six month
12 monitoring.

13 MR. FARRAR: I was concerned just about the
14 measurements, not the surveying, but the measurements
15 themselves. I was concerned that the testimony was written at
16 times when there was not agreement, and now there seems to be
17 agreement.

18 As long as you mentioned the reporting requirement, let
19 me see if I can put together my questions on that. As
20 Mr. McGurren mentioned, there's still a difference between the
21 staff and VEPCO on how often there should be this surveying.

22 After the surveying comes reports, and I'm a little
23 concerned about that. We wrote a decision what seems like
24 a great many years ago involving a utility company in the
25 midwest dealing with quality assurance and the company's

m 1 previous track record and so forth, and we've had on our
2 mind -- I was particularly interested in Mr. Foster's cross
3 examination yesterday dealing with the July, 1977, readings.

4 I'd like to pursue that a little more with anybody who
5 wants to talk about it.

6 BY MR. FARRAR:

7 Q First, Mr. MacIver, you, at one point, said -- and
8 correct me if I misstate it, because I don't have the
9 transcript -- that you personally did not see a report of
10 those Stone & Webster surveys until February of '78.

11 A (Witness MacIver) That is correct, to the best of
12 my knowledge.

13 Q Okay. When the Stone & Webster construction people
14 do these surveys, are they supposed to write a report
15 immediately? Immediately, meaning, you know, a week or two
16 weeks, whatever?

17 A There are no specific requirements. Some of this
18 monitoring has gone on for many years. There is typically,
19 unless directed otherwise, a certain amount of informality in
20 the reporting of these values. Perhaps there might be two or
21 three surveys conducted before the sketch that reports the
22 values is updated and distributed to the people that receive
23 it.

24 Q Okay. I think you said yesterday that that survey
25 or that report once it's done would go officially to several

1 people including yourself in Stone & Webster and one or more
2 people at VEPCO. Can you tell me who those people are?

3 A I cannot recollect all who were on the list. I
4 know that C. M. Robinson, Jr., of VEPCO is on the list. A
5 number of people within Stone & Webster, project engineers,
6 project managers, structural engineers, receive this. The
7 specific names I wouldn't think pertinent, but I can try to
8 remember them if you wish.

9 Q Let me ask Mr. Cartwright, would you be on that
10 distribution list, and if not, in any even, who else in VEPCO?

11 A (Witness Cartwright) I am not on the distribution
12 list for the Stone & Webster data. I don't know of anyone
13 else in VEPCO that is.

14 Q Can anybody tell me, I guess Mr. MacIver, you said
15 you didn't learn of this until February. Do you recall when
16 you learned of it in February what the date of the survey or
17 update of the sketch was? If you didn't see it until
18 February, was it a November document that just happened not to
19 get to you until February, or was it a February document, or
20 don't you recall?

21 A (Witness MacIver) I did not have available to me
22 in the second half of February, to the best of my knowledge,
23 any of Stone & Webster construction surveyors' reports since
24 their survey in May of 1977. I became aware of the settlement
25 that occurred in July, '77, only by my review of the

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Moore, Hardy & Carrouth survey in December of '77.

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1 Q Okay. Let me ask this, and remembering that I am
2 an outsider, I've never built a nuclear power plant, so I
3 don't know exactly how you function day to day.

4 If the Stone & Webster surveyors went out just routinely,
5 you know, for their own purposes — nothing to do with the
6 formal monitoring that's required, but just their day to day
7 work to help them in constructing the plant or whatever, and
8 something had settled six inches, to use an exaggerated
9 example, would somebody just go back and write in his notebook,
10 you know, six inches, and nobody would get alarmed?

11 It strikes me from what you've just said that somebody
12 writes it down, and eventually they get around to updating
13 the survey. Isn't there anybody there who's conscious that
14 these figures, inaccurate as they may be, you know, six inches
15 may be dead wrong. Maybe just the guy was reading his
16 instruments wrong.

17 But isn't there somebody there who would get alarmed enough
18 about this to say, "Hey, we'd better call in, you know, the
19 big guys, and have them do an accurate reading because
20 something's wrong here?" Something may be dreadfully wrong
21 here. Or does this just get written down in somebody's
22 notebook, and nobody pays any attention to it?

23 A I think it would be fair to believe that if it was
24 something on the order of six inches that they surveyors would
25 have taken alarm.

1 Q Now six inches is exaggerated. In finishing your
2 answer, let's talk not only about six inches but about what
3 happened in July when we went over -- I don't want to call it
4 a tech spec because it wasn't in existence -- but over a
5 figure that many people knew was or would be soon, if you got
6 your license as soon as you wanted to -- a crucial figure.
7 Wasn't that enough to alarm anybody? Or if it wasn't enough
8 to alarm anybody, why wasn't it?

9 A The construction surveyors are performing a simple,
10 mechanical task of running the surveys. They see the numbers,
11 and they report them. They are essentially unconscious of the
12 significance of these numbers we've had.

13 Q They don't know what the old figure was; they might
14 not know what a tech spec is; they just go out -- you want a
15 reading from that. Is that what you're saying?

16 A They feel no responsibility for interpretation or
17 evaluation of the monitoring that they perform for us.

18 Q Now, these are people working for Stone & Webster?

19 A Yes, sir.

20 Q Then they must turn those figures in to somebody.
21 They wouldn't be out there doing it -- unconscious of why
22 they're doing it -- unless they're going to turn it in to
23 somebody who's conscious of why they're doing it, who can put
24 those figures to some useful purpose.

25 A Their monitoring of pump house settlement as well as

1 other monitoring of settlement on site as well as measurement
2 of weirs, water levels, are submitted through the resident
3 engineer who performs the distribution through Stone & Webster
4 and to certain people in VEPCO.

5 Q The resident engineer would be, to use your phrase,
6 he would be conscious of the significance of the figures as
7 opposed to unconscious as the surveyors themselves would be?

8 A I don't believe that there's any review of the
9 monitoring records by the Stone & Webster resident engineer.
10 He performs a reproduction and distribution function on the
11 reports of the surveyors.

12 Q All right. Then we depend on the people that he
13 sends his reproductions to, and then, presumably at this level,
14 there's somebody who's conscious or who interprets or who looks
15 at the significance of these figures?

16 A Several of the recipients of the monitoring data
17 would be responsible for evaluating the results of that
18 monitoring.

19 Q You would be one of those recipients?

20 A Yes, sir.

21 Q Mr. Bradbury, would you?

22 A (Witness Bradbury) Yes, sir.

23 Q Who is the resident engineer?

24 A (Witness MacIver) For the last approximately two
25 years, it would be Mr. Dave P. Berry.

m. 1 Q Mr. Bradbury, do you recall when you saw these
2 figures -- the July, '77 figures that you talked about?

3 A (Witness Bradbury) No, I don't. The best of my
4 recollection is I became aware of these figures when informed
5 from Mr. MacIver.

6 (Pause.)

7 Q That's as far as my questioning can go.

8 Let me ask, on the existing or the proposed tech spec, as I
9 understand it, there's no requirement that you report to the
10 NRC staff until you've reached the 75 percent level. Until
11 that point, you keep the figures in-house. When you hit the
12 75 percent, you have to let them know. Is that right?

13 A (Witness Cartwright) That's correct.

14 Q Is what -- can anyone on the panel give me any good
15 reasons -- of course, the staff may have reasons of its own,
16 but are there any reasons from VEPCO's or Stone & Webster's
17 standpoint -- that figures couldn't be reported to the staff
18 at whatever level they come out? You hire your people to do
19 the survey; they do it -- what are the objections to sending
20 the reports whether they're done monthly or every six months
21 to the staff, whether or not they reach the 75 percent level?

22 A I may point out that this is a formal procedure
23 whereby the documentation of the settlement is accomplished,
24 and it's always open to the staff's review, which they do on
25 a regular basis. I shouldn't say staff -- the I & E. They

1 review this data.

2 Q When the inspector comes down, he can say, "Let me
3 see your surveys."

4 A That's correct, yes.

5 Q You would not --

6 A What was that?

7 Q You don't send them up here automatically, but
8 rather when he goes down for a site inspection, he might
9 look at them?

10 A That's correct.

11 Q Now, if I recall, the inspectors and what I've read
12 about them, they spend a couple of days at the plant, and they
13 get to review one or two percent of the paperwork that's there,
14 so we can't be certain that an inspector is going to look at
15 these every time, can we? That's not a question for you unless
16 you have an opinion about, you know, what types of things they
17 usually are looking for.

18 BY CHAIRMAN ROSENTHALL:

19 Q Are you slated for a resident inspector?

20 A We have a resident now.

21 Q You have one that's there all the time.

22 A Plus the full slate of Region 2 inspectors above him.
23 (Laughter.)

24 BY CHAIRMAN ROSENTHALL:

25 Q I take it that the suggestion is that it's unlikely

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1 that between any resident inspector and the team of Region 2
2 inspectors that these records would go unnoticed.

3 A (Witness Cartwright) Especially on this issue.

4 BY MR. FARRAR:

5 Q This issue being a hot one of sorts. But you're not
6 suggesting that inspectors, even if you have a resident or
7 ten resident inspectors, would ordinarily examine every report
8 that you people have ever prepared. I mean, as I have seen the
9 testimony through the years, if they get to look at one or
10 two percent of the paperwork, they've done alot. Does that
11 comport with your notion of what they look at?

12 A I'm not certain about the one or two percent, but I
13 seriously doubt they would examine everything that is
14 generated.

15 Q But what you're saying is this would be a key,
16 probably one of the key items on their checklist at least,
17 given the publicity and the questions raised about this
18 particular issue?

19 A Again, I can't speak for them, but I would guess
20 that.

21 Q One last question on this matter, and I can't find
22 in this mass of paper the reports to quote from. If I get
23 it wrong, anybody is free to correct me.

24 When the report -- I think I have this right -- when the
25 report finally came in about exceeding the 75 percent, does

1 anyone recall who wrote the report?

2 A (Witness MacIver) It should have been a report
3 from VEPCO to the NRC.

4 Q Whoever wrote it, if I recall it correctly, it was
5 in that document or another one contemporaneously, it seemed
6 to focus less on the fact that the 75 percent had been
7 exceeded than on the fact that it was the staff's fault that
8 it had been exceeded, because they were the people who
9 insisted the drains be put in. And it gave me the notion,
10 reading the report, that it had almost reached the point, in
11 the writer's judgement, that he shouldn't of even had to report
12 it, because he agreed to this tech spec under one set of
13 conditions and the staff had altered the ground rules. And so
14 it wasn't his fault that it was over 75 percent, and I got the
15 feeling we almost didn't even get the report then, because he
16 figured the groundrules had changed. Am I right? Is my
17 recollection faulty?

18 A This would have been discussed certainly in the 60
19 day report that was triggered by exceeding the 75 percent of
20 the allowable settlement given in the technical specification.
21 I can't recall specifically the wording of any earlier
22 communication advising the staff of the additional settlement
23 in July, 1977.

24 Q I'm not talking about that one. I'm talking about
25 the one that finally reported — the official survey.

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1 A The Moore, Hardy & Carrouth. Yes, sir. In the
2 May 31, 1978, report — the 60 day report — it does describe
3 the interpretation of the settlement record, as we believed
4 it was influenced by the horizontal drains. And it did
5 indicate that our interpretation was that some 7.00th of a foot
6 of settlement during 1976 and 1977 had been the result of
7 having installed the horizontal drains which was settlement
8 beyond the .15 foot of settlement that had been indicated in
9 Appendix E to the FSAR, and the overall tone of the May 31
10 report was that this 7.00th of a foot due to the horizontal
11 drains was, indeed, not a problem for VEPCO, but one of the
12 NRC staff who required the installation of ground water control
13 systems.

14 Q Thank you for that answer. The reason that I asked
15 the question was my feeling is there was a marked contrast
16 between the tone of that letter and the assurance I got from
17 Mr. Cartwright today that if the next survey showed settlement
18 beyond the limit, that's it, you know -- no questions asked.
19 You've got six hours and the plant goes into, you know, begins
20 to go to cold shutdown. I'm glad that he said that today but
21 I think it was somebody at a level higher than him who wrote
22 the letter that had a somewhat different tone to it in May of
23 1978. And that gives me some degree of trouble.

24 Mr. Cartwright?

25 A (Witness Cartwright) If I may comment on that, sir.

1 it is my responsibility to enforce tech specs, and that's one
2 of my prime responsibilities.

3 Q Do you recall who signed that report?

4 A No, I do not.

5 Q Does anybody?

6 MR. FOSTER: Mr. Stallings.

7 BY MR. FARRAR:

8 Q What level is he?

9 A (Witness Cartwright) He's a vice-president of
10 power operation.

11 Q Do you report to him?

12 A I report to him. I can assure you there is no
13 problem in that respect with the tech specs. If I had to take
14 action to enforce tech specs, I could do so without his
15 approval.

16 A (Witness MacIver) Sir, I would not interpret -- I
17 don't see the basis for interpreting the May 31 report as
18 indicating any lack of responsibility on the part of VEPCO for
19 compliance with the technical specifications. I would have no
20 reason to believe that had that additional settlement caused
21 the technical specification's allowable settlements to be
22 exceeded that action would have been taken similar to that
23 described by Mr. Cartwright this morning.

24 Q Your point is well taken. I'm not saying there was
25 something in there that says it explicitly. What I was

1 concerned about is just the tone and maybe something I was
2 reading into it. But I wanted to get Mr. Cartwright's -- I
3 wanted to tell you, you know, what tone I saw in it, combine
4 that with the problems and the questions that I had at the
5 July, '77, unofficial readings, and get Mr. Cartwright's view
6 on whether that was consistent with what he had told me this
7 morning about the action he would take, and we now have his
8 answer. That's as far as I wanted to take that particular
9 one.

10 Let's talk about the expansion joint, to change the subject
11 slightly. We've got the three figures in the testimony -- 8,
12 15, and 26 more or less -- give us a picture in the absence of
13 a model. Is there anybody who can paint me a picture in words?
14 I have the drawings in front of me, and I have a long time in
15 my past learned a little something about how to read them.

16 But can you tell me how these are fabricated? I take it
17 an expansion joint -- well, does it end up as one piece? In
18 other words, when you cut these pipes and you haul to the sight
19 from this manufacturer an expansion joint -- that was a one
20 piece thing.

21 A (Witness Wert) When the expansion joint was
22 delivered to the site, it was delivered primarily in two
23 pieces -- the double ballast assembly with the piece of 36
24 inch schedule -- well, whatever the schedule of the pipe for
25 this piping system -- was one piece, and the pressure balancing

1 bellows and its associated hardware came with it and was then
2 attached with the tie ride assemblies.

3 Q Okay. Leave the balancing piece out for a moment.
4 The rest was the joint itself, the bellows. How is that
5 fabricated?

6 A I don't know the specifics of the fabrication
7 process.

8 Q Let me make it simpler. Is that a one piece
9 forging? It's not two pieces with their convolutions screwed
10 into each other?

11 A This is a welded joint. This is not a mechanically
12 assembled joint. This is a welded joint at the pressure
13 boundry. This is not mechanically assembled.

14 BY DR. BUCK:

15 Q I think Mr. Farrar is asking how do you make the
16 bellows?

17 BY MR. FARRAR:

18 Q How do you make the bellows?

19 A Each of the bellows with the subsequent convolutions,
20 with four convolutions, is a separate piece that forms the
21 pressure boundary.

22 Q Now, can you describe for me in words how this
23 balancing piece gets on there. I see it in the drawings, and
24 yet I have trouble visualizing how, and of course, the record
25 won't reflect the gestures — how the pipe comes, you know,

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into the bellows and then the pipe makes an angle and somehow
this balancing piece is scabbed on there, and I can't quite
visualize that.

A (Witness Bradbury) I refer you to Figure 8. There
is another section of pipe that comes out from the elbow in
the 36 inch header, a section of 24 inch pipe that is
essentially spliced into the header and connects to the
balancing bellows. It's welded into the heading.

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1 Q Okay. I think I have that. Why, in your testimony,
2 do you consider it incredible -- and this is the focus of
3 Dr. Buck's question. He said he just wanted you to assume
4 that you got these cracks without reaching the tech spec limit.
5 Why do you consider it incredible that you would get any of
6 these leaks and cracks propagating before you reach the tech
7 spec limit? In light of the background that we operate under
8 here where we're always assuming that these huge pipes, for
9 no reason whatsoever, you know, suffer a guillotine break
10 right in the middle of things -- why is the failure of the
11 expansion joint any more incredible than the other things that
12 we routinely -- any more incredible than the things that we
13 routinely assume happen, or the things we routinely assume
14 happen, the things we guard against happening, in the
15 construction and operation of a nuclear power plant?

16 A (Witness Wert) Let me attempt to answer that. I'm
17 not sure this is exactly what you're getting at.

18 Let's refer to Figure 15, and let us consider for a moment
19 the generation of the mechanism of failure. When we're
20 talking about these fatigue cracks, we're talking about these
21 cracks developing. Notice where the word "convolution" is in
22 the center of the page.

23 If you were to move that arrow slightly over to the left,
24 the very peak of that hump, so to speak, the tip of one
25 convolution, that would be the point that would be most highly

1 stressed in this flexibly designed material that these
2 convolutions are fabricated from. When this convolution was
3 set up completely solid, such that the two circles on either
4 side of that hump were in relative contact with each other,
5 that portion would have an extremely small bend radius and
6 would be forced to flex considerably. It is the flexing
7 motion going back and forth that leads to the mechanism of
8 failure for these expansion joints as explained by the
9 expansion joint manufacturer.

10 Expansion joints are primarily used to mitigate cyclic
11 consequences. They're normally flexed back and forth. These
12 joints are not so flexed, and as such, the design basis of
13 these expansion joints results in them being very conservative
14 for this application.

15 Q All right. I understand that's the theory. But
16 that comes back to what I asked Mr. Bradbury yesterday.
17 I think it was him -- that he was saying that things couldn't
18 happen or wouldn't happen, and I think Dr. Buck and I had
19 pretty much the same kind of question.

20 You know there's no natural law that says it can't happen.
21 There's a natural law, I take it, that says that hydrogen can't
22 burn except in the presence of so much oxygen. It's a matter
23 that we debated here several years ago and has just been the
24 focus of attention recently. But that's a principle, you know,
25 of how the universe works. But I take it it's not a principle

1 of how the universe works that these things cannot fail unless
2 they go through 40,000 overstress cycles. They can fail for
3 what we would call, in layman's reasoning, no reason at all.

4 A It's certainly credible to postulate a failure of
5 this joint as much as it is any other piece of pipe in the
6 piping system, and in referring to our testimony, the original
7 postulations included failures of single expansion joints.
8 I personally, in my own opinion, don't think it would be
9 credible to assume it simultaneously without some outside
10 influence that more than one of these joints would develop
11 any type of failure mode at any particular point in time.

12 And as has been previously discussed in this testimony, a
13 failure of any one expansion joint does not lead to a
14 mitigation of the system capabilities.

15 Q Except your testimony is framed in terms of the
16 failure of one joint after the tech spec limit has been reached
17 and after the plant has gone to cold shutdown. It does not
18 take up the question of failure of it while the plant is
19 operating at full power, and the staff guy came in here and
20 withdrew certain testimony or corrected it because he didn't
21 want it to look as if he'd analyzed it on that basis.

22 So, I'm looking for why there was no attempt to analyze
23 the failure not of the four of them but of one of them at some
24 time prior to the tech spec limit being reached and with the
25 plant operating at full power?

1 A I'd like to refer back to the testimony yesterday.
2 If my recollection is correct, and please correct it if I'm
3 incorrect, I believe you asked a question, or a question was
4 asked of Mr. Cartwright, that was very similar to that which
5 he responded to.

6 The loss of an expansion joint is a design accident for the
7 plant, and there is a procedure to handle that accident. The
8 loss of an expansion joint, even in catastrophic failure, would
9 be no different than any major leak in a service water header,
10 and as such is an analyzed and proceduralized event.

11 Q Okay, Mr. Cartwright, can you confirm that? What
12 I think I'm hearing is that while it's not analyzed in this
13 testimony, which, of course, was written for a different
14 purpose, there has been an analysis done and accepted by the
15 staff of what happens with the failure of one of these
16 expansion joints suddenly for no reason at all with the plant
17 operating at full power.

18 A (Witness Cartwright) I am not aware of any
19 engineering analysis of the failure of the service water
20 system in the FSAR or by other means that the staff has
21 reviewed. I can't recall now.

22 What I intended to say yesterday — we do have what we call
23 an abnormal procedure, an approved procedure, which is
24 entitled "Loss of Service Water System", and there are several
25 possible causes that you could have a loss of service water

1 system of which one is a rupture of the service water pipe.

2 Q So you're saying that you have a procedure to handle
3 that.

4 A That's correct.

5 Q But you don't know of your own knowledge whether the
6 results of that incident have been analyzed and found
7 acceptable by the staff.

8 A I would have to research the FSAR. I can't recall
9 now that situation of that type is in the FSAR. I don't
10 believe it is.

11 A (Witness Bradbury) The loss of one of the headers in
12 the service water system is considered the design basis of the
13 system, which is one of the prime reasons we have redundant
14 headers in the system. So certainly the loss of one header of
15 this system is within the design basis of the system, which
16 has been reviewed by the NRC staff, I believe.

17 Q We can ask them when they have their time.

18 Mr. Cartwright, you said yesterday that -- and you repeated
19 today that you had this procedure -- and you mentioned your
20 operators -- is this a procedure that in a large manual
21 somewhere, that an operator could find -- you know, after
22 awhile, if he were looking for it, or have your operators
23 actually been trained on a simulator or whatever to handle this
24 particular accident.

25 A (Witness Cartwright) VEPCO does have a simulator.

m 1 Whether this particular accident has been simulated or not
2 I don't know at this time.

3 The procedure in the control room is very handy in two
4 forms to the operator that he can obtain relatively fast, and,
5 of course, they are trained and retrained in the use of all
6 abnormal and emergency procedures. That's one of the specifics
7 of the retraining and requalification program for licensed
8 operators.

9 MR. BUCK: I don't think I have any questions. I
10 have a concern. Let me try to express the thoughts I have
11 in here listening to these questions. I've been worrying
12 about it all morning.

13 We started out with the settlement problem on a pump
14 house. There have been certain tech specs put on this thing
15 which rely on measurement of a surveyor. We have, under the
16 proposed specifications, a statement. The surveyor comes up
17 with a measurement; you've got to shut the plant down whether
18 you're anywhere close to the specifications and tolerances of
19 a flexible joint or anything else.

20 Now it seems to me, yes, you've got to get the measurements
21 on the settlement, and you've got to know where they are. But
22 to me it's just plain unscientific to pretend that you're
23 looking for a pinhole leak with a theodolite at a thousand
24 yards, which is about what we're looking at here. And it
25 seems to me that while the survey situation every month or

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1 every six months is necessary, it shouldn't be a cause of
2 suddenly shutting a plant down.

3 But in order to avoid that sort of thing, one has to have
4 some type of scientific measurement and a basis for saying,
5 okay, we're getting a leak, or we're close to a leak. And
6 there must be simpler ways of detecting the bending of an
7 expansion joint. There must be simple ways of detecting the
8 beginning of a leak in one of these things. You detect the
9 beginning of a leak and a crack, and you've got time to make
10 adjustments. You've got time to change your headers around so
11 as to cut that joint out.

12 My feeling at the present moment is, and this is a personal
13 feeling on my part just sitting here and reading this testimony
14 and listening to all the answers here this morning, that we're
15 making a great big mountain out of this poor old surveyor out
16 there. And we're not trying to detect the things that may
17 cause the problems in the plant.

18 So I'm going to ask the staff to take a good look at this
19 thing. I think our technical specifications at the present
20 moment of safety shutdowns of this plant are being based on
21 the wrong thing. I think this has just grown up over a period
22 of time because of the plant settlement.

23 You have to watch the plant settlement. You have to know
24 what's happening to the pump house and that sort of thing. But
25 I also think you shouldn't be shutting the plant down when the

1 specifications of the expansion joint have not been reached
2 and where there's no indication of any problems with the
3 expansion joint.

4 Now, this is an off-the-cuff remark. I'm not making any
5 decisions or anything else here this morning. I'm just
6 giving you my view of what I see of this testimony at the
7 present point. It's my personal feeling.

8 I don't have any questions, except to ask the staff and the
9 applicant both, is this the right way to go at this problem?

10 CHAIRMAN ROSENTHAL: Do any members of the panel
11 wish to comment on Dr. Buck's expression of at least a
12 tentative view?

13 WITNESS BRADBURY: One comment I could offer that I
14 do agree that, in fact, we're measuring settlement. We're not
15 measuring the expansion joint. In doing so and in considering
16 the numbers that are in the new tech spec, we are well on the
17 conservative side. There's no question in any of our minds
18 that we are significantly conservative. Perhaps more accurate
19 measurements --

20 DR. BUCK: My point is that being conservative is not
21 necessarily being scientific.

22 WITNESS BRADBURY: I agree with that.

23 DR. BUCK: I'm just posing this as a problem to you
24 people. I'll ask the staff the same question and to have
25 their comments, but that's just a tentative feeling on my part.

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1 BY MR. FARRAR:

2 Q I just have two relatively inconsequential questions.
3 I just want to make sure that I understood two things that
4 were said yesterday.

5 First, all your figures -- Figure 7, I guess, show the
6 rainfall. I take it from your testimony that that's just for
7 our information, and you're staying clear of any
8 representations about the rainfall. I take it it means a
9 little more to you -- you didn't show the phases of the moon
10 on there, but you showed us the rainfall. Did you say, well,
11 we're just giving you that for your information?

12 Now that I have it for my information, what am I to do with
13 it?

14 A (Witness MacIver) It is referenced throughout both
15 the VEPCO and the staff testimony that there was coincidental
16 rainfall and increased settlement, and we wish to show what
17 that rainfall was. Indeed, the revision of Table 7 in June
18 incorporated additional rainfall quantities through 1974 and
19 up into 1976.

20 Q But you used the word again, "coincidental."
21 That's all you're saying at this point that it is is
22 coincidental?

23 A At this point in time, we cannot identify a cause
24 and effect relationship.

25 Q One last question on the surveys. You said that

n 1 Stone & Webster people don't deal with MH and C.

2 A That perhaps is not correct. They speak to one
3 another, and they have coordinated surveys, such as on the
4 13th of November, 1975, when both survey parties surveyed the
5 pump house. In general, they are two completely independent
6 operations.

7 Q If your surveyors came up with something and it came
8 to your attention, would you feel if they came up with
9 something alarming and it came to your attention in a timely
10 fashion, would you feel under any obligation at this point to
11 contact MH and C or VEPCO, or would you say to yourself, "No,
12 the agency is coming in with their next survey in three months;
13 they'll find it then; they're the official people"?

14 A No. Upon knowledge of something unusual in the way
15 of settlement, we would immediately be in contact with VEPCO,
16 and it would be up to us merely to recommend that Moore, Hardy
17 & Carrouth make an additional measurement.

18 MR. FARRAR: I think that's all I have.

19 BY DR. BUCK:

20 Q One question on this rainfall business. After the
21 rainfall in December of 1974, when the simultaneous rock
22 settlement occurred, have you researched very carefully as to
23 whether or not anything was put into that building or any
24 construction work done or anything of that nature during that
25 period of time that would cause this settlement? I mean water

1 wasn't put into the building or anything of that nature.

2 A The pump intake bays are below the bottom of the
3 reservoir so that rain water does collect in those to a
4 depth of, I believe, five feet.

5 Q And that would have happened the previous rain, too?

6 A Yes, sir. We have looked at the possibility of any
7 construction activity at that time. We have also looked, of
8 course, at what might have happened to the benchmark to offer
9 some explanations, and we find none.

10 DR. BUCK: Okay.

11 CHAIRMAN ROSENTHALL: My brethren have done such a
12 magnificent job of putting this panel, in the vernacular,
13 through its paces, that I see no necessity to prolong their
14 agony. I just want to ask one sort of overall question to make
15 certain that I understand the ultimate position of this panel.

16 BY CHAIRMAN ROSENTHALL:

17 Q If I understand you correctly, what your saying is
18 that while you have reasonable confidence that there is not
19 going to be appreciable additional settlement, you've been
20 wrong before, and you're not prepared to make any absolute
21 commitment along that line. Rather what it comes down to is
22 that even if there is further settlement beyond your present
23 expectations, that through the expansion joint and other
24 procedures that have been explored at some length over the
25 last day and half, any possible safety problem will be entirely

1 obviated. Is that a fair statement of your ultimate position?
2 In other words, your case here does not hinge upon your
3 present belief respecting the course of future settlement
4 being affected.

5 A (Witness MacIver) That's correct.

6 Q Other members of the panel I think would accept that
7 as well?

8 A I find that an excellent interpretation, sir.

9 CHAIRMAN ROSENTHALL: If there are no further
10 questions from the Board, I'll ask Mr. Christman if he has
11 any redirect examination at this point.

12 MR. CHRISTMAN: Yes, I have a little.

13 REDIRECT EXAMINATION

14 BY MR. CHRISTMAN:

15 Q Mr. MacIver, you were asked yesterday to give the
16 structure that had settled the most on the plant side -- what
17 percent of the proposed tech spec limit it has settled. Do
18 you want to correct or amend that answer?

19 A Yes, I would, sir.

20 We have indicated that the differential settlement between
21 the 14 line of the service building and the main steam valve
22 housing in the survey of May, 1979, was at approximately 47
23 percent of the tech spec allowable. The tech spec allowable
24 that we're speaking about here is not the one in existence,
25 which has some flaws in it, but rather the draft of the tech

1 spec that has been attached to VEPCO's testimony.

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1 We have another structure which has attained in the May, 1979,
2 survey a greater percentage of the allowable settlement in
3 the revision of the technical specifications attached to
4 VEPCO's testimony. This is the rock founded fuel oil pump
5 house, which lies to the south of the nuclear area, and we
6 have a settlement reading of .021 foot in May which we must
7 compare to a proposed allowable settlement value of .030 foot.

8 Hence, the settlement value of that one point Anna, that
9 rock founded structure, is 70 percent of the proposed allowable
10 settlement.

11 Q Thank you. Dr. Lucks?

12 Dr. Lucks, is halloysite suitable as a foundation material.

13 A (Witness Lucks) Yes, in my opinion, it is suitable
14 as a foundation material. Since the late 1950s, there have
15 been several studies made on the engineering properties of
16 saprolite, both from the point of view of strength and
17 compressability. The studies on halloysite have been conducted
18 by eminent people in the soil mechanics and the geotypical
19 engineering field. They've shown that, in fact, halloysite
20 has properties that are considerably better than many other
21 clay types that are commonly used for embankment construction
22 and are present in foundation materials.

23 Q While I'm with you, there was a question asked this
24 morning about the chemical changes or changes that may take
25 place in saprolite. Can you give us an understanding of

1 whether these changes take place over a short period of time
2 or a long one?

3 A There are two mechanisms of change that I think we
4 discussed this morning. One was the mechanical degradation
5 of the saprolite. I point out that we, in fact, had conducted
6 tests to see if we could measure any particle breakdown or
7 degradation of the saprolite in the laboratory. This test was
8 conducted to an effective stress of 64 KSF -- that is
9 approximately 16 times higher than the stress that exists --
10 the contact stress under the pump house, and no degradation
11 was measured to occur.

12 The second mechanism would be a chemical weathering
13 process. Now this process, I think we're talking in a geologic
14 time scale, and certainly nothing that would approach the time
15 scale of the plant life. It would be several thousand years.

16 Q Thank you. Mr. Cartwright, you testified yesterday
17 that the testing of the auxiliary pumps has begun or will
18 begin in June of this year. Why not earlier? Can you explain
19 why that is.

20 A Yes, the auxiliary service water pumps were not
21 required to be tested by the technical specifications. The
22 reason for that was that VEPCO applied for an exemption to the
23 ASME Section II testing requirements when we were forming the
24 tech specs with the staff. The exemption was based on the
25 chemistry control of the enclosed service water system and

1 our thoughts that the testing of the service water pumps, the
2 auxiliar service water pumps, which would introduce untreated
3 Lake Anna water into the controlled service water system, may
4 harm the chemistry control.

5 So we asked for the exemption, and the staff did grant
6 that. Now we have agreed to start the ASME testing of the
7 service water pumps, because after further looking into the
8 situation, we feel that the testing of these pumps on a monthly
9 basis will really not introduce that much untreated water to
10 the extent that it will harm the chemistry control of the
11 system.

12 Q Thank you. Mr. MacIver, would you very briefly
13 explain an error that was made in the judgement of the height
14 of piezometer 14 and the effect it had on your evaluations of
15 ground water at the site?

16 A (Witness MacIver) Piezometer 14 was installed in
17 an angle hole in order to place the tip of it actually beneath
18 the pump house, yet avoiding trying to drill through the
19 bottom of the pump house and through the three foot clay liner
20 beneath it. Since the tip of the transducer was placed in an
21 inclined hole, it is not possible to make a direct measurement
22 of the elevation of that tip, as is the case of a vertical bore
23 hole. The correct procedure in order to determine exactly what
24 the elevation of that tip is, is before the bore hole is
25 sealed and backfilled to connect the readout equipment to this

1 pneumatic transducer which comprises the tip and with the
2 casing filled with water to a known level, to measure, indeed,
3 the head of water above the piezometer tip, and hence, to be
4 able to calculate exactly what the elevation of that tip is.

5 Unfortunately, this measurement was not made at the time it
6 was installed, and it then becomes impossible to make an exact
7 determination of the elevation of that tip once the sand is
8 placed in the bore hole and the piezometer leaks are sealed
9 with clay.

10 The only alternative, therefore, in calculating the
11 elevation of that tip is to correct the length of the bore
12 hole for the inclination as it is measured at the surface. A
13 bore hole of this length -- and that bore hole is 90 feet
14 long -- can in a material such as the saprolite deviate several
15 feet from its intended direction, and based on the behavior
16 of piezometer P-14 following the installation of drain number
17 four in July, 1977, we have calculated that the actual
18 elevation of the tip of P-14 must be in the order of four feet
19 or more above the elevation which it was calculated at the
20 time.

21 Q And so what did readings from that piezometer lead
22 you to believe about the effect of the drainage system on the
23 ground water level.

24 A In June of 1977, as the remaining drains were to be
25 installed, piezometer P-14 indicated that the ground water

1 level beneath the pump house to be at approximately 275.

2 Hence, it was believed that the installation of the drains
3 at a target elevation of approximately 275 beneath the pump
4 house would be very close to the ground water level at that
5 point, and hence, would not influence the ground water level
6 markedly. And, therefore, would not cause further settlement.

7 Q Thank you. I apologize if I repeat myself now, but
8 is it the testimony of Mr. Bradbury or Mr. Wert that the tie
9 rods on that expansion joint would likely hold the ends of the
10 pipe in place were there to be a circumferential break around
11 the expansion joint itself.

12 A (Witness Bradbury) That was my testimony.

13 Q Did you also say that, in your opinion, a substantial
14 amount of water could still flow through that pipe in the event
15 of a circumferential break because of the tie rods?

16 A That's correct. I think I stated even if it were
17 partially a circumferential break, any significant lateral
18 displacement which you'd need to get a significant leak, would
19 be highly unlikely.

20 Q Thank you. Mr. MacIver or Dr. Lucks, is it your
21 opinion that it is necessary to monitor the four corners of the
22 pump house as often as once a month as opposed to twice
23 yearly -- once every six months?

24 A (Witness Lucks) In my opinion, no. There is no
25 mystery about the settlement off the pump house. It's due to

1 the compressibility of the saprolite. That compressibility
2 may have been higher than we had originally anticipated back
3 in 1970; however, the settlement due to the compressibility
4 is finite. All the loads have been applied for some time now,
5 and since the settlement is finite, and we're going along in
6 time, it would be less and less settlement. The abrupt steps
7 that were referred to yesterday, therefore, will be smaller
8 and become insignificant implications to the pipe stress and
9 performance of the pump house.

10 Therefore, I feel there's no need for settlement
11 measurement on the frequency of every month.

12 MR. CHRISTMAN: Thank you. Mister Chairman, that's
13 all I have.

14 CHAIRMAN ROSENTHALL: Mr. Cook? Cross, sir, do
15 you have recross examination.

16 MR. FOSTER: I just have a short recross and two
17 questions on cross for Mr. Wert, whom I didn't get to.

18 CROSS EXAMINATION

19 BY MR. FOSTER:

20 Q Mr. Wert, did I understand you when you were talking
21 about the current tech spec differential limit of 2.5 feet,
22 if you have that much differential settlement that would
23 translate to one inch lateral motion at the expansion joint?

24 A (Witness Wert) That is approximately correct.

25 Q Well I don't understand that. Maybe I don't

1 understand the lateral motion problem. But if you have
2 differential settlement, since one of end of the pipe is
3 connected to the pump pass on the other hand, it is on the
4 dike, you're going to have a lateral displacement of the same
5 amount as differential settlement. Why is that not true?

6 A Let me correct the last statement that I agreed to.
7 When you mentioned differential settlement, I visualized the
8 differential settlement across the expansion joint, and I am
9 not sure that's exactly what you were referring to.

10 What I stated earlier, or what I intended to state, was
11 that with the proposed technical specification limit for pump
12 house settlement of .33 feet since December, '75, the lateral
13 motion at the expansion joint would correspond to approximately
14 one half inch.

15 Q Let me try to get at this in a different way. Would
16 you look at Appendix B to the staff testimony, specifically
17 page I-7 of the I & E report.

18 Okay, now about half way down on that page.

19 A I'm sorry. Would you repeat the page?

20 Q I-7.

21 A Yes.

22 Q About halfway down that page, it says, it refers to
23 approximately one half inch of differential settlement that
24 may have occurred between the service water pump house and
25 the service water lines. Now you've already testified that the

1 expansion joint has this three inch lateral displacement limit.
2 Is that correct?

3 A Just the expansion joint by itself, if we pull that
4 out of the piping system and consider it as an isolated
5 entity.

6 Q Now what I would like to find out is how much of
7 that three inch limit has already been used up. So what I
8 would like you to do is take this one half inch differential
9 settlement that this I & E report refers to and tell me what
10 the equivalent of that is in terms of the lateral displacement
11 of the expansion joint. Do you follow my question?

12 A I follow your question, but I don't have the
13 capability.

14 Q Is it a one to one relationship? There's been one
15 half inch differential settlement here between the service
16 water pump house and the service water lines, and that means
17 we've used up one half inch of that three inch lateral
18 displacement limit, and if not, why not?

19 A One second.

20 (Pause.)

21 I think perhaps I'm trying to read more into your question
22 than you intended. If there is a half inch lateral
23 displacement at the expansion joint, that would be subtracted
24 from the three inches that that expansion joint is allowed to
25 move, which would mean that there is then two and a half

1 inches of lateral movement. This is irrespective of the
2 other motions on the expansion joint.

3 Q Okay. I understand, but now what I want you to do,
4 obviously you can't go down and measure the lateral
5 displacement or at least you don't intend to do that on the
6 expansion joint itself. You're going to figure out what's
7 happening to the expansion joint by what's happenind in terms
8 of settlement of the pump house, and what I want you to tell
9 me is, if I say to you, we have a differential settlement
10 between the service water pump house and the service water
11 lines of one half inch, figure out for me and tell me how much
12 of that three inch lateral displacement limit on the expansion
13 joint have we used up?

14 A I really can't do that. I'd like to refer for a
15 moment to the testimony starting on approximately page 28.

16 Let's go back to page 25 for a minute. The way this
17 expansion joint works at this point is to take and to combine
18 all the motions at the expansion joint into a number which
19 we've referred to hear as an equivalent axial compression.
20 This takes into consideration any motion superimposed on this
21 expansion joint, and that then refers to an allowable limit
22 for the expansion joint as designed by the manufacturer.

23 I'd like to be able to say that what you're saying is
24 correct, and it is approximately correct, but because I don't
25 have the compute program to calculate this, I cannot calculate

1 the exact number that would correspond to that amount. It
2 would be less than the half inch we're actually considering.

3 Q But you are saying that if we just wanted a rough
4 rule of thumb to get some idea of what was happening down
5 there and where we are in this three inch limitation, it would
6 be fairly correct to say you just take the amount of
7 differential settlement between the pump house and the service
8 water lines, and that's pretty much equivalent to how much of
9 that three inch lateral displacement, maybe not exactly but
10 that would give us a rough idea.

11 A It's approximately equivalent.

12 Q Thank you. So then we can say that we've already
13 used up -- let me look at this I & E report here again.

14 Okay, now, this was written, I guess, in '78. Is that
15 correct? December 6 to 8, 1978, so we can say as a rough
16 rule, then, that as of December, 1978, we've already used up
17 a half inch of that three inch lateral displacement since the
18 expansion joint was installed.

19 A That's not linearly correct, but it would be a
20 reasonable approximation.

21 Q Now the other question I'd like to ask you, Mr. Wert,
22 is that you referred to going back to the manufacturer to
23 give him different scenarios to run, I guess, through this
24 computer. Over what period of time? Was all that done at one
25 time back at the time you installed the expansion joints? Or

1 have you gone back since the time you installed the expansion
2 joints to give new scenarios? Over what time frame has that
3 occurred?

4 A There are effectively, at this point in time, three
5 steps in this consideration. There were the numbers that
6 were originally generated for the design of the expansion
7 joint. Those resulted in the expansion joint being designed
8 for certain lateral and certain compression elongation, et
9 cetera. Afterwards, the expansion joint was fabricated and
10 installed in the piping system in 1976.

11 Last summer, as I recall, when the question of pump house
12 settlement became brought to my attention with respect to the
13 integrity of the expansion joint, I went back to the
14 manufacturer -- we went back to the manufacturer and discussed
15 how much additional margin there was in these expansion joints.
16 And we found that to be a reasonable amount.

17 Recently, as a result of some reanalysis of the piping
18 system, we developed some different, slightly different
19 numbers. We went back to the manufacturer a third time and
20 asked him to rerun the program along with certain other
21 assumptions that were used in the development of this
22 testimony.

23 Q Okay. Over these three times -- there are basically
24 three times you've gone back to the manufacturer: the original
25 time and two subsequent times. I guess the parameters that

1 you've given, have they been more or less conservative over
2 time?

3 A I was not personally involved in the preparation
4 of the first set of data. The numbers that were developed
5 last summer were similar — very close to being identical, if
6 not — to the numbers that were originally developed for the
7 expansion joint.

8 The numbers that were retransmitted recently reflected a
9 change in the maximum operating temperature of the service
10 water system that was made subsequently.

11 Q Was that an increase, a higher temperature?

12 A Yes, it was a higher temperature, and it reflected a
13 slight change.

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1 Q What about in terms of settlement or stress, the
2 times you've gone back in the summer of '78 and then more
3 recently? Have you suggested higher stresses or higher
4 settlements to be evaluated by the manufacturer?

5 A Not specifically. We, in the development of this
6 testimony and in referring to it, we indicated that we asked
7 him to suppose that a particular thing happened. In this
8 case, we requested that he input or assume that the allowable
9 equivalent axial compression that this joint had actually, in
10 effect, set up solid, that we had motions that caused this
11 thing to set up completely solid, to put that into his
12 computer, evaluate it and find out what happens to the
13 expansion joint once it's already rigid, once it's already
14 been compressed.

15 And now we're at the point where we have, in effect,
16 a solid system. We don't have these convolutions assisting us
17 any more. And he found that the expansion joint was suitable
18 for that condition for a number of cycles beyond the designed
19 lifetime of the plant.

20 Q You hadn't originally asked him to do that at the
21 time of the design?

22 A That's correct, but we did not develop that number
23 as reflective of the design pump house settlement that the
24 expansion joint could take if we assumed all parameters to
25 be coincident.

1 Q Incidentally, did you always intend the design of
 2 the expansion joint to be made of steel as opposed to, say,
 3 rubber or some other material? The reason I ask that is I
 4 seem to recall some other references in earlier documents to
 5 a different material, and I just wanted to clarify.

6 A It's not uncommon to use rubber expansion joints in
 7 very large sizes. Rubber expansion joints have to be extremely
 8 rigid in order to take large, relatively large lateral offsets.
 9 Consequently, it's not uncommon in large joints recently to
 10 use metal expansion joints. And I might point out that this is
 11 a pressure-balanced expansion joint.

12
 13 BY MR. FOSTER:

14 Q Mr. Lucks, in response to Mr. Christman's question,
 15 you said -- I'm not sure whether you said saprolite or
 16 halloysite -- is a suitable material for construction. Is it
 17 halloysite?

18 A (Witness Lucks) I think it was halloysite, yes.

19 Q Can I conclude from that that if you had to start
 20 over again today, that you would still put this pump house on
 21 this site, this halloysite?

22 A I don't know of any reason why we shouldn't.

23 Q So that would be your recommendation?

24 A Yes.

25 Q Mr. MacIver, you've aroused my curiosity. When you

1 were talking about -- you corrected your testimony about the
2 percentage of settlement that occurred in two of these other
3 buildings. You referred to the percentage of settlement in
4 terms of Vepco's proposed technical specification. Could you
5 give us the percentages in terms as they would be under the
6 existing tech spec?

7 A. (Witness MacIver) We have a problem there in that
8 in both of those instances the existing tech spec is marred by
9 a typographical error. The decimal point is in the wrong place.
10 So the settlement relationship that existed to the technical
11 specification would only be about 10 percent of those values.

12 Q. So your change in tech spec is really only a decimal
13 point change rather than a number change?

14 A. In one instance it's more than just correcting the
15 decimal point. We have corrected the allowable settlement of
16 the fuel oil pump house for a difference in elevation of
17 two temporary benchmarks between the time that they were
18 established back in 1973-1974, and May of 1976. This difference
19 in elevation of these benchmarks is described in our response
20 to Staff Position 3.11 in the FSAR.

21 Therefore, in order to bring the technical
22 specification allowable settlement of that structure to a
23 starting date in May 1976, the allowable settlement based on
24 pipe stress analysis has been reduced by that previous indica-
25 tion of settlement.

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1 Q Let me ask you this. Maybe you can't answer this
2 question, but, allowing for changes in benchmarks that you
3 have to make accommodations for and changes in decimal points,
4 are the new proposed tech specs that you're proposing, insofar
5 as they affect some of these other Class 1 structures, do they
6 request additional allowances for settlements, ask that the
7 settlement allowance be increased for any of these other
8 Class 1 structures?

9 MR. CHRISTMAN: I'd like to make an objection, just
10 because I think this goes beyond the scope of my redirect, which
11 was really to correct something which was said wrong yesterday.

12 CHAIRMAN ROSENTHAL: I'll let that question stand.

13 WITNESS MAC IVER: With the exception of the
14 altering of the requirements for the monitoring of the service
15 water pump house, the other changes on the technical specifica-
16 tion which we proposed are solely to improve the precision of
17 the wording, by establishing clearly the date of the reference
18 baseline survey, or to correct for settlements which we have
19 indications may have occurred prior to the May 1976 survey.

20 In several instances, the allowable settlements
21 that are given in the existing technical specification have
22 been markedly reduced in the proposed technical specifications.

23 BY MR. FOSTER:

24 Q But I asked whether any of them have been increased.

25 A No, sir.

ite 5

1 Q And one last question. You refer to the rock-founded
2 floor of the pump house. Yesterday I thought you said to us
3 that we shouldn't expect settlement on any rock-founded
4 structure, that if we get any indication of settlement it's
5 probably an error in the survey. Yet you're referring to the
6 floor of the pump house as rock-founded and being at 70 percent
7 of the tech spec limit, the proposed tech spec limit.

8 Why is that?

9 A We interpret this to reflect surveying errors back
10 at the time that the temporary benchmarks were established in
11 this structure, or at the time that it was resurveyed in May
12 1976.

13 Q You talk about surveying. We've had a lot of
14 discussion about using surveys as a means of knowing whether
15 this expansion joint is going to fail. Yet we talk about
16 surveying errors that occurred years ago.

17 Was the surveying done at that time done according
18 to the second order Class 2 accuracy requirements?

19 A No, sir.

20 Q They were not?

21 A The surveying we're talking about here is the work
22 by the construction surveyors to establish structures at
23 elevations as shown on the construction drawings.

24 Q One last question. Mr. Lucke, do I understand you
25 to be saying that settlement will stop some time in the near

1 future?

2 A. (Witness Lucks) I believe that there'll be a
3 continuing gradual settlement at a decreasing grade over the
4 life of the plant. Theoretically, it will not stop.

5 Q. If it will not stop, can you project how many total
6 inches more you will have over the life of the plant?

7 A. I think my recollection of our prediction for
8 secondary settlement is .05 feet over the life of the plant.
9 Maybe Mr. MacIver can correct me if that's wrong.

10 A. (Witness MacIver) This is our approximate estimation
11 of the total future settlement of the subsoil of the pump house.

12 A. (Witness Lucks) Due to secondary effects.

13 A. (Witness MacIver) Yes.

14 Q. But you don't expect any due to primary effects?

15 A. (Witness Lucks) I think that we estimated about a
16 tenth of a foot settlement due to the filling of the reservoir,
17 if my recollection is correct. I don't think that we achieved
18 the full one-tenth of a foot. I guess it's conceivable there
19 may be some delayed primary settlement, but I don't expect it.

20 MR. FOSTER: I have no further questions.

21 MR. FARRAR: So you're talking five-eighths of an
22 inch over the rest of the lifetime of the plant?

23 WITNESS LUCKS: Due to secondary compression, yes.

24 CHAIRMAN ROSENTHAL: Mr. McGurren, do you have any
25 redirect?

1 MR. MC GURREN: Just a few questions, Mr. Chairman.

2 RE CROSS EXAMINATION

3 BY MR. MC GURREN:

4 Q Dr. Lucks, on redirect at the beginning you mentioned
5 halloysites and saprolites.

6 A (Witness Lucks) Yes.

7 Q I take it that part of the saprolite underneath the
8 service water pump house is made up from halloysite, is that
9 correct?

10 A If we go back to the original rock structure, there
11 were plagioclase feldspar veins in the original rock structure.
12 These grains have been weather-modified to clay material. Part
13 of that clay is halloysite. I think that some of the samples
14 that Dr. Martin analyzed for us contained up to 40 percent
15 halloysite. That would only be a percentage of the material
16 delivered to Dr. Martin.

17 Q I believe also on redirect you indicated that
18 settlement under the service water pump house was no mystery?

19 A No, it is due to compression of the saprolite, the
20 reduction of the void ratio.

21 Q Can you explain the rapid settlement that occurred
22 in December?

23 A This comes down to the point that the mystery that
24 exists is the time rate of settlement. We feel that, due to
25 the lab testing and the observation of the performance of the

1 structure, that we have confidence in the magnitude of the
2 settlement. The time rate just does not behave according to
3 the theories of soil mechanics. We can't explain with any
4 certainty the time rate.

5 Q Just one last question, and this was a question that
6 I believe was asked by Chairman Rosenthal and I don't believe
7 there was an answer to it. And that was there was some concern
8 expressed about defects in the expansion joints. And I think
9 the question was, was there any inspection that is made of the
10 expansion joints.

11 Do you know whether or not there is any inspection
12 made of these expansion joints before they are placed in the
13 enclosure?

14 A (Witness Bradbury) Yes. Our specification required
15 certain shop inspections. When the components are received at
16 the site, they receive a receipt inspection for damage. During
17 installation, the installers would note any significant
18 effects. So they have been inspected a number of times.

19 MR. MC GURREN: That's all I have, Mr. Chairman.

20 MR. FARRAR: That means visual, Mr. Bradbury?

21 WITNESS BRADBURY: I do not have the specification
22 here. I'm sure that it's visual. There may have been other
23 inspections, at least dimensional checks in addition to visual
24 inspections. I'm sure that some of the welding on the joint
25 received other types of nondestructive testing.

1 MR. FARRAR: Aren't there more sophisticated
2 techniques that you can use on pipe to see if it's been fabri-
3 cated properly or forged properly, or whatever the term is?

4 WITNESS BRADBURY: Yes, and the other types of
5 nondestructive testing I referred to are the liquid penetrant
6 examination, the likes of that, for the welds.

7 MR. FARRAR: That would have been done by the
8 manufacturer?

9 WITNESS BRADBURY: By the manufacturer.

10 MR. FARRAR: And he would have furnished those to
11 you? You asked him to do those, or do you ask him to do those
12 and you look at the results?

13 WITNESS BRADBURY: We ask him to do those and we
14 confirm it has been done and pass them if done properly.

15 MR. FARRAR: You ask him, did you do it, and he
16 tells you he did, and that's it?

17 WITNESS BRADBURY: We verify the proper paperwork
18 exists to show he did it in accordance with his quality one
19 assurance program.

20 MR. FARRAR: Mr. Wert or somebody, would you look
21 at Figure 8, please. Until Mr. Foster asked a couple of his
22 questions, I thought I understood this. But I apologize for
23 my own ignorance, but I seem to be a little confused. Let's
24 look at Section BD on Figure 8.

25 Can somebody help me get my three inches and my

1 half inches straight? If the wall on the right side drops down,
2 I believe the example used was half an inch, then we're going
3 to get a half-inch lateral motion on the expansion joint,
4 roughly one to one. Is that what you said?

5 WITNESS WERT: Not precisely. I referred to the
6 half-inch lateral displacement of the expansion joint as
7 corresponding to the proposed technical specification limit of
8 .33 feet in December '77, and that, with the existing settle-
9 ment that we have had to date, it would not be a linear
10 relationship, but it would be less than the half-inch lateral
11 displacement so indicated.

12 MR. FARRAR: Now I know that I'm confused. I only
13 thought I was confused before. I'm not saying it's your fault.
14 It may be mine.

15 Let's start without any tech specs. All right, let's
16 just look at this picture. Let's assume this is day one. This
17 structure has just been built. If that wall on the right side
18 of that section drops down three inches, what's the lateral
19 displacement of the expansion joint going to be?

20 MR. WERT: Three inches or four? It drops down
21 three inches, it would be less than the .5 that was calculated
22 for four inches, .33 feet.

23 MR. FARRAR: No, no, I don't want to know about
24 what's calculated. It's a simple question in geometry, I think.
25 If that right-hand wall drops down three inches -- in other

1 words, I've got a differential settlement of three inches
2 between that wall and the pipe on the left, which isn't moving
3 at all under my hypothetical. What's the lateral displacement
4 on the expansion joint?

5 Now, I didn't ask what the manufacturer is calculating.
6 I just want to know what it's going to sink.

7 WITNESS WERT: If a differential existed between
8 the pump house wall and the center line of the pipe at the
9 elbow that we're referring to here of three inches, then the
10 lateral offset at the expansion joint would approximate three
11 inches.

12 MR. FARRAR: Okay. We're going to have roughly
13 one to one.

14 Now, let's stick with the three inches, three inches
15 on the wall, three inches on the expansion joint. What will
16 that translate to in terms of your phrase, allowable equivalent
17 axial compression? Not allowable -- equivalent axial
18 compression?

19 WITNESS WERT: That number would refer to a number
20 less than that calculated in our testimony on page 26, when
21 we refer to the fact that the differential movements super-
22 imposed on the expansion joints by the Vepco-proposed technical
23 specification limit, .33 feet, represents 54 percent of the
24 dynamic allowable and 40 percent of the static allowable. That
25 is with respect to the allowable equivalent axial compression.

1 I cannot personally break out one motion without
2 considering the other ones. They work in conjunction with
3 one another.

4 MR. FARRAR: Don't read too much into my question.
5 I'm trying to get just a very simple -- I'm looking for some
6 rule of thumb so I can correlate all these figures.

7 Will three inches mean roughly half an inch, give or
8 take a factor of two?

9 WITNESS WERT: That's correct.

10 MR. FARRAR: So three inches differential settlement
11 gives me three inches lateral displacement at the expansion
12 joint and a half-inch equivalent axial compression, roughly?

13 WITNESS WERT: Roughly.

14 MR. FARRAR: Okay. I recognize here your previous
15 answer and that I am asking you to do it roughly.

16 Then the figure you gave the manufacturer -- do
17 you recall, when you first took the stand, you told them about
18 a figure you gave the manufacturer of a half-inch to plug into
19 his program? That was equivalent axial compression?

20 MR. WERT: No, sir.

21 MR. FARRAR: What was it?

22 WITNESS WERT: That was a lateral displacement at
23 the expansion joint associated with the proposed technical
24 specification limit, pump house settlement. I may point out
25 that at the proposed technical specification limit for pump

1 house settlement, that does not arbitrarily imply that the
2 pipe has not also settled.

3 MR. FARRAR: Okay. But we have a three-inch
4 differential settlement limit.

5 WITNESS WERT: That's correct.

6 MR. FARRAR: Okay. Why didn't you give him a
7 lateral displacement figure that correlated with the possible
8 three inches? Why did you give him a half inch instead of
9 three inches?

10 WITNESS WERT: We gave him the numbers that reflected
11 the condition of the service water pipe and pump house at the
12 proposed technical specification limit.

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1 MR. FARRAR: How can a limit of 3 inches, which
2 presumably can be reached, translate to you thinking it's
3 only going to be 1/2 inch? If things don't go according to
4 Dr. Lucks' plan, we could get 3 inches differential
5 settlement. That's in the tech spec. That's presently
6 allowable. Why don't we have to tell the manufacturer,
7 "put that 3 inches in"?

8 WITNESS WERT: There are two things that come
9 into consideration here. Number one is that the dike is
10 settling at a rate which approximates that of the pump house,
11 at least from my consideration.

12 MR. FARRAR: Okay, let me stop there. That's
13 what you say. But the tech spec doesn't require that it
14 happens that way. The tech spec would allow the pump house
15 to settle differentially to the other end of the pipe by
16 3 inches.

17 Now if you're telling me that's not going to
18 happen so let's change that tech spec, then we're talking
19 about something else. But as I read it, we are allowing
20 you to let this pump house drop -- the present tech specs
21 allow you to let this pump house drop 3 inches, and you
22 don't have to -- you can keep operating.

23 WITNESS WERT: Let me take another shot at it.
24 I think I understand where you're going.

25 If we assume that there's a 3-inch differential

1 settlement across this expansion joint, and we likewise
2 assume that all the other motions, the possible differential
3 movements on this expansion joint were maximum at their
4 peak, that would correspond to the equivalent axial
5 compression.

6 So 3 inches of differential motion across this
7 expansion joint does not imply that we have reached a
8 failure point. That is, we could, if all the other motions
9 were also maximum, have reached a point at which the
10 expansion joint equivalent axial compression is equivalent
11 to the manufacturer's allowable equivalent axial compression.

12 MR. FARRAR: That's I'm with you on. I understand
13 that. But you told me you didn't tell him to put in an
14 axial compression of a half inch; you told him to put in
15 a lateral motion of a half an inch.

16 WITNESS WERT: The expansion joint was designed
17 for 3 inches of lateral offset.

18 MR. FARRAR: That's what the manufacturer said.
19 But you told him, "run these programs and codes using only
20 half an inch." I apologize for not making myself clear
21 here. Why didn't you say to the manufacturer, "put into
22 your codes 3 inches"?

23 WITNESS WERT: Let's back up here for a second.
24 When we originally purchased the expansion joints, we gave
25 the manufacturer a 3-inch lateral offset and told him to

1 design an expansion joint with that. He gave us that.

2 When we went back to him last summer, and again
3 recently, the intent was to find the margin that existed
4 between the existing, or the potential condition of the
5 expansion joint, and its designed condition. We were not
6 attempting to prove how far we could go on the
7 expansion joint before it failed.

8 We were only attempting to find out what the
9 margin was between the condition of the expansion joint under
10 the proposed technical specification, and its design
11 capabilities.

12 I still haven't done it.

13 MR. FARRAR: I may be the only one in the room --

14 WITNESS WERT: Let me try one other thing here
15 and see if that's clear.

16 If we were to assume, as we discussed in our
17 testimony, also that the expansion joint were to have all
18 the other motions on it that it normally does associated
19 with thermal and earthquake, et cetera, and we then allowed
20 the differential settlement to go to the full designed
21 3 inches of the expansion joint, the equivalent axial
22 compression under that condition would be less than the
23 manufacturer's allowable.

24 By giving him half an inch, all we did was to
25 define the safety margin.

1 MR. FARRAR: I can't see how that can be a
2 "margin" until you've given him the 3 inches and added a
3 half inch on top of it. I'll give up for the moment.
4 Maybe there's another lawyer, or someone else on the panel
5 who sees what my difficulty is and can help me. I'm not
6 saying the blame is in the answer; the blame may be in the
7 questioner, but I'm having trouble, and I'd rather get the
8 trouble straightened out here and now than when I sit down
9 to write an opinion and realize that I'm still in trouble.

10 MR. FOSTER: If I could ask one question,
11 Mr. Chairman?

12 CHAIRMAN ROSENTHAL: Go ahead.

13 MR. FOSTER: I believe you stated in your
14 response to Mr. Farrar's question that you gave the
15 manufacturer one-half inch lateral displacement to fit into
16 his computer. Is that correct?

17 WITNESS WERT: That's correct.

18 MR. FOSTER: You had said to me that, according
19 to this I&E report, you already had one-half inch differential
20 settlement between the pump house and the pipes, and that is
21 roughly equivalent to one-half inch of lateral displacement.

22 So in other words, you have given the manufacturer
23 a lateral displacement that has already taken place. Have
24 you given him something more? I mean, we're already at
25 that point. We want to know what's going to happen in the

1 future.

2 WITNESS WERT: One second.

3 (Pause.)

4 WITNESS WERT: Let's try -- let me make two
5 points.

6 The -- first of all, the differential settlement
7 that has taken place to date between the pump house and the
8 piping, or the expansion joint, the north end of it, is
9 approximately the differential settlement that is anticipated
10 at that point in the system. The dike is also settling with
11 the pump house.

12 However, the design basis of the expansion joint
13 was to be able to accommodate a three-inch difference between
14 the pipe -- in this case, the 30-degree elbow -- and the
15 pump house wall, which represents the south and the
16 expansion joint.

17 The expansion joint is fully capable of taking
18 an additional three inches of lateral offset. If we postulate
19 that we have one-half inch of lateral offset, and we further
20 postulated that the rigid end of the pipe, or that the end
21 of the pipe on the north end of the expansion joint, remained
22 rigid, and that the pump house merely settled vertically
23 downward adding an additional vertical offset to that
24 expansion joint, it would be capable of taking three inches,
25 or roughly 2-1/2 inches additional direct vertical

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1 settlement.

2 MR. FARRAR: How can you say that without having
3 told the manufacturer to run that?

4 WITNESS WERT: I need to point out, we know that
5 it can do that, because that is within the design capabilities
6 of the expansion joint.

7 When he analyzed this particular case for us,
8 he used the same computer programs that he used to design
9 the joint, and the joint was designed to take 3 inches of
10 lateral offset.

11 We have not exceeded -- at 3 inches of
12 differential settlement, we will not have exceeded the
13 elastic limit, the design parameters for the elastic limit
14 of the expansion joint.

15 MR. FARRAR: If you knew that, why did you even
16 have to go through this little one of giving him a half inch?
17 If you knew it was good at 3 inches, why did you tell him
18 "run it for me at a half inch"?

19 WITNESS WERT: Because we wanted to find out how
20 much margin we had in the design at that point.

21 I don't want to leave the Board with the
22 impression that we can just consider one of these motions
23 totally independent of the other motions that take place.
24 When we're talking about subtracting a half inch from the
25 3 inches, it's not a purely linear relationship, because

1 we have to consider the effects of compression and rotation
2 on the joint, as well.

3 But assuming that those remain within acceptable
4 limits -- which they appear to -- then the increase in
5 the lateral component to 3 inches from the existing one-half
6 inch, would be within the design elastic limit of the
7 expansion joint.

8 MR. FARRAR: Let's leave it at this.

9 Mr. Christman, perhaps you can talk to your
10 people during the lunch hour. I think at the end there I
11 was beginning to see a ray of light, but if I don't understand
12 it, it's going to redound against your client's interests.
13 So it's in your interest to make sure that this gets
14 explained so that I see the light whether it's, you know --

15 DR. BUCK: Let's keep at it, for goodness sake,
16 right now. What is it that you don't understand about the
17 half-inch? I don't understand what it is you're objecting
18 to about the half-inch.

19 Mr. Wert, can you go through it again on the
20 design basis of the joint, and what you later asked the
21 manufacturer to give you on the basis of the half-inch that
22 you already had displacement in the joint?

23 WITNESS WERT: Yes, sir.

24 MR. FARRAR: If that's being done for my benefit,
25 it's not going to do any good. I think the reason I said

1 le' wait until lunch is that there might be somebody out
2 there who sees what my problem is and can get this story
3 told in a different way, and to hear the same thing again
4 is going to be a waste of time.

5 MR. CHRISTMAN: We'll be glad to try to do that.
6 We'll talk it over at lunch.

7 MR. FARRAR: I don't mind you talking to anybody
8 in the audience who may also see it. I think we're close,
9 but the way I'm hearing it isn't helping me, and that just
10 might be my fault, but there may be somebody who can say,
11 "tell it to him this way and maybe he'll understand it."

12 MR. CHRISTMAN: I don't think it's your fault.
13 I think it's an inherently difficult subject. All of us who
14 are not involved closely in it have trouble understanding
15 it. We will see what we can do at lunchtime, which I
16 certainly hope will be soon.

17 (Laughter.)

18 CHAIRMAN ROSENTHAL: I will take that suggestion,
19 Mr. Christman. It's now 10 minutes of 1:00. Let's see if
20 we can resume at quarter after 2:00. That's an hour and
21 25 minutes. I think you ought to be able to get that done
22 in that time.

23 If there's no objection, we will commence at
24 2:00 o'clock.

25 (No response.)

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CHAIRMAN ROSENTHAL: Hearing none, we will do so.

(Whereupon, at 12:50 p.m., the hearing was recessed, to reconvene at 2:00 p.m., this same day.)

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AFTERNOON SESSION

(2:00 p.m.)

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3 CHAIRMAN ROSENTHAL: Before we resume, one
4 housekeeping detail. I announced yesterday that, by reason
5 of the fact that one of the members of the Board had an
6 ophthalmologist appointment tomorrow morning, we would not
7 start until 10:15. The Board member has now changed his
8 appointment to Friday afternoon. Unless anyone had made
9 irrevocable commitments based upon the assumption that we
10 would not start until 10:15, I would like to plan to start
11 tomorrow morning at 9:00.

12 Is there any problem?

13 (No response.)

14 CHAIRMAN ROSENTHAL: Then we will begin tomorrow
15 morning at 9:00.

16 The other announcement I wish to make is that
17 Mr. Gambardella's office notified us to the effect that he
18 will not be with us tomorrow, either.

19 All right. Well, we left off with Mr. Farrar
20 in a state of self-confessed confusion. Maybe we can try
21 to obtain clarification, if that's possible, on the point
22 that was bothering Mr. Farrar. Then perhaps we'll be in a
23 position to excuse this panel.

24 MR. CHRISTMAN: Mr. Farrar, we talked about this
25 the entire lunch hour. Would you prefer the panel to attempt

1 to answer what we think the question is, and then you can
2 follow up with additional questions? I think you're going to
3 have to help us.

4 MR. FARRAR: I've been trying to think about
5 where we might have gone off. Maybe it's something very
6 simple. Let me draw out what it might be, where the lack
7 of communication is, and maybe that'll be right.

8 Whereupon,

9 C. R. CARTWRIGHT,
10 ROBERT B. BRADBURY,
11 STANLEY A. LUCKS,
12 BRUCE N. MAC IVER,
13 and
14 DOUGLAS A. WERT

15 resumed the stand and, having been previously duly sworn,
16 were examined and testified further as follows:

17 FURTHER BOARD EXAMINATION

18 BY MR. FARRAR:

19 Q Many hours ago, Mr. Wert, I thought that you had
20 said you had gone to the manufacturer and said, "here's
21 the limit that we are concerned about, a half inch," you
22 know, "that's the worst that's going to happen. How many
23 cycles can we go through at that" -- at, you know, "the
24 half inch having happened?"

25 I think the very last thing you said before the

1 lunch hour was: No, you didn't go to them and say that's
2 the worst that's going to happen. You went to them and
3 said, "That's where we are now. How much margin do we have
4 left?"

5 A. (Witness Wert) That's correct.

6 Q. I thought all along that you had said that a half-
7 inch was the limit. A half-inch was the worst we were going
8 to see.

9 And what my confusion was: Why didn't you go to
10 them with 3 inches?

11 What you're saying is that you went to them with
12 3 inches a long time ago. Now you were just looking for how
13 much margin you had, given present facts?

14 A. Let me clarify it. When I said "where we are
15 now," I was referring to the Vepco proposed technical
16 specification position.

17 REDIRECT EXAMINATION

18 BY MR. CHRISTMAN:

19 Q. Mr. Wert, is it true that you originally asked
20 the manufacturer to provide you an expansion joint, an
21 expansion joint that would accommodate 3 inches of lateral
22 offset?

23 A. (Witness Wert) That's correct.

24 Q. And the half-inch we are discussing, is it true
25 that you later went back to the manufacturer, having

1 calculated that at the proposed tech spec limit of .033 foot
2 for an average settlement, the expansion joint would see
3 about a half-inch of lateral offset, that you then went
4 back to the manufacturer and gave him those facts, based
5 on your calculations of what would happen at the proposed
6 tech spec limit, and asked him to analyze for that set of
7 facts?

8 A. That's correct.

9 FURTHER BOARD EXAMINATION

10 BY MR. FARRAR:

11 Q. The half-inch being, unlike my hypothetical
12 which was all differential settlement, that in fact we're
13 not seeing as much differential settlement, they're both
14 going down together. So a certain amount of total settlement
15 means a very small amount of differential settlement?

16 A. (Witness Wert) That's correct.

17 Q. Okay, I apologize to the extent that I couldn't
18 follow.

19 CHAIRMAN ROSENTHAL: Are there anymore questions
20 of this panel?

21 (No response.)

22 CHAIRMAN ROSENTHAL: Hearing none, the panel may
23 be excused.

24 (Panel of witnesses excused.)

25 CHAIRMAN ROSENTHAL: Mr. McGurren, I assume that

1 your panel of, as I calculate it, five witnesses, are present?

2 MR. MC GURREN: That's my understanding,
3 Mr. Chairman. I will call them.

4 CHAIRMAN ROSENTHAL: If you would, please.

5 MR. MC GURREN: The Staff calls Dr. Lyman Heller,
6 Richard Kiessel, Joseph Lenahan, Jared Wermeil, and
7 Alexander Dromerick, to be sworn.

8 CHAIRMAN ROSENTHAL: If you gentlemen would come
9 up to the table, but remain standing for a moment for the
10 administration of the oath.

11 (Witnesses sworn.)

12 Whereupon,

13 LYMAN HELLER,
14 RICHARD KIESSEL,
15 JOSEPH LENAHAN,
16 JARED WERMEIL,
17 and
18 ALEXANDER DROMERICK

19 were called as witnesses by the Nuclear Regulatory Commission
20 staff and, having been first duly sworn, were examined and
21 testified as follows:

22 MR. MC GURREN: At this time, Chairman Rosenthal,
23 I note that I have distributed to the Board and the parties,
24 with the required number of copies to the court reporter,
25 copies of the Corrected NRC Staff Testimony Regarding Pump

1 House Settlement.

2 This corrected testimony includes the corrections
3 noted to this Board and the parties by letters dated June 8th
4 and 14th, 1979, and also represents the testimony that was
5 dated originally April 27th, 1979, as supplemented May 4, 1979.

6 This testimony is entitled "NRC Staff Testimony
7 Regarding Pump House Settlement, by L. Heller, R. Kiessel,
8 J. Lenahan, J. Wermeil, and A. Dromerick," dated April 27,
9 1979, consisting of a cover sheet, a table of contents, two
10 pages of references, Tables A and B, Figures 1 and 2, and
11 Appendices A, B, and C.

12 Copies of the panel members' professional
13 qualifications have also been distributed to the Board and
14 the parties with the required number of copies to the court
15 reporter.

16 DIRECT EXAMINATION

17 BY MR. MC GURREN:

18 Q Addressing myself to the panel, will each of you
19 state your full name, title, and affiliation, commencing
20 with yourself, Mr. Dromerick.

21 A (Witness Dromerick) My name is Alexander
22 W. Dromerick. I am the Licensing Project Manager of the
23 North Anna Power Station, Units 1 and 2.

24 A (Witness Heller) My name is Lyman W. Heller.
25 I'm the Section Leader for Geotechnical Engineering in the

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1 Office of Nuclear Reactor Regulation.

2 A (Witness Lenahan) My name is Joseph Lenahan.

3 I'm a civil engineer and inspector in the Office of Inspection
4 and Enforcement, Region 2, Atlanta.

5 A (Witness Wermeil) My name is Jared Wermeil. I'm
6 an auxiliary systems engineer in the Auxiliary Systems
7 Branch of the Division of Systems Safety of the NRC.

8 A (Witness Kiessel) My name is Richard J. Kiessel.
9 I am a mechanical engineer in the Mechanical Engineering
10 Branch, Division of Systems Safety, NRC.

11 Q Will each of you be testifying as a member of the
12 panel on pump house settlement matters?

13 A (Witness Dromerick) Yes.

14 A (Witness Heller) Yes.

15 A (Witness Lenahan) Yes.

16 A (Witness Wermeil) Yes.

17 A (Witness Kiessel) Yes.

18 Q Will you please indicate what part of that
19 testimony you prepared?

20 A (Witness Dromerick) I had overall supervision of
21 the preparation of the testimony.

22 A (Witness Heller) I prepared most of Section 3
23 on soil mechanics; a large part of Section 4 on the watering;
24 and contributed to Section 6 on stress analysis.

25 A (Witness Lenahan) I prepared Section B-2, metal

1 settlement history; the first paragraph of section B-5;
2 and Appendices A, B, and C.

3 A (Witness Wermeil) I prepared a portion of
4 Section 1 in the relationship to public safety concerning
5 the postulated consequences of expansion joint failure.

6 A (Witness Kiessel) I prepared a portion of
7 Section 1 and Section 6 dealing with stress analysis, and
8 also the review of the testimony pertaining to stress
9 analysis in the Vepco testimony.

10 Q Addressing myself to the panel, will you indicate
11 please if there are any additional corrections or
12 additions to the testimony or professional qualifications.

13 Mr. Dromerick?

14 A (Witness Dromerick) Yes, there are a few
15 corrections.

16 On page 14, the first full paragraph, the first
17 line, please change "Part V" to "Part III," roman numeral "V"
18 to roman numeral "III."

19 Page --

20 Q Could you slow down a little, please?

21 A All right.

22 Page 51, line 14 from the top, the word "about"
23 should be changed to "above."

24 Q Would you please read that sentence with the
25 correction?

1 A "The explicit answer to the coalition question is
2 'no,' because the ground water control system has not been
3 in service long enough to predict its effect over the life
4 of the plant, say 40 years. In theory, if the water table
5 is above 274 feet elevation when the horizontal drains are
6 installed, the drains will lower the water table and cause
7 an increment of pump house settlement due to increased
8 effective stress."

9 Page 53, line 4 from the bottom, the words
10 "likely occur" should be changed to "likely to occur."
11 "There is no evidence whatsoever to indicate that an
12 earthquake would more likely to occur on saprolite than
13 other materials."

14 CHAIRMAN ROSENTHAL: You mean "be more likely"?

15 WITNESS DROMERICK: "Be more likely," sorry.

16 Page 56, the last line, the words "have not been"
17 should be changed to "have been." "The staff's
18 interpretation" --

19 CHAIRMAN ROSENTHAL: I don't think you really
20 need to read that sentence. That change is perfectly clear.

21 WITNESS DROMERICK: All right.

22 Page 58, line 8, the words "addition expansion"
23 should be changed to "addition of expansion."

24 Page 2 of "List of References," item 16 and item
25 17 should be deleted.

1 That's all I have.

2 BY MR. MC GURREN:

3 Q Mr. Dromerick, is the testimony and your statement
4 of professional qualifications, which we have identified
5 previously, true and correct to the best of your knowledge
6 and belief?

7 A (Witness Dromerick) Yes, they are.

8 Q I ask the same question of each of the other
9 panel members.

10 A (Witness Kiessel) Yes.

11 A (Witness Wermeil) Yes.

12 Q Mr. Lenahan?

13 A (Witness Lenahan) I have one other correction.

14 It's in Appendix B of the staff testimony. On page 5-7 of
15 the Region 2 report, number 53-38-78-34 --

16 CHAIRMAN ROSENTHAL: Page I-7?

17 WITNESS LENAHAN: Yes, sir.

18 It's stated that expansion joints were installed
19 in the service water lines in March 1976. This is on line--

20 CHAIRMAN ROSENTHAL: The first line in the
21 second full paragraph.

22 WITNESS LENAHAN: Yes, sir, first line second
23 full paragraph. That date is incorrect. It is clarified
24 in the next report, but the correct dates are August 1976
25 and October 1976.

1 CHAIRMAN ROSENTHAL: Instead of March '76 it
2 should be August?

3 WITNESS LENAHAN: August 1976 and October.

4 CHAIRMAN ROSENTHAL: August a.³ October.

5 BY MR. MC GURREN:

6 Q Mr. Lenahan, with that correction, is your
7 statement of professional qualifications and your testimony
8 true and correct to the best of your knowledge and belief?

9 A (Witness Lenahan) Yes, it is.

10 MR. MC GURREN: At this time, Mr. Chairman, I'd
11 like to ask that the documents I've identified, the profes-
12 sional qualifications of the panel, will be received in the
13 record of this testimony and be bound in the record as if
14 read, in accordance with the stipulation of the parties.

15 CHAIRMAN ROSENTHAL: They will be entered as if
16 read.

17 (The documents referred to follow.)
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ALEXANDER W. DROMERICK

PROFESSIONAL QUALIFICATIONS

LIGHT WATER REACTORS BRANCH NO. 3

DIVISION OF PROJECT MANAGEMENT

I am a Senior Project Manager in Light Water Reactors Branch No. 3 of the Division of Project Management, U.S. Nuclear Regulatory Commission. I am responsible for the evaluation of nuclear safety aspects of nuclear reactor facilities and serve as Project Manager for technical evaluation of power reactor license applications.

I received a Bachelor's degree in Mechanical Engineering with honors from Polytechnic Institute of Brooklyn, New York, in 1954. In addition, I have taken graduate courses in Engineering Administration and have taken special courses in Nuclear Engineering and Stress Analysis.

In 1954, I took a position as an engineer with the Special Products Group of the American Can and Foundry Company (ACF) Industries. I was responsible for the design of various types of nuclear weapons developed for the Atomic Energy Commission. I spent two years as supervisor of the Stress Analysis Group which evaluated reactor components for various types of nuclear reactors.

In 1957, I was appointed Section Head of the Research and Development Section for the Experimental Gas Cooled Project. In this position I was responsible for all R&D work performed by ACF Industries and in addition was responsible for coordinating R&D programs with National Laboratories.

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In 1960, I became Section Head of the Reactor Design of the Atomic Energy Division of Allis-Chalmers Manufacturing Company.

In this position I have had the responsibility of design and analysis of reactor components for various types of nuclear reactors. During this time I became a registered Professional Engineer in the State of Maryland.

In November 1968, I joined the AEC Division of Reactor Licensing in the Containment and Component Technology Branch as the Branch Chief, and I am presently with the Division of Project Management as a Senior Project Manager. In this position, I have the primary responsibility for safety review of the Millstone Nuclear Power Station, Unit 3, the South Texas Project, and the North Anna Power Station, Units 1 and 2.

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LYMAN W. HELLER
SECTION LEADER
GEOSCIENCES BRANCH
DIVISION OF SITE SAFETY AND ENVIRONMENTAL ANALYSIS
U. S. NUCLEAR REGULATORY COMMISSION

My name is Lyman W. Heller. I presently reside at 13605 Rolling Acres Way, Olney, Maryland 20832, and am employed as Section Leader, Geotechnical Engineering Section, Geosciences Branch, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, Washington, D. C. 20555.

PROFESSIONAL QUALIFICATIONS

I received a Bachelor of Science degree in Agricultural Engineering and Civil Engineering from the University of Illinois in 1950 and 1957, respectively. I received Master of Science and Doctor of Philosophy degrees in Civil Engineering, with majors in soil and foundation engineering, from the University of Florida in 1959 and 1971, respectively. Prior to my present position, which I assumed in February 1974, I was employed for 9 years as Chief of the Analytical Section, Soil Dynamics Branch, Soils Division at the Waterways Experiment Station, U. S. Army Corps of Engineers. In this position, I was responsible for special analytical and experimental Corps studies in soil and foundation dynamics as well as earthquake engineering aspects of earth and rock-fill dams. The results of these studies have been published as Corps reports and as papers in national and international symposia and proceedings. Prior to my employment with the Corps of Engineers, I was employed for 6 years as a Research Civil Engineer in the Soils and Pavements Division, Civil Engineering Department, Naval Civil Engineering Laboratory, Bureau of Yards and Docks, Department of the Navy. In this position, I was responsible for soil and foundation studies related to buried protective structures to resist the effects of nuclear weapons as well as design criteria for piles and other waterfront foundations. My other professional experience includes University teaching appointments, from Instructor to Adjunct Professor, employment with a consulting engineering firm, and employment as a project and product engineer in industry. My academic honors include an Ira O. Baker award from the University of Illinois, Tau Beta Pi, Chi Epsilon, and Phi Kappa Phi. My research contributions have been recognized by membership in Sigma Xi - Scientific Research Society of America. I am a member of the American Society of Civil Engineers and the International Society of Soil Mechanics and Foundation Engineering. I am also a registered professional engineer in the State of Florida.

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PROFESSIONAL QUALIFICATIONS

RICHARD J. KIESSEL

Education

- BS U.S. Coast Guard Academy 1962
- SM(ME) Massachusetts Institute of Technology 1968
- NAV.E. Massachusetts Institute of Technology 1968
- MBA New York Institute of Technology 1974

Background

Upon graduation from the U.S. Coast Guard Academy in 1962, in the period 1962-1965, I served as a deck watch officer, student engineer, and engineering watch officer and assistant engineering officer on a 6,000 shp turbo-electric powered Coast Guard vessel. In 1965-1966 I served as an engineering watch officer and first assistant engineering officer on a 6,000 shp geared diesel Coast Guard vessel.

Following post graduate training in mechanical engineering and navel architecture at MIT, in 1968, I was assigned to duty in the Marine Engineering Branch, Merchant Marine Technical Division, Office of the Merchant Marine Safety in Washington, D. C. While there, I was responsible for technical plan review of marine boilers, pressure vessels, and piping systems to determine compliance with the ASME and ANSI Codes adopted by Coast Guard regulations. This included stress analysis of spherical, cylindrical, and Siamese cargo tanks for the carriage of liquified natural gas.

In 1971, I was assigned to the Merchant Marine Technical Branch at Governors Island, New York, as Chief, Marine Engineering Section. In addition to performing technical plan review on conventional marine pressure vessels and piping systems I wrote numerous computer programs to permit evaluation of ASME and ANSI Code requirements on both a CDC 3300 and Wang 2200 computer. I also served as the marine engineering technical advisor to the Marine Safety Board investigating the causes of the collision between C. V. Sea Witch and Esso Brussels in 1973.

I joined the U.S. Nuclear Regulatory Commission in October 1974 as a mechanical engineer in the Mechanical Engineering Branch, Division of Systems Safety, Office of Nuclear Reactor Regulation. In this capacity I have been involved in

the review of the following plants: Atlantic Generating Station Units 1 and 2; Byron and Braidwood Units 1 and 2; Competitive Nuclear Ship Program; Floating Nuclear Plant Units 1 thru 8; GAISSAR; GIBBSSAR; Grand Gulf Units 1 and 2; Skagit Units 1 and 2; Susquehanna Units 1 and 2; Three Mile Island Unit 2; and Washington Nuclear Project Unit 2.

I am a member of the American Society of Mechanical Engineers, Sigma Xi, American Society of Naval Engineers and am licensed as a Professional Engineer by the State of New York.

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STATEMENT OF QUALIFICATIONS OF JOSEPH J. LENAHAN
OFFICE OF INSPECTION AND ENFORCEMENT, REGION II

My name is Joseph J. Lenahan. My business address is 101 Marietta Street, Suite 3100, Atlanta, Georgia 30303. I am employed by the United States Nuclear Regulatory Commission, Office of Inspection and Enforcement, as a Civil Engineer in the Reactor Construction and Engineering Support Branch.

I received a Bachelor of Science degree in Civil Engineering from Drexel University in June 1969 and a Master of Science degree in Civil Engineering from Drexel University in June 1973. Approximately 70 percent of my graduate work was in the area of soil mechanics and geology. I am registered as a professional engineer in the states of New Jersey and Pennsylvania and I am an associate member of the American Society of Civil Engineers.

From June 1969 through September 1970, I was employed as a Civil Engineer with the U.S.D.A. Soil Conservation Service, Upper Darby, Pennsylvania. My duties involved design of small earth dams. From January 1971 through August 1971, I was employed as a Civil Engineer in the Philadelphia Naval Shipyard. My duties involved structural design related to maintenance of shipyard structures, including buildings, piers, drydocks and large cranes.

From September 1971 through June 1976, I was employed as a soils engineer with the Philadelphia District of the Army Corps of Engineers. My duties included preparation of foundation designs and foundation design criteria for earth dams, powerhouses, pump stations, and various other civil works projects.

From June 1976 through June 1978, I was employed as a soils engineer with the Middle East Division of the Army Corps of Engineers in Winchester, Virginia and Saudi Arabia. I was responsible for preparation of foundation design, foundation design criteria, and determination of construction material sources for approximately five billion dollars of new construction. The projects included two commercial ports, two naval bases, four large military schools, and several military bases.

In June 1978, I joined the U.S. Nuclear Regulatory Commission as a Civil Engineer (Reactor Inspector). My duties involve inspection of nuclear power plant construction in the civil areas. These areas include concrete construction, foundation and embankment construction, and special studies, e.g., settlement monitoring programs.

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Joseph J. Lenahan

3/27/79

Jared S. Wermiel

Professional Qualifications

Auxiliary Systems Branch
Division of Systems Safety
Office of Nuclear Reactor Regulation

I am a Reactor Engineer in the Auxiliary Systems Branch in the Division of Systems Safety, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. In this position I perform technical reviews, analyses, and evaluations of reactor plant features pursuant to the construction and operation of reactors.

I received a Bachelor of Science Degree in Chemical Engineering from Drexel University in 1972. Since 1972 I have taken courses on PWR and BWR System Operation, Reactor Safety, and Fire Protection.

My experience includes seven years with the Bechtel Power Corporation as a Systems Design Engineer engaged in the design of various nuclear power plant auxiliary and balance of plant systems. These have included cooling water systems, water treatment systems and fire protection systems.

I joined the Auxiliary Systems Branch of the Commission in March, 1978. Since joining the Commission I have performed safety evaluations on safety related cooling water systems for the Virgil C. Summer Nuclear Station, Palo Verde Nuclear Generating Station Units 4 and 5, Allens Creek Nuclear Generating Station, Byron/Braidwood Stations and Units 1 and 2. In addition, I have reviewed and commented on the proposed ANSI Standard for

safety related cooling water systems. I have responsibility for the review of the following nuclear power plant auxiliary systems: new and spent fuel storage, spent fuel pool cooling, fuel handling, service water, component cooling water, condensate storage, ultimate heat sink, instrument air, chemical and volume control, main steam isolation valve leakage control, heating ventilating and air conditioning, fire protection, portions of the main steam system, and auxiliary feedwater.

I am a registered Professional Engineer in the State of Maryland.

I am an Associate Member of the American Institute of Chemical Engineers.

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of)
)
VIRGINIA ELECTRIC AND POWER COMPANY) Docket Nos. 50-338 OL
) 50-339 OL
(North Anna Nuclear Power Station,)
Units 1 and 2))

NRC STAFF TESTIMONY REGARDING PUMPHOUSE SETTLEMENT

By L. Heller, R. Kiessel, J. Lenahan,
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APRIL 27, 1979

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NORTH ANNA 1 & 2 PUMPHOUSE SETTLEMENT

A. Background and Introduction

The service water system for North Anna Units 1 and 2 is designed to provide cooling water to the safety-related plant systems for normal operating conditions, anticipated operational occurrences, and accident conditions. Service water flow is provided to the charging pump coolers, control room air conditioners, instrument air compressors, and pipe penetration cooling coils for any of the above three conditions. During normal operation and cooldown, service water flow is also provided to the component cooling heat exchangers. In the event of a loss-of-coolant accident, service water flow will additionally be provided to the recirculation spray heat exchangers for cooling containment spray water during recirculation. The service water system provides seismic Category I backup water supply for the spent fuel pit makeup and the auxiliary feedwater system, and backup cooling flow for the spent fuel pit coolers and the recirculation air cooling coils.

The service water system is shared by both Units 1 and 2. It consists of two full capacity redundant trains, each of which supplies water to both units. The normal service water is supplied from the service water reservoir by means of four service water pumps, of which two are required during all operational modes,

while the other two pumps may be used for fast cooldown. As a backup, if the service water pumps are not available, service water can also be supplied from Lake Anna by means of two auxiliary service water pumps, both of which would be required during emergencies. In summary, the service water pump requirements during power operation or under accident conditions can be met by either two service water pumps or two auxiliary service water pumps, or one of each. The cold shutdown cooling requirements can be met by one service water pump or one auxiliary service water pump. All service water pumps are located in seismic Category I structures and are protected from tornado missiles as well as internal missiles. The pumps are powered by redundant emergency electrical buses.

The entire system is designed to seismic Category I requirements. Sufficient redundancy is provided to meet the single failure criterion.

The following is a discussion of foundation material at the site. Lake Anna has been created by the construction of an earth dam on the North Anna River five miles southeast of the site. The North Anna River watershed has a drainage area of about 343 square miles. The dam crest is 265 feet above mean sea level, plant grade is 271 feet above mean sea level, and the normal lake is 250 feet above

mean sea level. Lake Anna will normally be used to supply circulating water for plant operation and during shutdown.

The soil and foundation conditions at the site include residual saprolite soil composed predominantly of silty fine sand, severely weathered rock that is soft and friable, moderately weathered rock having more than 50 percent intact rock in core borings, and slightly weathered to fresh rock. The North Anna site is underlain by metamorphic rocks, mainly medium to high grade gneisses and schists, and in the vicinity of the containment structures, the surficial weathered material was removed so that structures could be founded on sound, fresh rock. Other important structures are founded on slightly weathered to moderately weathered rock, with the exception of the service water reservoir and dike, which are founded on saprolite.

Properties of the foundation material, as given in the Final Safety Analysis Report for Units 1 and 2 of the facility, indicate that the rock has a density of 165 pounds per cubic foot and a shear wave propagation velocity of 5000 to 6000 feet per second. The shear wave propagation velocity of residual soil is 800 to 850 feet per second and for saprolites the velocity is 950 feet per second. The dry density of saprolites (severely weathered rock and residual soil) varies from 98 to 135 pounds per cubic foot with porosity

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values ranging from 21 to 40 percent. The average saprolite porosity value is 30 percent. The permeability of the foundation saprolite is 1×10^{-6} centimeters per second and the permeability of the compacted dike core and two-foot-thick pond liner is 1×10^{-6} centimeters per second, as reported in Table 3.8.4-1 of the Final Safety Analysis Report (FSAR). As stated in the FSAR, backfill under tanks and other structures is select granular material placed to a density of not less than 95 percent of Modified Proctor Compaction, in accordance with American Society of Testing and Materials, Specification ASTM D-1556.

More detailed investigations described in the licensee's latest reports on geotechnical investigations and interpretation reveal that the dry density of the sampled saprolites underlying the spray pond dikes and pump house varies from about 66 to 106 pounds per cubic foot and that the permeability of the saprolite is 2×10^{-4} centimeters per second. The pond liner permeability is 2×10^{-7} centimeters per second. Additional laboratory tests on undisturbed saprolite were conducted to estimate its compressibility under foundation and dike loadings.

A comparison of the properties of the saprolite as reported in the FSAR and as determined by a later detailed investigation in the vicinity of the dikes and pumphouse, reveals that the capability of

the saprolites under these facilities is less than was originally expected; the dry densities are considerably less and the permeability is considerably greater. Because of these differences in saprolite properties, the foundation performance of structures and facilities supported by these saprolites might be expected to differ from that anticipated during their design.

The dikes used to impound the service water reservoir are a few to forty feet high and some 3000 feet long, with a crest elevation at about 320 feet above mean sea level. Dikes are composed of compacted earth fill, with an upstream slope of one vertical on three horizontal, and a downstream rock fill shell with a slope of one vertical on two horizontal. A sand layer serves as a filter to separate the earth fill from the rock fill. The dikes are supported on residual soil.

The service water pumphouse for Units 1 and 2 is located within the dike that impounds the spray pond reservoir. It is founded on a 64-foot by 61-foot mat on residual soil, at an elevation of 297 feet above mean sea level. The foundation loading is 3,050 pounds per square foot and the allowable bearing value based upon laboratory tests is 4,200 pounds per square foot. The main reservoir screenwell on Lake Anna is founded on a 64-foot by 187-foot mat on residual soil, at an elevation of 218 feet above mean sea level.

The foundation loading is 3,330 pounds per square foot and the allowable bearing value based on laboratory tests is 8,000 pounds per square foot.

The compacted earthfill main dam impounding Lake Anna has an upstream slope of one vertical on 2.75 horizontal and a downstream slope of one vertical on 2.5 horizontal. At its maximum section, it is about 90 feet high with a crest elevation of 265 feet above mean sea level. Drainage features include a central chimney drain, a blanket drain, and relief wells along the downstream toe of the dam. A gated concrete spillway, which is founded on rock, occupies the center portion of the dam. Foundations for the embankment sections of the main dam consist of residual soils and saprolites which were stripped of surficial vegetation. The properties of these materials are expected to be similar to those beneath the service water pond, dikes, and pump house.

The necessary reliability of a source of service water to safely shut down the plant in the event of the design basis earthquake is based on the existence of the service water reservoir and Lake Anna. We believe that the dikes for the service water reservoir and North Anna dam together have an adequate degree of stability, and resulting reliability, under the seismic effects of the postulated safe shutdown earthquake. Our review of VEPCO's information on the main dam on Lake Anna, and its foundations, indicates

that this dam has considerable seismic resistance and could survive the effects of the safe shutdown earthquake. We thus conclude that the foundations and earthworks features of these two service water sources combined have adequate reliability, under seismic conditions.

In April 1975, VEPCO informed the NRC Staff that the average settlement of service water pumphouse for North Anna Units 1 and 2 exceeded that predicted in the PSAR. An inspection of the situation at the site indicated that the PSAR predicted settlement had been exceeded since December 1972. The matter of pumphouse settlement, and its safety significance, has been under continuing review and evaluation by the NRC Staff since April 1975. This evaluation has led the Staff to conclude that operation of the facility was acceptable provided that the settlement was monitored so that any necessary corrective action could be taken in time.

B. Responses to Specific Appeal Board Concerns

The following parts of this testimony are in response to the specific requests for testimony contained in ALAB-529 regarding pumphouse settlements. As suggested by the Appeal Board, the Staff and VEPCO divided up the responsibility for responding to the areas of concern contained in ALAB-529. Under this agreement, the Staff has principal responsibility for providing testimony regarding subject numbers 4 (dewatering) and 6(a)-(c) (stress analysis). As to the remaining

matters, VEPCO has principal responsibility. VEPCO has provided draft testimony to the Staff on all questions raised by the Appeal Board. The Staff has reviewed this draft testimony, and in addition to its own testimony on questions where it has principal responsibility, has provided comments on the VEPCO draft testimony, and where appropriate, additional independent testimony.

1. Relationship to Public Safety

ALAB Question: The Appeal Board asks for information that furnishes a perspective of the potential seriousness of the pumphouse settlement problem from a safety standpoint. It asks what would happen if the subsidence of the land were to lead to a failure of the service water system. It asks for (a) the upper limits of functional requirements and system capability of the service water system (e.g., the pump and pipe flow requirements and capacity) both during normal operation and under accident conditions; (b) which service water systems or components could fail as a result of further settlements; (c) where and how might they fail and what leak rates might be expected; (d) how such failures would be detected and what actions would be taken; and (e) how failure of the service water system affects other plant safety systems under normal operation and accident conditions.

Response

Section B.1 of ALAB-529 raised a number of questions concerning the continued settlement of the service water pumphouse (SWPH) and its relationship to public safety. Those were addressed by VEPCO in Section III of his direct testimony. Based on a review of this and other information available to the Staff, we made the following observations:

- a. Information available from the expansion joint manufacturer indicates that the joints were designed for a 3-inch (0.25 foot) lateral displacement.
- b. Because of the conservatism inherent in the design of all piping system components, it is reasonable to expect that the expansion joints can withstand lateral displacements in excess of the design value without failure.
- c. The slow manner of the settlement, coupled with the proposed technical specification reporting requirement at 75 percent of the design value, provides assurance of ample time to bring the plant to a safe condition before the design value of an expansion joint is reached.
- d. Because of the ductile nature of the material used in the bellows of the expansion joints, it is reasonable to

expect that, should failure occur, it would be in the form of cracks as opposed to a complete severance.

e. The licensee has performed a failure analysis for the service water system piping expansion joints. It is our understanding that the analysis is based on the service water pumphouse having reached its Technical Specification limit for settlement and, therefore, the plant is in the cold shutdown mode. Continued settlement is assumed to occur resulting in failure of the expansion joints. The licensee submitted evaluations for the following events:

- (1) Complete failure of one expansion joint in a return header.
- (2) Complete failure of one expansion joint in a supply header.
- (3) Simultaneous failure of all four expansion joints.

Since the service water system cooling water has performed its design function prior to being returned to the service water reservoir in the return header, a failure of the expansion joint in the return header would only result in a reduction of the level of the water in the reservoir. There is an ample supply of water in the reservoir to allow for detection of the failure, and realignment of the system to use the auxiliary service water pumps at Lake Anna before the service water system function would be affected. We, therefore, agree with the licensee that plant safety is assured by use of the auxiliary service water pumps. The complete failure of one expansion joint in a service

water supply header would result in isolation of the affected header and the redundant supply header would be placed in service. We again agree with the licensee that plant safety is assured as the redundant train of service water is available. If the expansion joints in the four service water lines were to fail, the plant would again have to resort to using the auxiliary service water pumps at Lake Anna, circulating cooling water through the system and returning the cooling water back to Lake Anna. We agree with the licensee that the plant safety is assured by the auxiliary service water pumps even after postulating this worst case occurrence, and, therefore, the health and safety of the public will not be affected.

Based on the above, the Staff concludes that the health and safety of the public is protected through a multilayer defense in depth.

2. Settlement History

ALAB Question: The Appeal Board asks for two separate charts, one for the pumphouse and one for other relevant points (e.g., exposed pipe ends and any other monitoring points on the pipes) each showing the amount of settlement that has taken place with the passage of time. The span of time involved should be labeled not only by date but also in terms of the construction activities that were taking place at various

points (including, especially, such foundation-related activities as excavation and backfilling, building of the pumphouse, laying the service water lines between pumphouse and reactor buildings, dewatering for reactor or other major building construction, building of the cooling pond and dikes, and dewatering of the ground under the pumphouse and service water lines.)

Response

The licensee informed IE Region II, by telephone on April 16, 1975, that the average settlement of the SWPH had exceeded the values predicted in the PSAR. An inspection of the SWPH settlement was performed on April 29, 1975. Based on the results of this inspection, it became apparent to IE Region II management that resolution of this problem would require extensive additional testing and design analysis. Because of this, the lead responsibility for resolution of the SWPH settlement problem was transferred to NRR on May 13, 1975. IE's role after May 13, 1975 was to provide to NRR the information obtained during the various inspections conducted during construction of the plant pertinent to the SWPH settlement, and to provide inspection and enforcement for any additional requirements defined by NRR actions.

After May 13, 1975, IE Region II received copies of correspondence between the licensee and NRR, but did not participate in technical evaluation of the SWPH settlement. A summary of the inspections performed by IE Region II pertaining to the SWPH settlement and horizontal drain installation, related to this testimony, is attached as Appendix A. IE Region II did not make any independent settlement measurements. All settlement measurements (surveys) were made by the licensee's contractors.

The licensee notified IE Region II on April 28, 1978 that the SWPH average settlement exceeded the value required by the Technical Specifications for reporting, i.e., 75 percent of the maximum allowable value of 0.15 feet. IE Region II transferred the lead responsibility for evaluation of the licensee's special report required by the Technical Specifications to NRR on May 15, 1978. The licensee submitted the special report to NRC on May 31, 1978.

In response to allegations that the licensee had knowledge of SWPH settlement in excess of the Technical Specification limits in August 1977 but withheld the information from NRC for seven months until April 28, 1978, IE Region II conducted a special inspection on December 6-8, 1978 and a special inspection and inquiry on March 5-15, 1979. The results of these inspections and the inquiry are contained in IE Report Number 50-338/78-44 (December 6-8, 1978

inspection; previously sent to Appeal Board) and IE Report Number 50-338/79-13 (March 5-15, 1979, inspection and inquiry). Although the inspection reports relate to enforcement matters, which are not within the scope of the issues raised by the Appeal Board, they contain information regarding settlement of the service water pumphouse. Accordingly, these reports are attached to this testimony as Appendices B and C, respectively. The allegations were not substantiated.

IE Region II has reviewed Part V, entitled, "Settlement History", of the April 27, 1979 testimony prepared by Virginia Electric and Power Company. This review was limited to verification of the accuracy of the time versus settlement data stated in Part V and Figures 7A through 7G and Figures 25A and 25B. The data presented appears to be accurate except for the following:

- a. There are several minor errors in plotting of the magnitude of average SWPH settlement on Figures 7A through 7G. These errors are on the order of .002 to .004 feet which results in the data plotted on the figures indicating slightly less average settlement than has actually occurred.
- b. The scale on the ordinate on the right side of Figures 7D, 7F and 7G labeled, "Average Settlement since December 75-Ft", is

plotted incorrectly. The numbers shown on the scale should be increased by .005, i.e., 0 should read .005, .02 should read .025, .04 should read .045, etc.

Figures 1 and 2, attached to this testimony, show a cross section of the service water pumphouse and embankment with an identification of construction sequence and the time versus settlement of the northwest corner of the service water pumphouse.

VEPCO's testimony, Figures 7A through 7G, provide the time versus average pumphouse settlement along with the labeled construction sequence. VEPCO's testimony, Figures 25A and 25B, provides the time versus settlement of the exposed end of the service water pipes buried in the dike fill. The Staff believes that the settlement history of each corner of the pumphouse and piping supports is significant because the differential movement across the expansion joint, the settlement-induced pipe stress, and the tilt of the pumphouse which could affect operability of the pumps, are directly influenced by the settlement of each measurement point.

Recent settlement data for corners of the pumphouse are given in attached Table A. This table also gives the settlement of marker ASM-5 on top of the service water reservoir dike. Table B,

attached, gives settlement values for pipe hangers H584 and H569 which are located within the spray pond.

As shown in VEPCO's Figure 6 of the draft testimony, settlement points SM-7, 8, 9 and 10 are located, respectively, at the NE, SE, SW and NW corners of the pumphouse. Settlement points H569 and H584 are located on pedestal-supported pipe hangers within the spray pond. These hangers, H584 and H569, support the ends of water supply pipes from the pumphouse to the spray header system for Units 1 and 2, respectively. Settlement markers SM-15, 16, 17 and 18 are located on the crown of exposed pipes to the north of the pumphouse, as shown in VEPCO's Figure 6.

3. Soil Mechanics

ALAB Question: The Appeal Board asks for a discussion of the current understanding of the engineering properties of the soils underlying the pumphouse, the reservoir dikes and the service water lines. It asks precisely what the term "secondary consolidation" is intended to mean, and asks that the discussion include an indication of how the parties' knowledge of this subject has developed in terms of the timing of the studies and investigations that have led to their current understanding.

Response

Engineering Properties of Soils: Our understanding of the engineering properties of the soils underlying the pumphouse and reservoir dikes has developed from our review of information docketed by VEPCO in support of their license application, from inspections of compacted soil exposures in trenches adjacent to the pumphouse, from an examination of tested laboratory soil specimens performed by VEPCO's consultants (Ref 14), and from the results of the laboratory soil tests performed by our consultants, the U.S. Army Corps of Engineers (Ref. 15). Although there has been no detailed program to determine the specific properties of soil underlying the service water lines, it is reasonable to expect that they are consistent with the soils at other locations on the site.

Our review of docketed information concerning soil properties in the pumphouse and dike area began in the spring of 1975, shortly after unexpected settlement of the pumphouse was brought to our attention. From the docketed information available, we and our consultants were unable to conclude that the dikes and their foundation possessed adequate stability under all loading conditions. We asked VEPCO to confirm their design assumption by performing additional soils exploration and sampling. As a result of VEPCO's investigation and report of in situ soil conditions, we asked VEPCO to reassess the static and seismic stability of the

dikes. Based on the results of these investigations, tests, and analysis, we then asked VEPCO to provide toe drains at the critical dike section and to control groundwater levels under the pumphouse to improve the long-term functional reliability of these safety-related facilities.

Our current understanding of the properties of the soils underlying the pumphouse and dike may be summarized as follows. The dominant overburden soils are saprolites. These are residual soils which consist of fine-grained material near the ground surface and grade to coarse-grained material with depth. The residual soils are underlain by weathered and unweathered rock. Soil depths vary, depending on the weathering processes which produced the soil from the parent rock, a granite gneiss. Engineering properties of the soils are quite variable, depending on the degree of weathering, orientation of relic jointing with respect to applied stresses and, to a lesser degree, the mineralogy of the soil constituents.

Since 1975, VEPCO has performed a number of investigations to establish the occurrence and engineering properties of the saprolitic foundation soils in the vicinity of the reservoir dikes and service water pumphouse. These investigations include compressibility, mineralogy shear strength, and resistance to cyclic loads, such as those induced by earthquakes. The results of these

investigations are described on pages 3 and 4 of this testimony (see also Ref. 14). In 1976, the Corps of Engineers was asked by the Staff to independently assess the cyclic resistance of these saprolitic soils because little information is available on the dynamic behavior of these soils. The objective of the Corps investigation was to determine the resistance to earthquake effects of undisturbed samples of saprolites by performing cyclic triaxial tests on these materials. As a result of their tests, the Corps made the following observations:

- a. ...the specimens tended to expand when they were extruded from the tubes, resulting in a lower density; however, the after-consolidation density was close to but generally higher than the in-tube density. This might suggest that the samples expanded during the sampling process and that the in situ density was greater than the in-tube density.
- b. All samples achieved 100 percent pore water pressure response, i.e., initial liquefaction with cyclic stress values similar to those for medium dense sands (e.g., at 10 cycles $R = 0.26$ to 0.37). The strain response of the specimens ... was also similar to that of sands.
- c. ...the shape of the normalized pore water pressure response is concave downward whereas that for most sands tends to be concave upward.
- d. The strength, strain, and pore pressure responses of a specimen consolidated for approximately 2 days ... were virtually identical to those of a specimen consolidated for approximately 30 minutes It may be noted that these two "specimens", were adjacent 6-in segments taken from the same boring and sample....
- e. ...the results of three tests performed by Geotechnical Engineers, Inc., on similar undisturbed samples taken

from adjacent borings at similar depths, are very similar to the results of specimens tested in this investigation." (Ref. 15, pp. 19, 20)

The agreement of the laboratory test results obtained by VEPCO's consultants and the Army Corps of Engineers indicates that the earthquake resistance of the saprolite soils supporting the dikes and pumphouse would be adequate. We would expect these soils to develop excess pore-pressures during the occurrence of the postulated safe shutdown earthquake, and that some residual shear strain of the foundation soils would occur. We would not expect the soils to strain sufficiently to cause a breach of the service water reservoir dike or the main dam that impounds Lake Anna. In addition, the tests confirms the ability of the saprolites to support the pumphouse in the event of the postulated safe shutdown earthquake.

4. Dewatering

ALAB Question: The Appeal Board asks for (a) the bases upon which the staff requirements for groundwater control were developed, and (b) the safety factor normally required, with appropriate supporting references, to protect against seismic induced soil liquefaction.

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Response

[NEXT PAGE IS 23]

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Bases for Position

We required VEPCO to bring the probable cause of rapid foundation settlement under control before a license could be granted and that a program to monitor groundwater levels be established. The bases for this requirement are as follows:

- a. Changes in groundwater levels in the saprolite supporting the pumphouse can cause settlement of the pumphouse.
- b. Unexplained rapid settlement of the pumphouse had occurred coincident with unusually heavy rainfall and it is known that

seasons of heavy rainfall result in a rise of groundwater levels.

- c. There is a potential for leakage of reservoir water into the saprolite supporting the pumphouse.
- d. Future groundwater levels are likely to change beneath the pumphouse due to a number of other factors.
- e. Future changes in groundwater levels may be greater than that which probably caused the rapid pumphouse settlement between November 1974 and February 1975.
- f. We judged that this safety-related structural foundation, which had settled at the rapid rate of one inch in three months and has the potential for greater rates of settlement, did not meet the safety and performance requirements of an operating nuclear power plant.
- g. Groundwater control seemed the most practical remedial measure for reducing the potential for rapid settlement.

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These bases are discussed sequentially in the following paragraphs:

- a. The first basis of our position is information communicated to the Staff from VEPCO in a letter dated May 16, 1975 (Ref. 1). The second paragraph of page 2 of the attachment to Reference 1 (dated 5/15/75) reads:

"Heavy rainfall during the last winter has saturated the dike materials and resulted in additional settlement...."

Figure 6 of VEPCO's testimony indicates that an inch of settlement occurred from mid-November 1974 to mid-February 1975, a period of 3 months.

The Staff could not agree with VEPCO's interpretation that the cause of the inch of pumphouse settlement was due to dike saturation because 1) the dike material is relatively impervious, and 2) the filters placed over the dike fill should have conducted rainfall away from the dike and pumphouse before it could soak into the fill. On this basis we believed that another cause of rapid settlement seemed more likely.

- b. The second basis of our position is information contained in a letter from VEPCO to the Staff dated February 5, 1976 with an attached letter from Ralph Peck to VEPCO dated January 17,

1976 (Ref. 2). The last paragraph on page 3 of the Peck letter reads:

"Unusually great rainfall occurred in September 1974) as shown also in Figure 2, and appears to have produced further settlement. A second acceleration of settlement occurred in January 1975, following relatively heavy December and January rains."

The referenced Figure 2 is reproduced as Figure 1 in this testimony. The first paragraph on page 5 of the letter reads:

"A substantial part of the total settlement of the NW corner (about 0.12 feet) that has actually been experienced appears not to be associated with increase in load. Probably, as suggested by Stone and Webster, it can be attributed to rainfall."

In addition to the above, Dr. Peck, on page 5 of his letter, suggests that one conceivable mechanism causing settlement is the:

"weakening of the bonds between particles of the saprolite due to an increase in moisture content."

He also indicates that the increase in weight of the embankment fill by saturation appears to play a minor role in the potential mechanism for settlement. In addition, he states:

"Beneath the dike, where stresses have been appreciably increased, added moisture might activate further settlement...."

In the last paragraph on page 5 and the discussion on page 6 of his letter, Dr. Peck indicates that reactivation of settlement under unchanged ambient conditions might occur in subsoils that had achieved a state of secondary consolidation after a reduction in applied loading.

In the Staff's view, changes in groundwater levels beneath the pumphouse might contribute to the realization of these phenomena and result in additional pumphouse settlement.

Accordingly, we attributed the unexplained rapid settlement that occurred from November 1974 to February 1975 to changes in groundwater levels in the saprolite supporting the pumphouse because such changes 1) cause changes in effective stresses in the saprolite and 2) could cause a weakening of the bonds between particles of the saprolite.

- c. The third basis of our position is information obtained from our site visits. On October 1, 1975, members of the Staff visited the North Anna plant in company with our geotechnical engineering consultant, the U.S. Army Corps of Engineers. We viewed two inspection trenches cut into the embankment fill adjacent to the east and west walls of the pumphouse foundation. The trenches were cut to examine the integrity of the contact

between the wall of the pumphouse and the fill; a crack at this interface could allow water to leak from the reservoir to the downstream filter. A crack at this interface might be expected because of the differential settlement and tilt of the pumphouse with respect to the adjacent fill. Such differential movement was evident from cracked wingwalls attached to the pumphouse.

Our observations did not reveal any evidence of cracks opening along the foundation - fill interface, but we noticed two conditions which caused concern and which influenced our judgments regarding the need for control of groundwater levels under the pumphouse. First, there was no visible evidence of a three-foot thick clayey liner (select fill) between the dike fill material and the pumphouse, as shown, for example, on NIF 3.8.4-15 of the FSAR, Part B, Volume II and NIF Figure S2.20-1 and S2.20-2 (Ref. 6). The absence of this liner could allow more water to seep from the reservoir to the saprolite underlying the pumphouse than was expected. Second, there was visible evidence of the presence of organic matter in the dike fill. Eventual decomposition of this organic matter with time could increase the amount of water leaking from the reservoir into the saprolite beneath the pumphouse.

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On July 8, 1975 and again on October 1, 1975, before the reservoir was filled, we noticed plants growing in the soil on the bottom of the reservoir. The roots of these plants penetrate into, and perhaps through, the liner of the reservoir. Eventual decomposition of these roots could provide paths for leakage of water from the reservoir into the saprolite underlying the reservoir.

Leakage of water from the reservoir into the saprolite underlying the service water pond and pumphouse in amounts greater than was anticipated in the design of the facility could lead to a rise in groundwater levels, and to saturation and soaking of portions of the saprolite which might again trigger unanticipated high rate of pumphouse settlement. Control of groundwater levels, by means of pumps or drains, appeared necessary to alleviate this cause of rapid pumphouse settlement.

- d. The fourth basis of our position has been mentioned previously under the heading Dewatering - Background. We believe that the groundwater levels under the service water reservoir and pumphouse are likely to be affected and changed with time by a number of factors that include 1) changes in topography and surface drainage due to construction of the plant, 2) changes due to impounding Lake Anna, 3) changes due to construction

activities (dewatering, etc.), for Units 3 and 4, and 4) seasons of unusually plentiful or sparse rainfall.

Our bases e, f, and g express the Staff's concerns, judgments and logic leading to the requirement for groundwater control beneath the service water pumphouse. The Staff considered that the potential for recurrence of rapid settlement of the pumphouse, without groundwater level control or some other remedial measure such as replacing or underpinning the foundation of the pumphouse, would be present throughout the useful life of the nuclear plant, and that rapid pumphouse settlement could stress safety-related piping beyond design and Code values before being detected or corrected by VEPCO.

Conclusion

Because of the potential effect of groundwater level on the behavior of saprolite soils, i.e., that soaking these soils could soften them and that changes in effective stress could consolidate them, the Staff required a system and program to measure and record the groundwater levels in the vicinity of the dikes and pumphouse. The Staff also required that a system to control the groundwater levels under the settlement-sensitive pumphouse and the critical section of the dike for the service water reservoir; control could be attained by drains. The Staff believes that drains which limit

groundwater levels and large fluctuations in groundwater levels can significantly reduce the possibility of rapid settlement of the pumphouse. The data obtained from the settlement monitoring program, the groundwater monitoring program, and the drain flow measurements will, in time, either confirm or discount the effect of groundwater levels on the behavior of the saprolite. In any case, the settlement monitoring program and the provisions of the Technical Specifications give an advance notice of settlement effects such that a reasonable assurance of the availability of service water for plant shutdowns is attained.

Safety Factor

The Staff has not established a generic or site specific safety factor for soil liquifaction. The reason for this is that the Staff does not believe that information about soil conditions and required soil and foundation performance can be reduced to a unique safety factor which represents, in any meaningful way, the functional reliability of these foundations when they are subjected to earthquake effects. It should be pointed out that, although applicants present safety factors for soil liquefaction in their license applications, the Staff does not consider these factors as the basis for acceptance. The bases for our acceptance, for safety-related facilities, are the foundation performance requirements,

the degree of hazard involved, and the level of confidence in the knowledge of site conditions.*

We believe that a sufficient and appropriate investigation of the soils in the vicinity of the service water dikes has been conducted to demonstrate that these dikes and their foundations have a reasonable assurance of functionally surviving the effects of the safe shutdown earthquake assigned to this plant. We base this judgment mainly on the results of cyclic loading tests performed on the saprolite soils by VEPCO's consultants and by the Staff's consultants. The results of the Army Corps' work has been described previously under the heading Soil Mechanics - Response. Our confidence in the data base supporting our judgments has been enhanced by our examination of the VEPCO contractor's laboratory, and raw test results obtained in this laboratory. Our confidence in the data base supporting our judgment is also enhanced by the agreement of test results obtained by VEPCO's consultant and by our consultant.

5. Monitoring

ALAB Question: The Appeal Board asks (a) for a description of the type of instruments and methods by which settlement of Class I structures are monitored, together with an evaluation of the accuracy of such monitoring and (b) for information as

* A discussion of soil liquefaction along with a number of references is contained in Reference 7.

to how the movements of buried service water pipes are monitored or estimated. They also ask whether the "47 degree elbows" in the service lines near the pumphouse have been monitored and how much these elbows settled before and after dewatering.

Response

With regard to part (a) of the Board's question, IE Region II has reviewed paragraph a of Part VII, entitled, "Monitoring," of the April 27, 1979, testimony prepared by VEPCO. The settlement monitoring program and data for the SWPH and other Class I structures were reviewed in detail by IE Region II during special inspections conducted on December 6-8, 1978 and March 5-15, 1979. The results of these inspections, contained in Inspection Report Numbers 50-338/78-44 and 50-338/79-13, are in substantial agreement with the statements contained in paragraph a of Part VII of the licensee's testimony. These inspection reports are attached as appendices to this testimony.

With regard to part (b) of the Board's question, the only part of the service water piping being monitored is the exposed ends of the pipes located north of the service water pumphouse and expansion joints which are within the expansion joint enclosure structure.

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The buried service water piping has not been monitored. Historically, such pipes are not monitored since access to them is not readily possible. Our analysis, described in Section 6, assumed that the 47 degree elbow has not settled. This is a conservative assumption as settlement of the elbow results in a decrease in the differential settlement between the elbow and markers 15, 16, 17 and 18. Thus, any settlement of the elbows would result in an increase in the allowable settlement of markers 15, 16, 17 and 18.

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6. Stress Analysis

ALAB Question: The Appeal Board asked for a discussion of the topic of stress analysis, and to indicate the impact of varying amounts of settlement. They asked for a description of the types of loads assumed and methodology used in analyzing stress limits for service water piping and whether stresses due to the apparently greater settlement of pipes relative to that of the pumphouse are included in the analysis. They asked the staff to (a) provide a full justification for selecting the differential motion limit of 0.22 feet between corners of the north side of the pumphouse and the expansion joint, and explain how this satisfies the staff's concerns on stress limits in the flexible couplings, (b) explain how limiting the absolute elevation of the exposed ends of the expansion joints to 0.22 feet (measured from August 3, 1978) satisfies the staff's concerns on stress limits in the buried pipes, and (c) set forth the basis for choosing 75% of the limit as the level which triggers the reporting requirement for all established limits.

Response:

The Staff reviewed VEPCO's proposed testimony regarding the assumed loads and methodology used in analyzing stress limits for service water piping. The Staff does not disagree with these aspects of VEPCO's testimony.

The objectives of the staff's evaluation of allowable settlement limits were to assure during the period of plant operation, that the stress levels in the service water piping did not exceed the allowable values defined by the ASME Boiler and Pressure Vessel Code, Section III, and that the movement of the expansion joints in the service water lines did

not exceed the design values of the expansion joints. The following paragraphs address the Appeal Board's specific questions and contain the staff's explanation of the basis for satisfying the stated objectives.

a) Justification of Differential Motion Limit

In the following discussion, the staff uses the term differential motion to mean differential motion between either corner of the north side of the pumphouse and the exposed ends of the pipes that are buried in the gravel filter portion of the dike fill.

The limiting value for differential settlement after July 1977 (0.22 ft.) was developed in the manner described in this and the following paragraphs. Although VEPCO has indicated other dates, we have conservatively assumed that the flexible joints were installed in December 1975, thereby setting that date as the initial reference point for settlement of the north wall of the pumphouse. The July 1977 date was chosen as the first measurement of the pipes because this is the date that marks SM-15, 16, 17, and 18 were established on the pipes; no settlement readings were made on these pipe ends prior to July 1977. Accordingly, no computations of the differential settlement between SM-7 or 10 and SM-15 through 18, based on direct measurements, could be made for the period December 1975 to July 1977. The approximate settlement of SM-15 through 18 can be established, however, by assuming that the top of the dike near these markers settled the same amount as the exposed ends of the pipes embedded in the dike. The settlement values for the top of the dike near these pipes (ASM-5) and for SM-7 and SM-10 are given in Table A.

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During the period December 1975 to July 1977, the top of the dike settled 0.079 feet (the locations of SM-15 through 18 were assumed to have settled the same amount), SM-7 settled 0.046 feet and SM-10 settled 0.089 feet. Thus, the estimated differential settlement across the joint that occurred during this time period was between 0.033 feet ($0.079-0.046$) and -0.010 feet ($0.079-0.089$). A value of 0.03 feet was conservatively chosen to represent the differential settlement of SM-15, 16, 17 and 18 with respect to the north side of pumphouse during this period of time.

Information from the flexible coupling manufacturer indicates that the coupling is designed for a lateral movement of one end with respect to the other end of 0.25 feet (neglecting twist about the axis of the coupling and rotation of the ends of the coupling in the axial plane). (Ref. 11, p.4).

The limiting differential settlement between markers SM-7 or SM-10 and any marker SM-15, 16, 17 and 18, after July 1977 is the joint design limiting differential settlement (0.25 feet) when the flexible joint was installed (December 1975) less the differential settlement estimated to have occurred (0.03 feet) during the period December 1975 to July 1977. This difference ($0.25-0.03$) is 0.22 feet.

In summary, then, because the expansion joints were designed to accommodate 0.25 ft. of movement without exceeding stress and fatigue limits in the joints, and because we conservatively estimate 0.03 feet of differential settlement has occurred since the joints were installed, the staff's

concerns about stress limits in the flexible coupling are satisfied with the differential limit of 0.22 ft.

b) Stress in Buried Pipes

The staff assumes that the Board's question refers to the absolute settlement of the exposed ends of the expansion joint rather than their absolute elevation. On August 2, 1978, VEPCO informed the staff that it had concluded that 0.33 feet of additional settlement since December of 1975 would not overstress the buried pipes (Ref. 10, p.10). As a rough check of this conclusion, the staff made the conservative simplifying assumption that the pipes could be modeled as being rigidly anchored in the soil at a point 60 feet from the exposed ends and that the deflected shape of the pipes due to dike settlement is the same as a cantilever beam with a concentrated load at its end. For such a model, the maximum moment and deflection are (Ref. 18):

$$M = Pl$$

$$y = Pl^3/3EI$$

where M = maximum bending moment, lb-in

P = concentrated load, lb

l = length of beam, in

y = maximum deflection, in

E = modulus of elasticity (Young's modulus), psi

I = moment of inertia, in⁴

The maximum bending stress is defined by the following (Ref. 18, p.513):

$$\sigma = Mc/I$$

where σ = maximum bending stress, psi

c = distance from natural axis to extreme fiber (outer surface), in

Combining the above equations yields an expression for the maximum deflection of a cantilever beam, with a point load at the end, as a function of the maximum bending stress at the section with the maximum bending moment:

$$y = \sigma l^2 / 3Ec$$

Although the value of the modulus of elasticity varies with the composition of the material and the temperature, a commonly used value for carbon steel (such as the SA-155 used for the service water piping) at normal temperatures is 29×10^6 psi. The distance between the neutral axis and the extreme fiber for 36 inch (3.0 ft.) pipe with a 3/8 inch (0.03 ft.) wall thickness is 18.375 inch. Using these values and the 60-foot (720 in.) length of the pipe yields:

$$y = \sigma / 3084$$

For the SA-155, Grade C5, material used in the service water pipe, Table I-7.1 and ND-3652.3 of Section III of the ASME Code would permit an allowable stress of 41,100 psi for the effect of any single nonrepeated anchor movement.

Stresses in the pipes due to friction forces of the fill on the pipe were estimated at about 4,000 psi by assuming the pipes were buried 12 feet deep in a fill with a unit weight of 120 pcf and a friction coefficient (with steel) of 0.6. Allowing 4,000 psi for friction loads in the pipe leaves a limiting stress of 37,100 psi which equals a maximum deflection of 12.03 inches or 1.00 feet. The pipe stress caused by the friction forces along the deflected pipe were conservatively neglected in this rough check.

The next step in estimating the limiting additional displacement of the end of the buried pipes was to determine the displacement that had occurred since the pipes were buried in the fill. We conservatively assumed that the pipes were rigidly connected to the pumphouse at the elevation shown in the FSAR (Ref. 8), that this elevation was correct as of August 25, 1972, and that no pumphouse settlement had occurred prior to the time the pipes were connected.

The center line of the horizontal portion of the exposed pipes is at an elevation of 320 ft. - 10 inches (320.83 feet) (Ref. 8). The elevation of the top of the pipes would be 322.36 ft. ($320.83 + 1.50 + 0.03$) at the time they were attached to the pumphouse. VEPCO provided the following elevations for the pipe ends, as measured on August 3, 1978:

SM-15: 321.658 ft.

SM-16: 321.661 ft.

SM-17: 321.778 ft.

SM-18: 321.591 ft.

Settlement of pipe SM-18 (the one that apparently settled the most) between the time it was assumed to be buried and attached to the pumphouse and August 3, 1978 was thus $322.36 - 321.59 = 0.77$ ft.

Thus, settlement of the ends of the pipes at markers SM-15 through 18 necessary to reach code allowable stresses was estimated at about one foot and past settlements accounted for 0.77 ft. Therefore, the ends could settle an additional 0.23 ft. ($1.00 - 0.77$) without exceeding code allowable stresses in that portion of the service water pipes buried in the dike fill just to the north of the service water pumphouse.

The above steps led us to recommend that the allowable absolute settlement of the ends of these pipes, after August 3, 1978 be limited to 0.22 ft. to keep the buried pipe stresses below code allowable values. The staff believes this value of 0.22 ft. is conservative.

New information in VEPCO's Testimony on Service Water Pump House Settlement indicates that the service water lines were embedded in the coarse dike filter on August 27, 1973 (Figure 7B). Therefore, stresses induced in the service water pipes due to settlement of the dike would have started on August 27, 1973 rather than, as we had previously understood, on August 25, 1972. According to information provided by VEPCO to the Staff in a letter dated September 8, 1978 (Table 1 of Reference 3), the northeast corner of the pumphouse had settled 0.15 ft. by August 23, 1973. Assuming that the dike settled as much as the least settlement recorded on the northeast corner of the pumphouse between August 25, 1972 and August 23, 1973, the allowable settlement of these pipes might be increased to 0.37 ft. ($0.22 + 0.15$) without exceeding code limits for stress in the service water pipes. Accordingly, the staff believes that there is additional basis to believe that the 0.22 ft. limit is conservative.

In summary, then, we have conservatively estimated the stresses in buried pipes induced by the settlement of the service water reservoir dike. We have found that additional settlement of the dike and embedded pipes in the amount of 0.22 ft. after August 3, 1978 can be sustained without exceeding Code Allowable stress values. We believe that the technical specification for plant operation, which gives the allowable

limits of settlement of the exposed ends of these buried pipes, is adequate to satisfy staff concerns regarding stress in these pipes.

c) 75 Percent Reporting Requirement

The requirement that VEPCO report to the staff when settlement reaches 75% of the limits set in the technical specifications was proposed by VEPCO. It was accepted by the staff because it was judged to provide adequate time for remedial safety-related actions prior to reaching settlement values that would affect safety or plant operations. The staff would probably have accepted reporting values ranging from 60 to 80 percent, because the same objective would have been attained with those limits.

d) Frequency of Monitoring Settlement of Service Water Pumphouse

The Technical Specifications for Unit 1 require that the Category I safety related structures be surveyed every six months to assess settlement. VEPCO, however, is continuing to monitor the settlement of the Service Water Pumphouse every month. The staff concurs with VEPCO's practice. The Unit 1 Technical Specifications for monitoring groundwater elevations near the pumphouse and beneath the service water reservoir dikes call for monitoring every month for the first five years of plant operation. The staff believes that the frequency of monitoring settlement near the pumphouse should be the same as that now prescribed for measuring groundwater levels and drain flow rates. Accordingly, measurements on settlement markers SM-7, 8, 9, 10, 15, 16, 17, 18, H-569, and H-584 should be made at least once every 31 days until Unit 1 has been

in operation at least five years. Based on the past record of rates of pumphouse settlement and the expectation that the drains will reduce the potential for rapid settlement, a one-month interval is often enough to provide adequate warning that settlement limits given in the Technical Specifications are being approached. At the end of the 5-year period, an engineering study will be made by VEPCO to determine the need for and frequency of continued monitoring of settlement, groundwater and drain flow rates.

7. Other Concerns

In its January 9, 1979 submittal to the Appeal Board, the staff identified certain items of concern with respect to service water pumphouse settlement effects. These items are addressed in the following sections.

a) Differential Movement and Tilt of Pumphouse - Effects on Pipes

This item is discussed in Section 6 of this testimony.

b) Tilt of Pumphouse - Effect on Pumps

The second concern, pumphouse tilting effects on the service water pumps, is addressed in the response to question P3.6 of the Final Safety Analysis Report. VEPCO has stated that the pumps will be shimmed, as necessary, to correct for any pumphouse tilt so that the pump alignment is within the 0.011 inches per foot recommended by the pump manufacturer. This corresponds to a total allowable displacement of 0.29 inches for the 26-foot long vertical pump. The manufacturer has also indicated that a total displacement of 0.5 inches would not adversely affect pump operability.

In addition, VEPCO is measuring differential pressure, flow rate and vibration amplitude every 30 days as required by Article IWP-3000 of Section XI of the ASME Code. These pump performance parameters are to be maintained within the tolerances specified in Table IWP 3100-2 of Section XI, except that for the flow rate parameter, a tolerance of +8 percent is acceptable. If necessary, corrective action will be taken as required by paragraph IWP-3230 to assure the required pump performance.

Maintaining the pump performance parameters within the specified tolerances provides adequate assurance that the pump will maintain its operability and that any effects of tilt will be accounted for.

c) Stress in Buried Service Water Pipes

This matter is also discussed in Section 6 of this testimony.

d) Leakage of Service Water Through Shears

With respect to the fourth concern, the Final Safety Analysis Report indicates that the bottom of the service water reservoir was lined with compacted cohesive soil to impede leakage of reservoir water into the underlying saprolite. The FSAR indicates that the pumphouse foundation is supported by the compacted liner material. As the pumphouse settles with respect to the liner, it punches into the liner material, as evidence by the past relative movement of the pumphouse with respect to the wingwalls. A VEPCO letter to the staff dated September 8, 1978, includes an analysis of reservoir leakage potential due to bending of the liner. We have concluded that the lack of potential for leakage has not been

demonstrated and would be difficult to demonstrate and, therefore, have conservatively postulated that leakage will occur during the plant lifetime.*

Leakage of the reservoir liner will contribute to the quantity of water collected by the underdrain system and will change groundwater levels measured by piezometers. Technical Specification 3/4.7.13, which gives the present groundwater level monitoring program and limiting groundwater levels in the vicinity of the service water reservoir, is closely related to Technical Specification 3/4.7.12. Groundwater monitoring as presently required by the Technical Specification is to be conducted monthly for the first five years after the issuance of the Unit 1 Operating License. Adequate assurance that leakage will not be undetected and affect safe operation of the plant can be attained by changing Technical Specification 3/4.7.13 to require: (a) measuring and recording the quantity of groundwater flowing from the underdrains on a monthly basis for five years; if flow rates for any month become more than three times the average annual flow rate, an engineering evaluation of the cause of the changed flow rates should be conducted and a report filed with the NRC; (b) monitoring and recording groundwater elevations on a monthly basis for a period of five years; and (c) at the end of the five-year period, requiring an engineering report to be filed by VEPCO to determine if further measurements of groundwater levels are needed. A required

* As discussed in Section 4 of this testimony, we could not visually confirm the presence of a liner along the sides of the pumphouse (p.29). However, because we have postulated leakage of the liner under the pumphouse, the existence of the liner is not critical.

revision to Technical Specification 3/4.7.13 covering the above matters is presented in the proposed technical specifications included as an attachment to VEPCO's testimony.

e) Potential for Cracking of Pumphouse

The potential for significant cracking of the reinforced concrete pumphouse structure due to future differential settlement across the structure is likely to be preceded by warping of the pumphouse foundation. Available measurements and visual inspection by the licensee indicates that very little, if any, warping has occurred to date and that only nominal cracking is now evident. Because of the relatively soft foundation provided by the clay liner and underlying saprolite and the stiffness of the pumphouse foundation slab, significant differential settlement across the structure is unlikely. However, an out-of-plane distortion of any corner of the pumphouse foundation of about 0.06 feet would indicate the onset of additional cracking in the structure. The potential for crack development can be interpreted by analyzing measurements at settlement points SM-7, 8, 9, and 10. We have concluded that the out-of-plane distortion of any corner of the pumphouse foundation should not exceed 0.06 feet in order to limit the width of cracks. A required revision to Table 3.7-5 of the Technical Specification is presented in the proposed technical specifications attached to VEPCO's testimony. The 75 percent Technical Specification reporting criteria would apply to this limit.

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f) Effect on Spray Piping Connections

The effect on spray piping connections at the service water pumphouse from further settlement of the pumphouse has been reviewed with VEPCO's technical personnel and representatives of the Stone & Webster Engineering Corporation. The staff understands that one end of the four 35-foot long pipes supplying the spray system was rigidly connected to the pumphouse wall with concrete above the reservoir bottom in the spring of 1975. During June of 1975, the other end of the 24-inch-diameter pipes was supported above the reservoir bottom by a hanger and footing resting on the clay liner of the reservoir. To reach the American Society of Mechanical Engineers Boiler and Pressure Vessel Code allowable stress in these pipes, the differential settlement (as calculated by VEPCO and reviewed by the staff) between the southeast corner of the pumphouse and the hanger would need to be 0.175 feet. Tables A and B, attached to this testimony, show that the differential settlement between marker SM-8 and either H569 or H584 has been essentially zero during the period of time from early August 1976 to late April 1978. This evidence suggests that the differential settlement between the ends of the pipes has been negligible since June of 1975, when the ends of the pipes were tied down. Accordingly, in order to assure that future pipe stresses will not exceed Code allowable values, the differential settlement between marker SM-8 at the southeast corner of the pumphouse and markers H-569 and H-584 at the pipe support hanger should not become greater than 0.175 feet since the hangers were installed in June 1975.

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g) Inservice Testing of the Auxiliary Water Pumps

Our January 9, 1979, submittal to the Board indicated that we had previously granted VEPCO a 20-month relief from the inservice testing of the auxiliary service water pump for Unit 1. This relief was based on the fact that: 1) testing would result in untreated (Lake Anna) water being discharged into the service system; 2) four similar pumps (the service water pumps) would be tested monthly; 3) VEPCO committed to perform a study of methods to permit testing; and 4) the pre-operational testing of the pumps was successful.

We concluded our January 9, 1979, presentation to the Board by indicating that the staff would require VEPCO to provide an acceptable method of inservice testing of the auxiliary service water pumps at the end of the 20-month period of relief.

Subsequent to our presentation, VEPCO submitted its inservice testing program for Unit 2. This program, submitted with their letter of January 31, 1979, did not request relief for the auxiliary service water pump on Unit 2. Recent telephone conversations between the Staff and VEPCO have indicated that they have determined that the chemical content of Lake Anna has changed sufficiently to permit the use of untreated Lake Anna water in the service water system during periods of inservice testing of the auxiliary service water pumps. It is the staff's understanding that this information will be confirmed in a forthcoming letter from VEPCO. Thus, monthly inservice testing of the auxiliary service water pumps appears to be now feasible for Unit 1, also. In addition to

providing the bases for the change in position, VEPCO will also propose beginning the inservice testing for Unit 1 at the same time as it will begin for Unit 2, i.e. when it is licensed. The licensing of Unit 2 is currently scheduled for June 1979 and testing will be monthly thereafter. Coupling the start of the two inservice testing programs will permit an orderly implementation of the procedure and is acceptable to the Staff. If the issuance of an operating license for Unit 2 is delayed, we will require that monthly inservice testing of the Unit 1 auxiliary service water pumps be initiated during the first refueling of Unit 1.

The staff concludes that this resolves the previously noted concern with respect to the inservice testing of the auxiliary service water pump for both Units 1 and 2.

8. Response to Mrs. Allen's Concerns

ALAB Request: The Appeal Board asked that the testimony prepared by the parties contain sufficient information to address the concerns that the North Anna Environmental Coalition (NAEC or Coalition) has posed in its written communications which the parties believe are legitimately significant and relevant to the pumphouse settlement issue (ALAB-529, Slip op. 11, n.10). These concerns as well as the responses to these concerns are set forth below.

Coalition Question: The Coalition has questioned the effectiveness of the drain system as a means of protecting the pumphouse.

Staff Response: Section 4 of this testimony addresses this question in some detail.

Coalition Question: The Coalition asked whether any other nuclear plant had been required to install a comparable system of remedial drainage and if so, where is it located, and what has been its experience to date?

Staff Response: Some nuclear power plants have proposed ground water control systems for their sites. For example, a ground water control system was proposed by the application and has been found acceptable for use on the Perry nuclear plant. We are not aware of the required installation of a groundwater control system at any nuclear plant that is comparable to the one proposed for the North Anna Power Station, Units 1 and 2, service water pumphouse. Horizontal drains, based on the same principles as the proposed North Anna system, have been used for decades to reclaim swampy land for agricultural uses; clay tile is commonly specified for this purpose.

Coalition Question: The NAEC inquired about the length of time the staff specified as an adequate pre-operational testing period for the drainage system at North Anna.

Staff Response: No pre-operational testing period has been specified for the above system because future environmental conditions over any specified time period are not known. Piezometers will be read at scheduled intervals and used to measure the effectiveness of the system over the life of the plant. If the system is, or becomes inadequate, it can be replaced or supplemented with negligible risk to the health and safety of the public. Pre-operational testing is thus unnecessary.

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Coalition Question: The NAEC asked what specific measures will NRC take if the drainage system fails after the North Anna operating license is granted.

Staff Response: If the drain system fails (becomes clogged), the NRC will require it to be purged or otherwise cleared so that it will again limit groundwater levels. If the proposed drains transport fines from the saprolite, they can be abandoned and replaced with a redesigned system.

Coalition Question: The Coalition asked if it had been experimentally determined yet at North Anna whether controlling groundwater levels will prevent settlement or cause settlement beneath the service water pumphouse.

Staff Response: The explicit answer to the Coalition question is no, because the groundwater control system has not been in service long enough to predict its effect over the life of the plant (say 40 years). In theory, if the water table is about 274 feet elevation when the horizontal drains are installed, the drains will lower the water table and cause an increment of pumphouse settlement due to increased effective stresses. However, this increment of settlement would be no more than would be experienced by a natural seasonal decrease in water table elevation to an elevation of 274 feet. In theory, if the water table is at or below 274 feet when the drains are installed the drains would not cause any change in effective stress and no increment of settlement due to the drains would be expected.

The drains should reduce the total settlement of the pumphouse over the life of the plant because seasonal fluctuation of groundwater levels will be reduced.

Coalition Question: Coalition has asked how North Anna's design can withstand possible lack of integrity in saprolitic foundation.

Staff Response: Section 3 of this testimony addresses the Coalition's question in some detail.

As mentioned in Section 3, appropriate engineering tests have been performed on the saprolitic soils which exist at the North Anna site. Laboratory tests on undisturbed specimens (representative of in-situ foundation materials) and on reconstituted specimens (representative of engineered fill material used to construct the dikes and dams) of these saprolites show that this material has adequate strength to satisfy the design conditions imposed by the plant facilities.

The occurrence and compressibility of the in-situ saprolite and weathered rock beneath the pumphouse make future predictions of settlement and differential settlement of these structures complex and possibly imprecise. Future settlement, however, will occur slowly and upper bound values of settlement rates and magnitude can be based on past and continuing settlement measurements. We believe that a conscientious, complete and diligent program of settlement monitoring, interpretation, and plan for remedial action will provide adequate safety from the effects of past and future settlement of the pumphouse.

The design of the groundwater control system is compatible with the properties of the saprolite such that piping of fines from the saprolite should not occur as water drains from it. If piping of the fines begins some time in the future, a large increase in the turbidity and suspended

solids content of the effluent from the system would occur. As a precaution VEPCO will monitor the effluent for suspended solids and turbidity. Monitoring will provide sufficient warning on the onset of any piping so that remedial action can be taken before unsafe conditions can develop.

Coalition Question: The Coalition asked on what experiential or experimental basis can predictions be made about the future course of settlement at North Anna.

Staff Response: The main basis for predicting the future course of settlement at the North Anna Power Station, Units 1 and 2, will be the record of past settlements.

Coalition Question: The Coalition has asked what studies the NRC has done of the possible relationships between microseismic activity, regional faulting (Neuschel's Lineament, Stafford faulting et al), and the weakness of saprolite as a foundation material.

Staff Response: Microseismic activity, and any regional faulting together with other geologic and tectonic factors have been taken into account in determination of the safe shutdown earthquake. There is no evidence whatsoever to indicate that an earthquake would more likely occur in saprolites than other materials. However, any different behavior of saprolite during an earthquake has been taken into account in the design of the North Anna Power Station, Units 1 and 2.

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Coalition Question: The Coalition has asked if the North Anna dam is designed to withstand activity on a nearby fault or activity from the point where Neuschel's Lineament transects the reservoir.

Staff Response: The North Anna plant is designed to a reference acceleration of 0.12g based on an assumed intensity VII (Modified Mercalli). There are no known active faults near the dam that could localize an earthquake there.

The North Anna dam is expected to survive the ground motion effect of a safe shutdown earthquake with a peak acceleration of 0.12g on rock and 0.18g on saprolite. We believe our expectations are reasonable in light of the survival of similar California dams that were affected by the 1971 San Fernando earthquake which had a Richter magnitude rating greater than the magnitude of the SSE at North Anna.

Coalition Question: The Coalition asked for our present day judgments on matters pertaining to laboratory tests and seismic design and foundation engineering that transpired in 1969. They asked whether we considered the 1969 answers to questions were still accurate and, if not, when changes in soil profiles, bearing capacities, etc., were changed and by whom.

Staff Response: We would consider 1969 answers to questions to be accurate today, but incomplete. The 1969 answer did not include a bearing value for the highly weathered saprolite (residual soil) nor did it indicate allowable bearing values based on settlement considerations. On October 6, 1976, we learned that the allowable bearing value used for the design of

foundations on the highly weathered saprolite was about half of the value used for foundations on dense saprolite. The FSAR for Units 1 and 2 has been amended by VEPCO to include an allowable bearing value for this foundation material.

Our evaluation of the changed bearing value for the saprolite is stated on page 2-5 of Supplement Number 7 to our Safety Evaluation Report dated August 1977, wherein we concluded that the transient bearing value is acceptable.

In light of the limited information available at the time that the 1969 answer was filed, we still judge that the 1969 answer was a reasonable representation for the situation as known at that time. A considerable amount of additional information has been developed and docketed by VEPCO during the past few years. In our judgment, the new information provides a better interpretation of foundation conditions and dike stability than that provided by VEPCO in 1969 in answer to question 5. Thus, considering the new information, we would now judge that the margins of stability of the ultimate heat sink reservoir dike and foundation are somewhat less than indicated by the 1969 answer to question 5. Nonetheless we have concluded that, considering the existence of Lake Anna, they possess adequate reliability under seismic conditions. Our evaluation of the ultimate heat sink reservoir dike and foundation is stated on pages 2-12 and 2-13 of Supplement Number 2 to our Safety Evaluation Report dated August 1976.

Coalition Question: The Coalition has asked what the increased stresses are in the service water piping and whether these stresses have exceeded or are close to exceeding allowable safety limits.

Staff Response: Section 6 of this testimony addresses the Coalition's questions and concerns in some detail.

Coalition Question: The Coalition asked whether we agreed with a statement that "no additional settlement has occurred since the installation of the groundwater control system", and with the statement that "the majority of the recent settlement resulted from the installation of the groundwater control systems"?

Staff Response: The Coalition's questions can best be answered by referring to settlement data contained in Reference 11 and in Reference 2. These letters indicate that the average pumphouse settlement from December 1975 to October 1976 (10 months), was about 0.025 feet. From October 1976 to September 1977 (11 months), the period when drains were installed and the reservoir filled three times and emptied twice, the pumphouse settlement increased from about 0.025 to 0.105 feet. Of the 0.08 feet of additional pumphouse settlement that occurred during this 11 month period, about one third can be attributed to time effects (ordinary expected settlement), one third due to the influence of drains (causing a drawdown of the water table) and one third due to repeated reservoir fillings (changing loading on soils). More recent settlement amounts are included in VEPCO's testimony and in Appendices B and C of this testimony. The Staff's interpretation of the recent settlement data would not indicate that the drains have not been a significant cause of settlement.

Coalition Question: The Coalition has asked why there is any necessity to double the allowable pumphouse settlement from 1.8 to 3.96 inches.

Staff Response: According to Technical Specification 3/4.7.12, if the average settlement of the pumphouse exceeds 0.15 feet since December of 1975, the plant would have to be shut down. The pumphouse settlement is now approaching the specified limits. The Staff has proposed to increase the allowable settlement value for the pumphouse. The bases for the new limits are set forth in Section 6 of this testimony.

Coalition Question: The Coalition has asked the basis for the staff's validation of settlement predictions.

Staff Response: The staff is not attempting to validate predictions of pumphouse settlement as a basis for allowable settlement values. Rather, we are examining the consequences of increased pumphouse settlement values on the safety functions of service water system components.

Coalition Question: The Coalition asked how the staff interprets the pattern of settlement reflected in VEPCO's reading of April 25, May 10, and May 15, (1978) and asked if June and July readings show a similar trend.

Staff Response: The staff would avoid an interpretation of the pattern of average settlement from April 25 to May 15, 1978 because the time period is very short and because the change in settlement (0.006 feet) is too small to be significant considering the required sensitivity of

the measuring system. The pattern of settlement after May 15, 1978 is shown in Figure 7 of VEPCO's testimony.

Coalition Question: The Coalition has asked what remedial actions are being considered beyond those of changing allowable limits.

Staff Response: We will not consider immediate remedial measures until the limits for safe operation of the plant are approached. If and when that time comes, we view possible remedial actions to include reworking or replacing the expansion joints, addition expansion joints to pipes between the pumphouse and reservoir spray system, and mud jacking the north side of the pumphouse. Underpinning of the pumphouse foundation is another alternative remedial action.

Coalition Question: The Coalition has expressed concern that the expansion joints constitute an unreviewed safety question.

Staff Response: Expansion joints are commonly employed in the piping systems of fossil fuel and petrochemical plants and the technology associated with the use of expansion joints is well known. The use of such joints is familiar to staff reviewers and we have reviewed the expansion joint utilized at North Anna. Thus, we do not feel that their use at North Anna constitutes an unreviewed safety question.

Coalition Question: The Coalition has asked what caused the pumphouse to settle 0.66 inches in 50 days in late 1974 and early 1975.

Staff Response: This question is addressed in Section 4 (pp. 25-27) of our testimony.

Coalition Question: The Coalition has asked what caused the pumphouse to settle 0.57 inches in 23 days between July 11 and August 2, 1977.

Staff Response: It appears that the main cause of the settlement was significant lowering of groundwater levels by drain number 4 which was placed below adjacent drains and below the target elevation of 274.0 feet.

Coalition Question: The Coalition ask whether the increased stresses on the service water piping are due to settlement and whether they exceed allowable limits.

Staff Response: This matter was responded to in Section 6 of our testimony.

Coalition Question: The Coalition asked if settlements during December of 1974 and July of 1977 had the same causal mechanism.

Staff Response: We have no data to substantiate that the settlements had the same cause.

Coalition Question: The Coalition asked, if the groundwater level was below the drains during their installation post-drought in the summer of 1977, how were the drains able to significantly affect the groundwater level.

Staff Response: Previous Piezometer readings from which the groundwater levels were determined are now thought to be erroneous. Because groundwater flowed from the drains when they were installed, we conclude that the drains were placed below the groundwater level.

Coalition Question: The Coalition has asked if it has ever been clearly established that changes in groundwater level were responsible for settlement at the North Anna Site.

Staff Response: We are not aware of any direct evidence on the changes in groundwater levels during the period of rapid pumphouse settlement, except for the values reported during the period of drain installation. The period of rapid settlement preceded the initiation of periodic monitoring of groundwater levels.

Coalition Question: The Coalition has asked whether or not the causes of rotation and tilt have been clearly established.

Staff Response: The staff has not made an attempt to establish the reasons for the tilt (rotation is another term for the same phenomenon) of the pumphouse, but it is likely due to the different loads and soil properties under and near the pumphouse.

Coalition Question: The Coalition has asked for the safety rationale of basing remedial actions and reporting on "average settlement".

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Staff Response: This question is addressed in Section 6 of the staff's testimony. Average settlements are not used as a limiting basis for reporting in the proposed technical specification.

Coalition Question: The Coalition asked how the safety of the North Anna site is protected by changing the Technical Specifications to double the amount of settlement.

Staff Response: The staff's proposed change to the Technical Specification does not propose doubling of the average settlement. Staff testimony, Section 6, addresses this question.

Coalition Question: The Coalition has asked about the prompt surveillance and accurate reporting of settlements along with other chronological matters related to pumphouse settlement.

Staff Response: Settlement measurements and drain installation dates are given in VEPCO's testimony. The staff's evaluation of VEPCO's surveillance practices are described in Section 2 and Appendices B and C of the staff's testimony.

Coalition Question: The Coalition asked the basis for future predictions of settlement and why the saprolites can be found suitable as foundation material.

Staff Response: The basis for future estimates of settlement will be the record of past settlement; the evidence for the suitability of saprolite

as a foundation for the pumphouse is addressed in the staff's testimony, Section 3.

Coalition Question: The Coalition asked, if the causes of the settlement have never been firmly diagnosed, upon what basis can "remedial actions" be taken or a prognosis made regarding the 40-year foundation integrity.

Staff Response: The Technical Specifications for the North Anna plant prescribe a program of continual diagnostic procedures. If future symptoms indicate the recurrence of unexpected and unacceptable settlement, then appropriate remedies, based on a diagnosis of the new symptoms, will be implemented to assure that adequate levels of safety are maintained.

Coalition Question: The Coalition has expressed their belief that the staff has been inconsistent in their attempts to explain the cause of unexpected settlement of the pumphouse. The Coalition cites the staff's statement that, "settlement has been empirically related to precipitation" and the staff's statement that, "there is no known reason for settlement based on factual data such as infiltration of rainfall and changes in groundwater levels", as evidence of inconsistency.

Staff Response: Rates of rainfall and rates of settlement are the only available data. There are no data for changes in groundwater levels during the periods of rapid pumphouse settlement.

An empirical correlation of settlement and rainfall has been observed. Changes in groundwater levels can cause settlement, but there is no

data during the period of rapid settlement to prove that such changes actually occurred.

For the above reasons, the staff does not believe the cited statements are contradictory.

Coalition Question: The Coalition has asked if the change from 1.8 to 3.96 inches of allowable average settlement of the pumphouse is a solution to the problem.

Staff Response: The staff does not believe that the change is a complete solution. The staff's proposed Technical Specification change explained in Section 6 of the staff's testimony is considered to be an adequate solution to the problem of pumphouse settlement values that are approaching present Technical Specification limits.

Coalition Question: The Coalition noted that VEPCO's requested revision to the Technical Specification, allowing 0.33 ft average settlement since December 1975, when added to the average settlement in December of 1975, when added to the average settlement in December of 1975 (0.37 ft) is nearly the same as the staff's proposed December 22, 1978 specification (superseded) of 0.22 ft of allowable average settlement since July 1977, if one adds to this value the average settlement measured in August of 1977 (0.49 ft.).

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Staff Response: The Staff's December 22, 1978 proposed specification was superseded by our January 9, 1979 proposal. In the January 9, 1979 proposed specification, the staff proposed a limiting value of 0.22 ft. of differential settlement, whereas VEPCO proposed limit of 0.33 ft. of average settlement. The two figures cannot be compared by simply adding to the Staff's proposed limit the average settlement of the pumphouse prior to July 1977.

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REFERENCES

1. Ltr dated 5/16/75 from S. Ragone (VEPCO) to D. Knuth (NRC) w/attachment; ltr dated 5/15/75 from S. Ragone (VEPCO) to N. Moseley (NRC).
2. Ltr dated 9/8/78 from S. Ragone (VEPCO) to B. Rusche (NRC) w/attachment; ltr dated 1/16/76 from R. Peck to S. Ragone (VEPCO).
3. Ltr dated 9/8/78 from S. Brown (VEPCO) to H. Denton (NRC).
4. FSAR, Part B, Volume II, NIF, Figure 3.8.4-19 (dated 11/3/78).
5. FSAR, Part B, Supplement, Volume I, NIF Figure p3.9-1 (dated 6/16/76).
6. Ltr dtd 12/14/76 from S. Brown (VEPCO) to B. Rusche (NRC).
7. "Evaluation of Soil Liquefaction Potential for Level Ground During Earthquake - A Summary Report" (NUREG-0026, September, 1976).
8. FSAR, Part B, Volume I, Figures NIF Figure 1.2-31 dated 3/31/77 and NIF 1.2-32 dated 7/8/77.
9. FSAR, Part B, Volume II, NIF Figure 3.8.4-1 dated 11/3/78.
10. Ltr dated 8/2/78 from S. Brown (VEPCO) to H. Denton (NRC) w/Enclosure.
11. Ltr dated 5/31/78 from C. Stallings (VEPCO) to J. O'Reilly (NRC) w/enclosure.
12. Report on Geotechnical Investigations of Service Water Reservoir, North Anna Power Station Units 1 and 2, for VEPCO; Appendix E, NIF, December 23, 1975
13. Final Safety Analysis Report, Part B. Supplement Volume I, (e.g., pages NIV P3.6-1 to P3.11-9).
14. Appendix L, Report on Laboratory Soil Testing North Anna Power Station, Service Water Reservoir, VEPCO dated 7/14/76.
15. Ltr from F. Brown, Corps of Engineers to W. Gammill, NRC dated March 8, 1977, with enclosures.

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REFERENCES

16. Terzaghi, K., and Peck, R., (1967) Soil Mechanics in Engineering Practice, 2nd Edition, pages 86, 180, Wiley & Sons, New York
17. Lambe, T., and Whitman, R., (1969) Soil Mechanics, p.419, Wiley & Sons, New York
18. Eshbach, Oxid W. and Sounders, Mott, Handbook of Engineering Fundamentals, John Wiley & Sons, 1975, page 518

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TABLE - A

(From Brown (VEPCO) ltr. to Denton (NRC)
dtd. 9-8-78 and IE inspections,

DATE	SETTLEMENT - FT*				
	SM-7 NE	SM-8 SE	SM-9 SW	SM-10 NW	ASM-5 NW
13 NOV 75	0.411	0.194	0.349	0.561	0.576
1 DEC 75	0.404	0.191	0.346	0.561	0.572
17 DEC 75	0.404	0.188	0.346	0.555	0.576
11 AUG 76	0.402	0.185	0.354	0.564	0.590
23 AUG 76	0.409	0.195	0.364	0.576	0.593
1 OCT 76	0.419	0.206	0.377	0.586	-
7 OCT 76	0.426	0.213	0.385	0.592	-
10 NOV 76	0.427	0.211	0.394	0.601	-
6 DEC 76	0.423	0.204	0.392	0.606	0.612
3 MAR 77	0.454	0.232	0.421	0.632	0.649
11 JUL 77	0.450	0.232	0.429	0.644	0.655
12 DEC 77	0.489	0.265	0.473	0.686	0.694
15 MAR 78	0.509	0.281	0.490	0.707	0.714
30 MAR 78	0.507	0.279	0.488	0.703	0.713
25 APR 78	0.495	0.265	0.475	0.693	0.702
10 MAY 78	0.493	0.269	0.480	0.699	0.709
15 MAY 78	0.496	0.274	0.484	0.700	0.706
1 JUN 78	0.485	0.260	0.473	0.691	0.709
30 JUN 78	0.498	0.280	0.488	0.701	0.709
3 AUG 78	0.501	0.280	0.487	0.700	0.708
6 SEP 78	0.504	0.280	0.495	0.705	0.709
2 OCT 78	0.506	0.281	0.493	0.703	0.713
6 NOV 78	0.508	0.288	0.498	0.710	0.716
20 NOV 78	0.507	0.287	0.496	0.708	0.714
3 JAN 79	0.513	0.288	0.498	0.713	0.719
6 FEB 79	0.511	0.287	0.498	0.711	0.719
7 MAR 79	0.511	0.285	0.496	0.714	-

*The settlement values shown in the above table are based on adding the settlements measured by MH&C surveyors since 13 Nov. 1975 to the settlements measured by S&W construction surveyors through 13 Nov. 1975. The initial MH&C survey was performed on 13 Nov. 1975.

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TABLE - B
(from Brown (VEPCO) ltr to Denton (NRC)
dtd 9-8-78 and I&E)

SETTLEMENT OF UNITS 1 AND 2 SERVICE WATER
SPRAY PIPING SUPPORTS

SETTLEMENT SINCE 13 MAY 76 - FT

<u>DATE</u>	<u>Hanger H569</u>	<u>Hanger H 584</u>
10 Aug 76	0.01	0
6 Oct 76	0.06	0.05
10 Nov 76	0.08	0.07
28 Feb 77	0.06	0.06
12 Jul 77	0.06	0.05
14 Dec 77	0.08	0.08
25 Apr 78	0.07	0.07

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N ←

POOR ORIGINAL

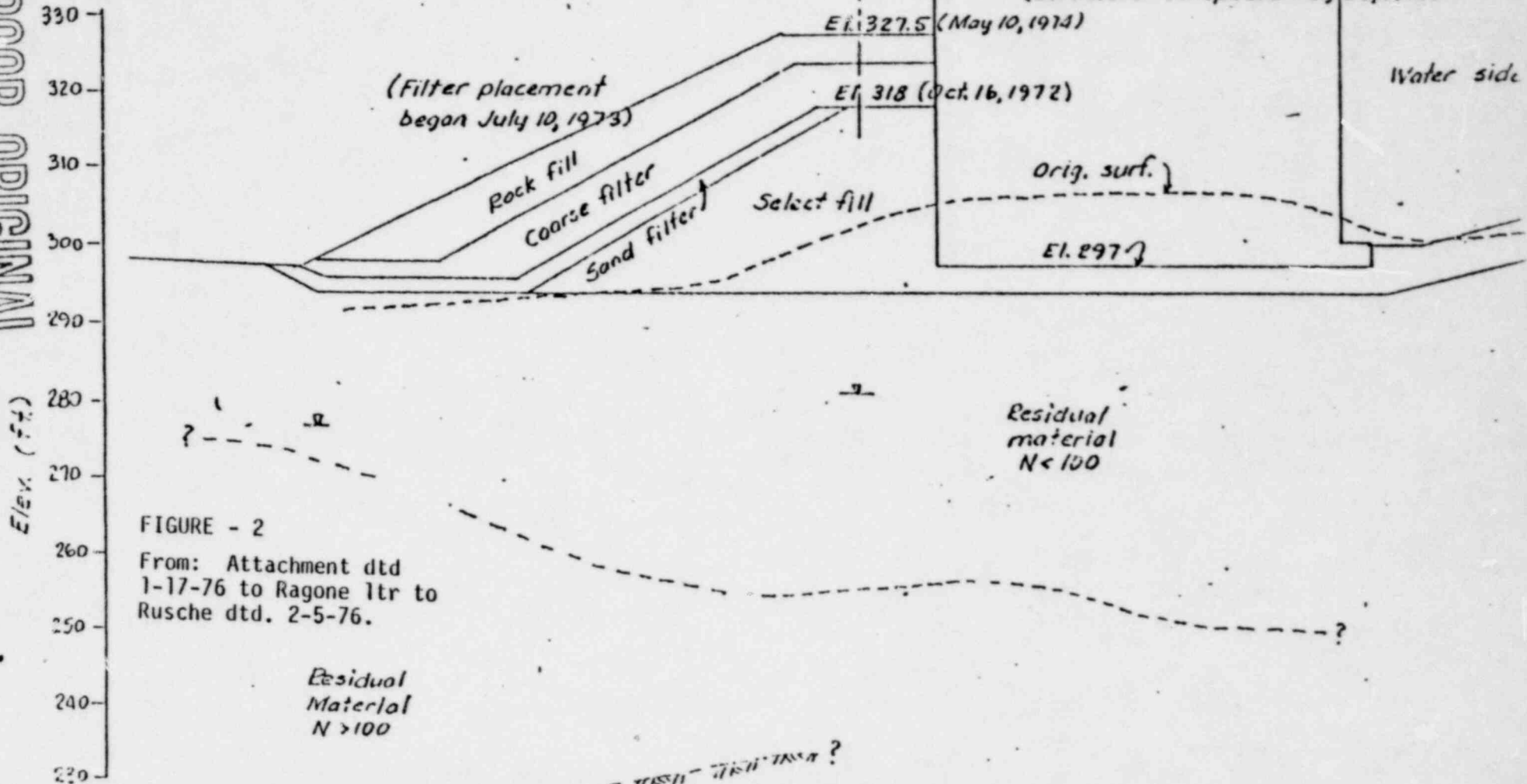


FIGURE - 2
 From: Attachment dtd
 1-17-76 to Ragone ltr to
 Rusche dtd. 2-5-76.

SECTION THROUGH SWPH
 1" = 20'-0"
 (From S&W Appendix E,
 NIF, Fig. E 2.6-6, 12-25-75)

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POOR ORIGINAL

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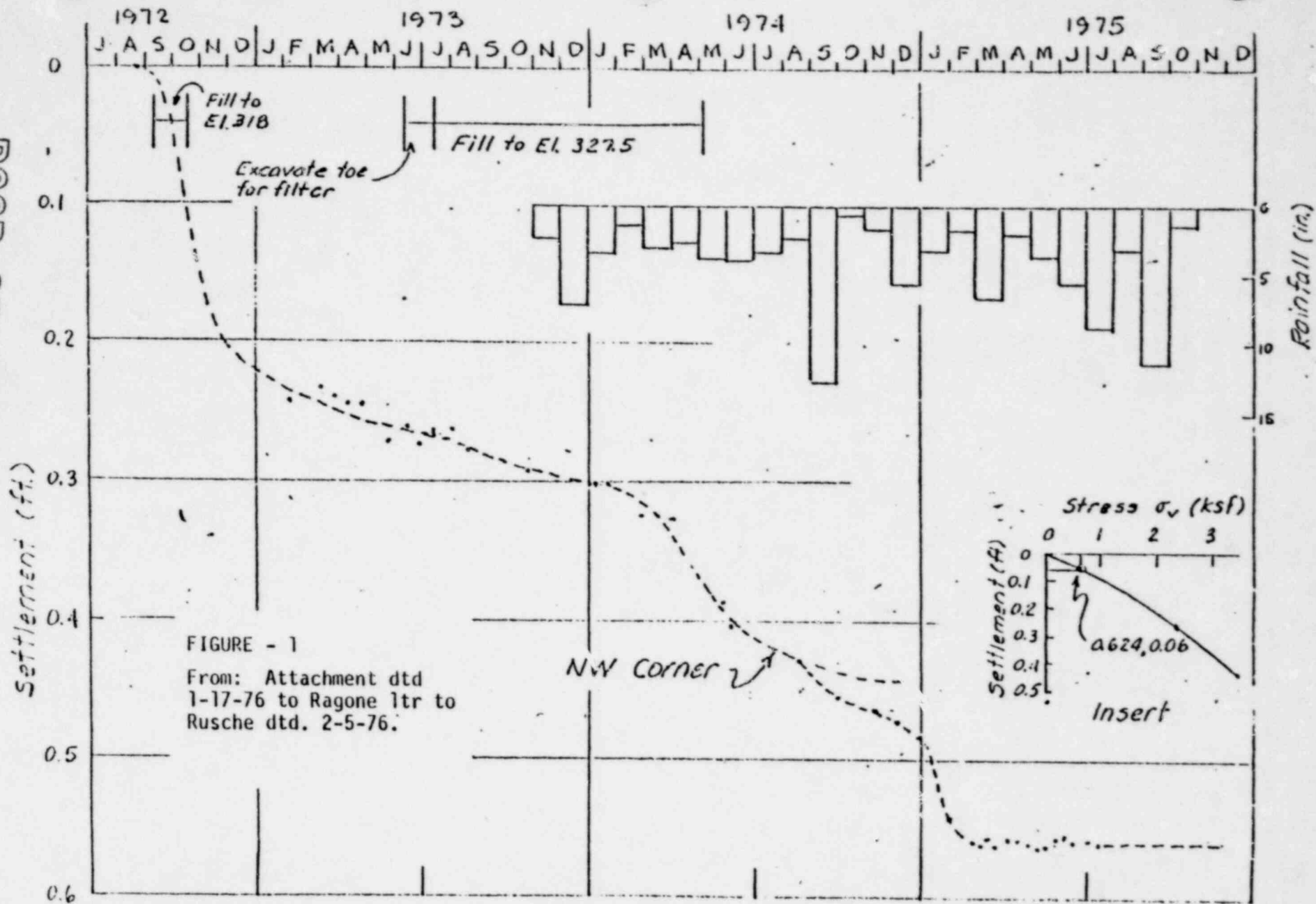


FIGURE - 1
 From: Attachment dtd
 1-17-76 to Ragone ltr to
 Rusche dtd. 2-5-76.

SETTLEMENT OF SWPH
 (Front various S.W. Drawgs.)

APPENDIX A

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SUMMARY OF INSPECTIONS PERFORMED
BY IE ON SWPH SETTLEMENT RELATED TO THIS TESTIMONY

<u>Report Number</u>	<u>Inspection Dates</u>	<u>Inspectors</u>	<u>Inspection Effort Relating to SWPH Settlement</u>	<u>Results</u>
50-338/77-56 339/77-35	November 16-18, 1977	McFarland	Inspection of completed horizontal drain installation and review of technical specifications related to horizontal drain.	Item closed: commitments implemented
50-338/78-11	March 27-31 and April 3-6, 1978	Kidd	Reviewed MH&C data collected through Dec. 1977 on SWPH settlement.	-
50-338/78-44	Dec. 6-8, 1978	Bryant Lenahan	SWPH and service water lines settlement data and unresolved item on settlement monitoring program.	-
50-338/79-13	March 5-15, 1979	Lenahan Alderson	SWPH settlement and service water lines settlement data, performance of horizontal drains, collection of piezometer data, and inquiry concerning handling and review of SWPH settlement data.	Unresolved items on collection of piezometer data

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APPENDIX B

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30301

DEC 27 1978

In Reply Refer To:
RII:JCB
30-338/78-44

Virginia Electric and Power Company
Attn: Mr. W. L. Proffitt
Senior Vice President,
Power
P. O. Box 26666
Richmond, Virginia 23261

Gentlemen:

This refers to the inspection conducted by Mr. J. C. Bryant of this office on December 6-8, 1978, of activities authorized by NRC License No. NFF-4 for the North Anna Power Station, Unit 1 facility, and to the discussion of our findings held with Mr. P. A. Slater at the conclusion of the inspection.

Areas examined during the inspection and our findings are discussed in the enclosed inspection report. Within these areas, the inspection consisted of selective examinations of procedures and representative records, interviews with personnel, and observations by the inspectors.

Within the scope of this inspection, no items of noncompliance were disclosed.

We have examined actions you have taken with regard to previously reported unresolved items. The status of these items is discussed in the enclosed report.

In accordance with Section 2.790 of the NRC's "Rules of Practice", Part 2, Title 10, Code of Federal Regulations, a copy of this letter and the enclosed inspection report will be placed in the NRC's Public Document Room. If this report contains any information that you (or your contractor) believe to be proprietary, it is necessary that you make a written application within 20 days to this office to withhold such information from public disclosure. Any such application must include a full statement of the reasons on the basis of which it is

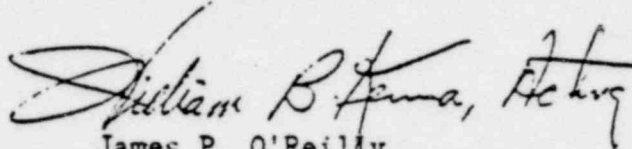
2136 280

DEC 27 1973

claimed that the information is proprietary, and should be prepared so that proprietary information identified in the application is contained in a separate part of the document. If we do not hear from you in this regard within the specified period, the report will be placed in the Public Document Room.

Should you have any questions concerning this letter, we will be glad to discuss them with you.

Sincerely,


James P. O'Reilly
Director

Enclosure: Inspection Report No.
50-338/78-44

cc w/encl:
Mr. W. R. Cartwright, Station Manager
North Anna Power Station
P. O. Box 402
Mineral, Virginia 23117

Mr. P. M. Perry, Senior Resident Engineer
P. O. Box 38
Mineral, Virginia 23117

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30303

Report No.: 50-338/78-44

Docket No.: 50-338

License No.: NPF-4

Category: B2

Licensee: Virginia Electric and Power Company
Post Office Box 26666
Richmond, Virginia 23261

Facility Name: North Anna Power Station, Unit 1

Inspection at: North Anna Power Station, Mineral, Virginia

Inspection conducted: December 6-8, 1978

Inspectors: J. J. Lenahan
J. C. Bryant

Reviewed by:

B. W. Cantor, Jr.
J. C. Bryant, Chief

12/27/78
Date

Engineering Support Section No. 1
Reactor Construction and Engineering Support Branch

Inspection Summary

Inspection on December 6-8, 1978 (Report No. 50-338/78-44)

Areas Inspected: Special announced inspection of data collected on settlement of Units 1 and 2 service water pump house and of licensee action on previously identified item concerning settlement surveys. This inspection involved 40 inspector-hours onsite by two NRC inspectors.

Results: Within the areas inspected, no items of noncompliance or deviations were identified.

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DETAILS I

Prepared by:

J. J. Lenahan
 J. J. Lenahan, Civil Engineer
 Engineering Support Section No. 1
 Reactor Construction and Engineering
 Support Branch

12/27/78

Date

Dates of Inspection: December 6-8, 1978

Reviewed by:

R. M. Combs
 J. C. Bryant, Chief
 Engineering Support Section No. 1
 Reactor Construction and Engineering
 Support Branch

12/27/78

Date

1. Persons Contacteda. Virginia Electric and Power Company (VEPCO)

- *C. M. Robinson, Jr., Supervisor, Civil Engineering Services
- *O. Schultz, Supervisor, Survey Services
- ***R. C. Sturgill, Assistant Engineer, Unit 1
- E. R. Bane, Supervisor, Construction QA
- *P. A. Slater, Resident QA Engineer
- **E. R. Smith, Jr., Supervisor, Engineering Services, Unit 1
- **J. D. Kellams, Superintendent Station Operations
- **W. F. Diehl, Engineer, Engineering Services
- **D. C. Woods, VEPCO NRC Coordinator

b. Stone and Webster Engineering Corporation (S&W)

- D. Barry, Resident Engineer
- B. McIver, Soils Engineer (telephone conversations)
- R. Allen, Field Engineer (telephone conversations)

c. Moore, Hardee and Carrouth Associates (M H & C)

- *M. Croker, Party Chief
- *G. Robertson

d. Nuclear Regulatory Commission Personnel (NRC)

- ***M. S. Kidd, Resident Inspector

*Denotes those present at the December 7, 1978 exit interview.

**Denotes those present at the December 8, 1978 exit interview.

***Denotes those present at the December 7 and 8, 1978 exit interviews.

2. Licensee Action on Previous Inspection Findings

(Open) Unresolved Item (338/78-37-04): Settlement of Class I Structures. Settlement survey requirements of Technical Specification 3.7.12.1 and enclosed Table 3.7-5 have not been met due to either the need to reset survey points or due to establishment of some points prior to or after baseline dates. The inspectors examined survey field notebooks kept by Moore, Hardee and Carrouth Associates (engineering firm retained by VEPCO to perform settlement survey), various settlement points, and settlement data. A review of the settlement data for points which have not been disturbed since the baseline date indicates that differential and total settlements are well within the limits established in Table 3.7-5 for all structures except for the total allowable average settlement of the service water pump house. Differential settlements between structures founded on rock or on fill concrete placed on rock are on the order of .005 to .010 feet. These apparent movements are a result of the limits of the accuracy of surveying.

After the baseline dates had past, NRC requested that the licensee establish additional settlement points. Settlement of these points can not be referenced back to the Technical Specification baseline dates. Other settlement points were established by the licensee prior to Technical Specification baseline date. Settlement of these points was recorded prior to the baseline dates. The licensee will submit a letter to NRC requesting permission to amend the Technical Specifications to clarify baseline dates. Six points have been reset since Technical Specification baseline date. This was either due to construction activities which resulted in points being destroyed or erection of permanent facilities which have made points inaccessible. The licensee has reconstructed the settlement history of points which have been reset from the settlement records of other points on the same structure and from settlement points on adjacent structures which have similar foundation and loading conditions. The licensee is evaluating methods to protect settlement points from construction and other activities.

The inspectors discussed requirements of a QA program with the licensee's representatives to audit the settlement survey program and the results of surveys performed by M H & C. On occasions, up to 4 months have elapsed between the time the M H & C surveys were made and data was transmitted to the licensee's engineers. The licensee was informed that the time lapse from making the surveys to analyzing the data must be reduced. In cases where the limits approach 75% of the allowable values listed in Table 3.7-5, this time lapse should be on the order of one to three days to insure prompt reporting as required by the Technical Specification. This item remains open pending NRC review of the licensee's final report.

3. Unresolved Items

No new unresolved items were identified during this inspection.

4. Independent Inspection Effort

There was no independent inspection conducted during this inspection.

5. Scope of Special Inspection

On April 28, 1978, the licensee notified RII that survey readings taken on March 30, 1978, indicated that the average settlement of the service water pump house (SWPH) exceeded 75% of the maximum allowable value of 0.15 feet. The licensee submitted a special report regarding the settlement of the SWPH to NRC RII on May 31, 1978. This special inspection was performed to review the settlement data collected at the site and determine the following:

- a. When 75% of the maximum allowable service water pump house settlement was attained.
- b. If settlement surveys are being performed at frequency required in Technical Specifications.
- c. If the licensee had reported to NRC within 60 days of when 75% of the allowable settlement of the SWPH was detected.
- d. Amount of differential settlement between the SWPH and the north side of the flexible joint in the service water lines.

The inspectors attended a meeting held in Bethesda, Maryland on December 5, 1978, between NRR, VEPCO and Stone and Webster to receive background on settlement history of the North Anna Site.

6. Findings

- a. VEPCO Service Water Pump House Settlement Surveillance Program-The licensee contracted with MH&C to perform the surveys for the settlement surveillance program required by Technical Specification 3.7.12.1. Settlement survey requirements of the Technical Specifications are to determine elevations of points listed in Table 3.7-5 to the nearest 0.01 foot at least once every six months. The elevation of the points is to be determined by precise leveling (surveying) with second order Class 2 accuracy as defined by U. S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). The inspectors reviewed MH&C survey field data and field data reductions and discussed survey techniques used in the settlement surveys with MH&C personnel. The inspectors

examined the settlement points in the service water pump house (SWPH) and on the north side of the expansion joint in the service water lines, and benchmarks (Reference Monuments A and B) used in the settlement survey. Reference Monuments A and B consist of steel casing drilled and grouted into rock. Settlement points in the SWPH are brass markers grouted into the concrete floor. Settlement points on the service water lines are painted on the pipes.

The procedure used by MH&C in the settlement survey for the SWPH is to run a level line from Reference Monument A along the dike of the service water reservoir to Reference Monument B, establishing a temporary benchmark (TBM) in the vicinity of the SWPH. The TBM is usually either settlement marker 5 or 6. A level line is then run into the SWPH to check the elevations of settlement points.

MH&C employs Precise Level Rods (solid one piece yard rods) and a Zeiss NI-2 self leveling level in the survey. These instruments meet the requirements specified by NOAA for second order, Class 2 surveys. Examination of survey methods, equipment and reduced field data indicated that the survey accuracy attained is equal to that required for second order, Class 2. Surveys are being performed at the frequency required by the Technical Specifications (at least once every six months).

MH&C survey data indicated the following average service water pumphouse settlements. (Note: Complete MH&C data not tabulated below. Data shown is that which brackets readings when 75% of allowable SWPH settlement was attained.)

<u>Date</u>	<u>Average Settlement (Feet)</u>	<u>Percent of Allowable Settlement (0.15 Feet)</u>
12/1/75	.000	0
7/11/77	.063	42
12/12/77	.103	69
3/15/78	.121	81
3/30/78	.119	79
4/25/78	.106	71
5/10/78	.110	73
8/3/78	.117	78

The above data indicate that 75% of the maximum allowable total average SWPH settlement was exceeded on March 15, 1978, and March 30, 1978. However, MH&C surveys made prior to March 15,

1978, indicated settlement was less than 75%. Based on the above data, the licensee sent a Licensee Event Report to NRC on April 28, 1978, that SWPH settlement exceeded 75% of the allowable value. A detailed special report was submitted to NRC on May 31, 1978.

- b. Construction Settlement Survey Program - Settlement of the SWPH along with other structures was monitored by Stone and Webster during construction. This was not a requirement of the PSAR, FSAR, or the Technical Specifications but was done in accordance with standard engineering practice to confirm design assumptions. The requirements of the S&W settlement surveillance program were determined by their Geotechnical Engineers. This program was not a rigid project requirement, and at times surveys were not made due to higher priority work. However, the frequency of the construction survey program was adequate to obtain a good settlement history of SWPH.

From the results of the S&W surveys, the licensee determined and reported to NRC in April 1975 that the SWPH settlement exceeded the PSAR estimates. Additional design studies were made by S&W to investigate settlement of the SWPH and determine stresses in the service water lines at their connections to the SWPH. As a result of these studies, S&W estimated that total average additional settlement of the SWPH would be approximately 0.15 feet after December 1975 and flexible couplings were installed in the service water lines at their connection to the SWPH.

The inspectors reviewed the survey field book in which the S&W SWPH settlement survey data was recorded and discussed survey techniques with S&W engineers. S&W surveys were made from a variety of benchmarks, including Reference Monuments A and B, and several temporary construction benchmarks. S&W engineers stated that the procedure they used on their settlement survey was to run a level line from one of the benchmarks to the SWPH, establish a TBM in the vicinity of the SWPH, and close the loop by either tying back into the originating benchmark or one of the other benchmarks on the project. However, the survey loop closure was not documented in the field book for each S&W settlement survey. Loop closures documented in the field book were closed within acceptable accuracy.

The rods used in the S&W survey did not meet the requirements of the type specified by NOAA for use in second order, Class 2 differential leveling. There was some discussion that one of the S&W rods might have been slightly damaged. The S&W engineer estimated errors of up to .01 foot. S&W survey data was incomplete for readings made from August 3, 1977, through January 5, 1978,

because settlement point SM-8 was inaccessible to S&W surveyors though MH&C surveyors did record data for this point in December, 1977. The missing data for point SM-8 can be interpolated from the other data to the nearest .01 foot.

In comparison of MH&C data with S&W data, the inspectors noted that S&W data consistently indicated approximately .01 feet more settlement than the MH&C data. From examination of the field data and the discussions with S&W engineers, the inspectors concluded that the S&W survey did not meet the requirements of a second order, Class 2 survey, and that the SWPH settlements shown for the period from August 3, 1977, through January 5, 1978 were based on incomplete data. The survey made for purposes of meeting the requirements of the Technical Specifications was that made by MH&C. In cases of conflict between the MH&C data and the S&W data, the MH&C data would be accepted as correct since it was obtained from a survey which was better controlled and more accurate than the S&W survey.

- c. Differential Settlement Between SWPH and North Side of Service Water Piping Expansion Joint - The inspectors reviewed the results of surveys performed by MH&C to measure settlement of the service water lines north of the expansion joints. Settlement of the service water lines was compared to the settlement of SWPH settlement point SM-7, which is located on the northeast corner of SWPH. This is the location where the service water lines enter the pumphouse. The settlement of point SM-7 versus the settlement of the service water lines is tabulated below.

<u>Date</u>	<u>Settlement of SM-7</u>	<u>SM-15</u>	<u>Differential Between SM-7 & SM-15</u>	<u>SM-18</u>	<u>Differential Between SM-7 & SM-18</u>
7/11/77	.000	.000	---	.000	---
12/12/77	.039	.051	.012	.058	.019
3/15/78	.059	.071	.012	.081	.022
3/30/78	.057	.072	.015	.077	.020
4/25/78	.045	.060	.015	.066	.021
5/10/78	.043	.064	.021	.071	.028
8/3/78	.058	.066	.008	.069	.011

NOTES: (1) July 11, 1977 is date when initial survey was performed on service water lines.

(2) SM-15 is settlement point on east pipe.

(3) SM-18 settlement point on west pipe.

- (4) Complete MH&C data not tabulated in above table.
- (5) Settlements shown are in feet.

The above data indicate that differential settlements between the service water lines north of the expansion joint and the northeast corner of the SWPH has been insignificant since July 1977. The data also indicate that the service water lines have settled more than the SWPH. The expansion joints in the service water lines are located where the height of fill in the dike is the greatest.

The expansion joints in the service water lines were installed in March 1976. An estimate of how much the service water lines have settled since the expansion joints were installed can be made by comparison of SWPH settlement data with the available service water line settlement data. Settlement point SM-7 settled .046 feet between December 1975 and July 1977. This is approximately the same magnitude SM-7 settled between July 1977 and May 1978 when the largest differential settlement between the service water lines and the point SM-7 is indicated. Therefore it is conceivable that an equal amount of differential settlement between SM-7 and the service water lines occurred between March 1976 and July 1977 as occurred between July 1977 and May 1978. This would mean that a maximum of approximately one-half inch of differential settlement may have occurred between the SWPH and the service water lines since the expansion joints were installed in March, 1976. The expansion joints are designed to tolerate up to three inches of differential settlement between the SWPH and the service water lines. The inspectors examined the expansion joints during the inspection and detected no problems.

d. Conclusions

Based on the results of examination of settlement data and survey procedures and discussions with responsible engineers the inspectors concluded:

- a. The survey performed to meet the requirements of Technical Specification 3.7.12.1 indicated that the average pumphouse settlement exceeded 75% of the maximum allowable value in March, 1978.
- b. Settlement surveys are being made at the frequency required in the Technical Specifications.

- c. The licensee notified NRC within 60 days (time period specified in the Technical Specifications) of when 75% of the allowable settlement of the SWPH was detected.
- d. The amount of differential settlement occurring between the SWPH and the service water lines is well within tolerance.

No deviations or items of noncompliance were identified.

7. Exit Interview

The inspectors met with the licensee representatives denoted in paragraph 1 on December 7, 1978 and on December 8, 1978 to discuss the results of the inspection. The inspectors summarized the scope and findings of their examination of data collected on settlement of the SWPH and of action on previous inspection findings concerning settlement surveys. No deviations or items of noncompliance were identified.

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APPENDIX C

NOTE: Appendix C, IE Report No. 50-338/79-13, is attached since it contains recent settlement figures that were reviewed by IE inspectors. The Summary of Inquiry, which is a part of the Report, is not relevant to this proceeding as it pertains only to the enforcement/compliance aspect of the investigation. However, it is being included for completeness since it is referred to in the earlier portions of the Report.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30303

APR 25 1979

In Reply Refer To:
RII:JJL
50-338/79-13

Virginia Electric and Power Company
ATTN: W. L. Proffitt
Senior Vice President, Power
P. O. Box 26666
Richmond, VA 23261

Gentlemen:

This refers to the inspection conducted by J. J. Lenahan of this office on March 5-15, 1979, of activities authorized by NRC License No. NPF-4 for the North Anna Power Station, Unit 1 facility, and to the discussion of our findings held with W. R. Cartwright at the conclusion of the inspection.

Areas examined during the inspection and our findings are discussed in the enclosed inspection report. Within these areas, the inspection consisted of selective examinations of procedures and representative records, interviews with personnel, and observations by the inspector.

Within the scope of this inspection, no items of noncompliance were disclosed.

We have examined actions you have taken with regard to previously reported unresolved items. The status of these items is discussed in the enclosed report.

One new unresolved item resulted from this inspection and is discussed in the enclosed report. This item will be examined during subsequent inspections.

In accordance with Section 2.790 of the NRC's "Rules of Practice", Part 2, Title 10, Code of Federal Regulations, a copy of this letter and the enclosed inspection report will be placed in the NRC's Public Document Room. If this report contains any information that you (or your contractor) believe to be proprietary, it is necessary that you make a written application within 20 days to this office to withhold such information from public disclosure. Any such application must include a full statement of the reasons on the basis of which it is claimed that the information is proprietary, and should be prepared so that proprietary information identified in the application is contained in a separate part of the document. If we do not hear from you in this regard within the specified period, the report will be placed in the Public Document Room.

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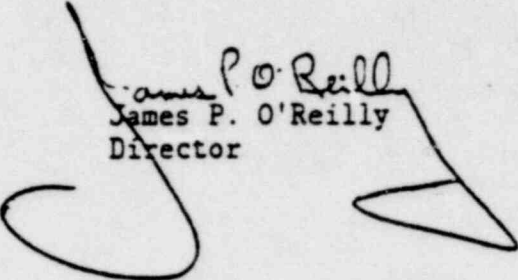
APR 25 1979

Virginia Electric and Power Co.

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Should you have any questions concerning this letter, we will be glad to discuss them with you.

Sincerely,


James P. O'Reilly
Director

Enclosure:
Inspection Report No.
50-338/79-13

cc w/encl:
W. R. Cartwright, Station Manager
Box 402
Mineral, VA 23117

P. G. Perry
Senior Resident Engineer
P. O. Box 38
Mineral, VA 23117

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30303

Report No. 50-338/79-13

Licensee: Virginia Electric and Power Company
Post Office Box 26666
Richmond, Virginia 23261

Facility Name: North Anna Power Station, Unit 1

Docket No. 50-338

License No. NPF-4

Inspection at North Anna Site near Mineral, Virginia, VEPCO offices,
Richmond, Virginia, and Stone and Webster Engineering Corporation (S&W)
offices, Boston, Massachusetts

Inspector: J. J. Lenahan, P.E. 4/5/79
J. J. Lenahan Date Signed

Accompanying Personnel: C. E. Alderson

Approved by: J. C. Bryant 4/5/79
J. C. Bryant, Section Chief, RCES Branch Date Signed

SUMMARY

Inspection on March 5, 6, 14 and 15, 1979, at North Anna site; March 7, 1979
at Richmond, Virginia; March 13, 1979 at Boston, Massachusetts

Areas Inspected

This special, unannounced inspection involved 21 inspector-hours on-site and
18 inspector-hours in the VEPCO and Stone and Webster Corporate Offices in
the areas of settlement data collected on Units 1 and 2 service water pumphouse,
performance of horizontal drains, collection of piezometer data and licensee
action on previously identified items concerning settlement surveys. In
addition, an inquiry was conducted concerning handling and review of service
water pumphouse settlement data. The inquiry involved 11 hours on-site and
18 hours in the VEPCO and Stone and Webster corporate offices by an NRC
investigator. The Summary of Inquiry is appended to this inspection report.

Results

Of the areas inspected, no apparent items of noncompliance or deviations
were identified.

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DETAILS

1. Persons Contacted

Licensee Employees

C. M. Robinson, Supervisor, Civil Engineering Services
O. Schultz, Supervisor, Survey Services
*C. E. Sorrell, Civil Engineer
*J. W. Waddel, Manager, Power Station Engineering
P. A. Slater, Resident QA Engineer
*E. R. Smith, Jr., Supervisor, Technical Services
*J. D. Kellams, Superintendent Station Operations
*W. R. Cartwright, Station Manager
R. C. Sturgill, Assistant Engineer
T. Schreckenghast, Engineering Technician

Other Organizations

D. Barry, Resident Engineer, North Anna Site (S&W)
B. McIver, Geotechnical Engineer, Boston (S&W)

NRC Resident Inspector

*M. S. Kidd

*Attended exit interview.

2. Exit Interview

The inspection scope and findings were summarized on March 15, 1979 with those persons indicated in Paragraph 1 above.

3. Licensee Action on Previous Inspection Findings

(Open) Unresolved Item (338/78-37-04): Settlement of Class I Structures. Technical Specifications are not clear on settlement survey requirements for reset survey points and baseline dates since several of the points were not required by NRC until after the baseline dates had passed. Also, though some of the points were in existence prior to the appropriate baseline dates, survey readings were not made on the baseline date. A typical example of this is point number 117 on the service building. The Technical Specifications specify a limit on the settlement occurring after April 1, 1977. However, settlement surveys were made on March 9, 1977, and not on April 1. Therefore, it is necessary to extrapolate the post April 1 settlement for Point 117. Other examples of the need to clarify baseline dates are settlement points 206 through

209 on the Boron Recovery Tank Dike. The technical specifications specify limits on settlement after completion of construction (i.e., "as built" settlement). However, these settlement limits were not required by NRC and initial settlement readings were not made until May 1976, more than one year after this structure was built.

Six points have been reset since the technical specification baseline date. This was due either to construction activities which resulted in points being destroyed or erection of permanent facilities which have made points inaccessible to surveying. However, the licensee has a large redundancy in survey monitoring points and, therefore, was able to reconstruct the settlement history of reset points from other settlement points on the same structure or from settlement points on adjacent structures which have similar foundation and loading conditions.

A typical example of how missing data were reconstructed for reset points can be illustrated for point number 144 on Unit 1 containment structure. In addition to point number 144, the licensee had established 5 other points, numbers 126, 127, 130, 143 and 149 on the Unit 1 containment structure. These additional points were surveyed at the same frequency as point number 144. Point number 144 was destroyed between the 10/8/76 and 7/7/77 readings; however, it is possible to reconstruct the missing data for point number 144 from data collected for the other points.

The readings collected for the other 5 points on the structure indicated an average of approximately 0.016 feet of rebound during the period 10/8/76 through 7/7/77. Since all the points are on the same rigid structure, it is reasonable to conclude that point number 144 also rebounded 0.016 feet during this period. Point number 144 indicated 0.003 feet of settlement between 5/13/76 and 10/8/76 and 0.005 feet of settlement between 7/7/77 and 10/25/78. Therefore, the net apparent movement of point number 144 since May 1976 is actually .008 feet of rebound, not settlement. The Unit 1 containment structure is founded on rock. The inspector concluded, based on the data, that the structure most likely has not moved since May 1976, and the small apparent movements are a result of the limits of accuracy of surveying.

The inspector examined installation of two additional permanent benchmarks which had been established in the main plant area. These benchmarks had been drilled and grouted into rock. Although the surveys made to date meet the requirements for U. S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) Second Order, Class II accuracy, the survey results will be improved when these benchmarks are used since they are much closer to the plant than the benchmarks presently in use. According to NOAA standards, accuracy in leveling is a function of the square root of the distance surveyed. A reduction in the distance

surveyed will lower the acceptable errors of closure, thus increasing survey accuracy. Also, a reduction in distance surveyed will reduce the number of turning points, which will add to increased survey accuracy.

The inspector examined the licensee's revised procedure to be furnished to Moore, Hardee, and Carrouth Associates (MH&C), the engineering firm retained by the licensee to perform the settlement surveys. This procedure lists requirements for collection and reduction of survey data, transmittal of the data to the licensee, and QC requirements. The time lapse between completion of the MH&C surveys and evaluation of the data by the licensee was up to four months in the past. This revised procedure requires MH&C to transmit survey data to the licensee within seven working days after completion of the survey.

The inspector discussed with licensee management the need to protect settlement points from being disturbed by construction and other activities. The licensee is still evaluating methods to be used to accomplish this.

Based on review of the settlement data collected to date, it appears that the licensee has met the intent of Technical Specification 3.7.12.1, i.e., to monitor and evaluate settlement of Class I structures. The licensee has requested a change to the Technical Specification to clarify baseline dates and reset survey points. Unresolved item 338/78-37-04 remains open pending revision of the Technical Specification and NRC review of the licensee's corrective action and final report.

4. Unresolved Items

Unresolved items are matters about which more information is required to determine whether they are acceptable or may involve noncompliance or deviations. New unresolved items identified during this inspection are discussed in Paragraph 7.e.

5. Independent Inspection Effort

The inspector examined the service water reservoir embankment, including slope protection, slope stability, and downstream embankment toe.

No deviations or items of noncompliance were identified.

6. Scope of Special Inspection

On April 28, 1978, the licensee notified NRC Region II that survey readings taken by MH&C on March 30, 1978, indicated that the average settlement of the service water pump house (SWPH) exceeded the value

required for reporting, i.e., 75% of the maximum allowable value of 0.15 feet. The licensee submitted a special written report regarding the SWPH settlement to NRC Region II on May 31, 1978. This special inspection was performed to:

- a. Make a comparison of the SWPH settlement data collected by Stone & Webster (S&W) with that collected by Moore, Hardee and Carrouth Associates (MH&C).
- b. Evaluate MH&C SWPH settlement data collected since November 1978.
- c. Evaluate differential settlement data between the SWPH and the north side of the service water piping expansion joints, and visually examine the expansion joints.
- d. Determine the performance of the horizontal drains.
- e. Review piezometer data.

In addition, an inquiry was conducted during the inspection by a Regional Investigator concerning the licensee's handling and review of SWPH settlement data. The Summary of Inquiry is appended to this inspection report.

7. Findings

- a. Comparison of S&W and MH&C SWPH Settlement Data - S&W, the plant designer and constructor, monitored settlement of the SWPH during its construction in accordance with standard engineering practice to confirm their design assumptions. MH&C was retained by the licensee to perform the surveys required by the Technical Specification 3.7.12.1.

The inspector examined the S&W survey field book containing the SWPH data collected by S&W surveyors, reviewed calculations reducing the raw field data collected by S&W and MH&C to the computed SWPH settlement, made an independent check of these calculations, and compared the SWPH settlement calculated from the S&W field data to the settlement calculated from the MH&C data. A comparison of MH&C and S&W settlement measurements is shown in the following table:

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<u>MH&C DATA</u>		<u>S&W DATA</u>	
<u>Date</u>	<u>Average SWPH Settlement (ft.)</u>	<u>Date</u>	<u>Average SWPH Settlement (ft.)</u>
12/01/75	0.000	12/10/75	0.000
12/17/75	0.001	12/19/75	0.000
8/23/76	0.011	8/21/76	0.020
10/01/76	0.022	--	--
10/07/76	0.029	10/06/76	0.027
11/10/76	0.033	11/13/76	0.039
--	--	12/01/76	0.038
12/06/76	0.031	12/15/76	0.064
--	--	2/24/77	0.061
3/03/77	0.061	3/28/77	0.068
--	--	5/23/77	0.066
7/11/77	0.063	--	--
--	--	8/03/77	0.114
--	--	8/29/77	0.112
--	--	10/06/77	0.114
--	--	10/31/77	0.113
12/12/77	0.103	12/08/77	0.117
--	--	1/05/78	0.116
3/15/78	0.121	3/01/78	0.112
3/30/78	0.119	3/29/78	0.123
4/25/78	0.107	4/20/78	0.118
5/10/78	0.110	5/12/78	0.132

Notes

- (1) Settlement shown is in feet
- (2) S&W settlement values for 8/3/77 through 1/5/78 are based on incomplete data; i.e., no readings were made on settlement point SM-8 during this period. Missing data for SM-8 was interpolated from other data.

The Technical Specifications require that the licensee perform an engineering evaluation to determine the consequences of additional settlement when the average settlement of the SWPH exceeds 75% of 0.15 feet (0.1125 feet). The licensee is required to notify the Commission and submit a special report within 60 days of when this limit is detected. S&W data indicate that 76% of the allowable SWPH settlement of 0.15 feet occurred by August 3, 1977. However, the MH&C data indicates only 42% of the allowable settlement had occurred by July 11, 1977, and that 69% had occurred by December 12, 1977. S&W data of December 8, 1977 indicates, for all practical purposes, no change from the August 3 data. The difference, 69%

of 0.15, and 76% of 0.15, is less than 0.01 foot. MH&C data did not indicate that the allowable settlement (75% of 0.15 ft.) was exceeded until March 15, 1978.

The S&W data generally indicated approximately 0.01 foot more settlement than MH&C data. Examination of the data in the S&W survey field book disclosed that survey loop closures were not documented for the period between March 28, 1977 and March 27, 1978. Since these loop closures are not documented, the accuracy of the S&W surveys for this period is questionable. In addition, S&W did not make settlement survey readings on settlement point SM-8 (S&W point number 3) from August 3, 1977 through January 5, 1978. The settlement data for point SM-8 was interpolated from the data obtained for point numbers SM-7, SM-9 and SM-10. Therefore, some of the S&W average settlements shown in the above table are based on suspect and/or incomplete survey data and in any case would not have the same degree of accuracy as the MH&C data.

The MH&C average SWPH settlement shown in the above table is based on complete data obtained from well controlled surveys which were made to Second Order, Class II accuracy. The MH&C survey loops were closed with acceptable accuracy in all cases. In cases of conflict between the MH&C data and the S&W data, the inspector concluded that MH&C data would be accepted as correct since it was complete and was obtained from a more accurate and better controlled survey than the S&W surveys. A more detailed discussion concerning MH&C and S&W survey procedures is contained in Region II inspection report number 50-338/78-44.

No deviations or items of noncompliance were identified.

- b. Evaluation of MH&C SWPH Data Collected Since November 1977 - The inspector reviewed MH&C SWPH data collected since November 1978. Selected MH&C data is given below to show trends:

<u>Date</u>	<u>Average SWPH Settlement (Feet)</u>	<u>Percent of Allowable Settlement (.15 Feet)</u>
12/01/75	0.000	0
7/11/77	0.063	42
12/12/77	0.103	69
3/15/78	0.121	81
3/30/78	0.119	79
4/25/78	0.106	71
5/10/78	0.110	73
8/03/78	0.117	78

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<u>Date</u>	<u>Average SWPH Settlement (Feet)</u>	<u>Percent of Allowable Settlement (.15 Feet)</u>
11/06/78	0.126	84
11/20/78	0.124	83
1/03/79	0.128	85
2/06/79	0.127	84
3/07/79	0.126	84

Notes

December 1, 1975 is the baseline date for SWPH settlement in the Technical Specifications.

The data for Spring and early Summer 1978 indicate that average SWPH settlement was approximately 0.115 feet. Readings made in November 1978 through March 1979 indicate that average SWPH settlement was approximately 0.125 feet. This means that the SWPH settled an additional 0.01 foot between early Summer and early Winter 1978. The licensee indicated that monitoring of SWPH settlement will continue on a monthly basis until further evaluation indicates the frequency can be reduced.

No deviations or items of noncompliance were identified.

- c. Differential Settlement between SWPH and North Side of Service Water Piping Expansion Joints and Inspection of the Expansion Joints - The inspector reviewed the results of surveys performed by MH&C since November 1978 to measure settlement of the service water lines north of the expansion joints. Settlement of the service water lines is compared to the settlement of SWPH settlement point SM-7, which is located on the northeast corner of the SWPH where the service water lines enter the pumphouse. The settlement of point SM-7 versus settlement of point numbers SM-15 and SM-18 on the two outboard service water lines north of the expansion joints is tabulated below. Data are selected to show trends.

Settlement in Feet

<u>Date</u>	<u>Point SM-7</u>	<u>Point SM-15</u>	<u>Differential Between SM-7 and SM-15</u>	<u>Point SM-18</u>	<u>Differential Between SM-7 and SM-18</u>
7/11/77	.000	.000	--	.000	-
12/12/77	.039	.051	.012	.058	.019
3/15/78	.059	.071	.012	.081	.022

<u>Date</u>	<u>Point SM-7</u>	<u>Point SM-15</u>	<u>Differential Between SM-7 and SM-15</u>	<u>Point SM-18</u>	<u>Differential Between SM-7 and SM-18</u>
3/30/78	.057	.072	.015	.077	.020
4/25/78	.045	.060	.015	.066	.021
5/10/78	.043	.063	.020	.071	.028
8/03/78	.051	.066	.015	.069	.018
11/06/78	.058	.081	.023	.082	.024
11/20/78	.057	.083	.026	.083	.026
1/03/79	.063	.095	.032	.090	.027
2/06/79	.061	.101	.040	.090	.029
3/06/79	.061	.097	.036	.088	.027

Notes:

- (1) July 11, 1977 is date when initial survey was performed on service water lines.
- (2) SM-15 is settlement point on east pipe.
- (3) SM-18 settlement point on west pipe.

The above data indicate that differential settlements between the service water lines north of the expansion joints and the northeast corner of the SWPH has been approximately 1/2-inch since July, 1977. The data indicate that the service water lines have settled more than the SWPH. The expansion joints in the service water lines are located where the height of fill in the dike is the greatest.

Monitoring of pipe settlement was not initiated until July 1977 while the expansion joints in the service water lines were installed in August and October 1976. However, conservative estimates of the total differential settlement which has occurred between the SWPH and the north side of the expansion joint can be made by comparison of SWPH settlement data with available service water line settlement data. Settlement point SM-7 on the SWPH settled 0.046 feet between December, 1975 and July, 1977. The maximum differential settlement between SM-7 and the service lines for this magnitude of settlement of SM-7 was 0.028 feet, occurring in May, 1978. Therefore it would be reasonable to conclude that the amount of differential settlement between SM-7 and the service water lines in the time period August 1976 to July, 1977 was approximately 3/8-inch (0.03 feet). This amount, added to 1/2-inch which has occurred since July 1977 would mean that approximately 7/8-inch of differential settlement has occurred between the SWPH

(point SM-7) and the service water lines since the expansion joints were installed in August and October 1976. The expansion joints are designed to tolerate up to three inches of differential settlement between the SWPH and the service water lines. The inspector examined the expansion joints during the inspection and detected no problem.

No deviations or items of noncompliance were identified.

- d. Performance of the Horizontal Drains - The licensee committed in an amendment to the FSAR to control the ground water level in the vicinity of the SWPH. The licensee had considered the use of deep wells, but this method was ruled out after the results of pumping tests indicated that, due to the low permeability of the insitu soils, large drawdowns and close well spacing would be required. The licensee then elected to use drilled horizontal drains.

Drilled horizontal drains to control groundwater have been in use since the 1940's on numerous projects, including dams, highways, railroads, buildings, and other structures.

The initial drain, drain 0 was installed in August, 1976. During installation of this drain the impermeable liner of the reservoir was punctured. The licensee reported this to NRC Region II as a 50.55(e) item. After repairs to the liner were completed and installation procedures were revised, horizontal drain number 1 was installed at North Anna in October, 1976 as a test drain. The data gathered from this drain was used to determine drain pipe size, drain spacing, and drain flow characteristics. Based on the data gathered from drain 1, the licensee determined that five additional drains were needed to control the groundwater level in the vicinity of the SWPH. The additional drains, drains 2 through 6, were installed in July and August of 1977. The drains were installed near the groundwater table elevation existing at time of installation.

The inspector examined field books containing records of the horizontal drain installation and discussed installation techniques with the responsible engineers. Examination of the records disclosed that after the problems with drain 0 had been resolved, installation of the remaining drains was carefully controlled. The location of the drains, both horizontal and vertical, was determined during installation using various types of instrumentation. Drain 4 was installed at elevation 272.5. The remaining drains were installed between elevation 274 and elevation 276.

The inspector examined records of periodic tests performed by the licensee to measure the volume of flow from the horizontal drains and to measure the turbidity and suspended solids in the effluent from the horizontal drains. Records examined were those of tests

performed on April 7, 1978, July 7, 1978, and January 4, 1979. Acceptance criteria for measurement and analysis of flow from the horizontal drain are contained in PT-75.6, "Service Water Pump House Drain System - Turbidity - Suspended Solids", and Technical Specification 3/4.7.7.1., "Service Water System". The required frequency of testing is at least once every six months.

No deviations or items of noncompliance were identified.

- e. Review of Piezometer Data - The inspector examined records of piezometers located in the vicinity of the SWPH to determine the effect of horizontal drain installation on groundwater levels. Prior to installation of the drains, piezometer number P-14 indicated ground water was at elevation 274. Piezometer P-14 is angled to a point under the center of the SWPH. Piezometer P-13 indicated groundwater was at elevation 276 prior to drain installation. Piezometer number P-13 is a vertical piezometer which was installed on top of the dike approximately 40 feet west of the SWPH. After installation of the drains, piezometer P-13 indicated a drop in groundwater from elevation 276 to elevation 274 while piezometer P-14 indicated a drop in groundwater from elevation 274 to elevation 270.5. Since this is below the level of the horizontal drains, the only explanation that S&W engineers could offer for the behavior of piezometer P-14 after drain installation was that the transducer for this piezometer was installed approximately 4 feet higher than previously believed.

The inspector examined monthly records of piezometer readings taken from June 1978 through February, 1979 to determine the ground water level of the service water reservoir. Acceptance criteria for measurement of the groundwater level are contained in PT-75.7, "Service Water Reservoir - Groundwater Level", and Technical Specification 3/4.7.13, "Groundwater Level - Service Water Reservoir-Limiting Condition for Operaton."

Piezometer numbers P-13 and P-14 have indicated drops in groundwater level of approximately 1.5 feet since late November, 1978. The inspector questioned North Anna site personnel concerning the apparent drop in groundwater level. These discussions disclosed that site personnel compare the piezometer readings to Technical Specification (TS) requirements and if the data is within the TS limits, no further action is required. Results are then filed in the Document Control Unit (DCU) after distribution of copies of the data to various personnel in the Richmond VEPCO and Boston S&W offices. Site personnel do not perform and procedures do not require a trend analysis which would disclose variations in data

from average monthly readings. Site personnel had no comment concerning the piezometer data, except to state that the data were within TS limits.

Discussions in the Richmond VEPCO offices with the VEPCO Supervisor of Civil Engineering Services and in Boston with the S&W Geotechnical Engineer disclosed that the apparent drops in groundwater levels in these piezometers are suspected to be either a result of errors by the individual making the readings or malfunction of the pore pressure indicator (instrument used to read the piezometers). The VEPCO Supervisor of Civil Engineering Services notified the site of the potential problem with the piezometer data in late February, 1979.

Further discussions at the site on March 14 and 15, 1979, with licensee management disclosed that the manufacturer of the pore pressure indicator will be contacted in the near future to send a representative to the site to service and calibrate the instrument, if required, review the procedure being used to read the instrument, and verify that the individual reading the piezometers is doing it correctly.

The inspector expressed concern over the delay in discovery of the potentially incorrect piezometer readings and questioned whether or not a trend analysis should have been performed to detect potential errors in readings. The apparent lack of adequate procedures to specify corrective action, e.g., perform a trend analysis, was identified to the licensee as Unresolved Item 338/79-13-01. This item is being evaluated by NRC to determine if adequate procedures have been established. NRC will also review the report of the pore pressure indicator manufacturer in evaluation of this item.

The most current SWPH settlement survey data at the site on March 6, 1979, were the November 20, 1978, readings. The inspector verified that these data were the most current available on site on this date by review of DCU files and discussions with the engineer responsible for review and analysis of SWPH settlement data. During discussions with the VEPCO Supervisor of Civil Engineering Services and his staff on March 7, 1979, the inspector questioned if any additional SWPH settlement surveys had been made since November 20, 1978. The inspector was informed that surveys were made in January and February but that this data had not yet been received from MH&C. During a discussion of the effect of the apparent drop of groundwater table elevation on SWPH settlement, the licensee's representative indicated that they were not concerned

that additional SWPH settlement had resulted from a drop in the groundwater table since they assumed the piezometer data was incorrect. At the request of the inspector, the licensee obtained copies of the January 3, 1979, and February 6, 1979, survey data. The inspector and the licensee reviewed the data and verified that additional SWPH settlement had not occurred since November 20.

No deviations or items of noncompliance were identified.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30303

SUMMARY OF INQUIRY

Subject: Virginia Electric & Power Company (VEPCO)
North Anna Unit 1
Docket No. 50-338

Allegations that VEPCO had knowledge of significant safety information regarding foundation conditions (Service Water Pump House settlement) at the North Anna site in August 1977 and withheld the information from the NRC for seven months until April 28, 1978.

Dates of Inquiry:

March 5-13, 1979

Performed by:

3-27-79

C. E. Alderson
Regional Investigator
Office of the Director

Date

Reviewed by:

3-27-79

F. J. Long
Acting Deputy Director
Office of the Director

Date

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I. INTRODUCTION

In a letter to the Commissioners dated November 1, 1978, the North Anna Environmental Coalition (NAEC) stated that from information available to the NAEC it appeared that significant safety information regarding foundation conditions at the North Anna site had been withheld from the NRC for a period of seven months and was never reported to the Atomic Safety and Licensing Board (ASLB). The letter alleged that VEPCO had been aware of abnormal and differential settlement in August 1977 and had not reported it to the NRC until April 1978. The letter further alleged that the matter was reportable under the Unit 1 Technical Specifications and had been reportable under the requirements of 10 CFR 50.55(e) prior to issuance of the Unit 1 operating license.

In a letter to the Advisory Committee on Reactor Safeguards (ACRS) dated November 3, 1978, the NAEC stated that it would appear that VEPCO undertook no evaluation for months after becoming aware of the excessive settlement. This letter to the ACRS included a copy of NAEC's November 1st letter to the Commissioners.

This inquiry and a special inspection were initiated under the authority provided by Section 1.64 of Title 10, Code of Regulations and were conducted jointly to: (1) determine the specific reporting requirements pertaining to the Unit 1 and 2 Service Water Pump House settlement which were in effect at the various times in question; (2) review Stone and Webster (S&W) and VEPCO procedures for the accumulation, evaluation and reporting of settlement data; (3) determine the specific handling of the data resulting from the survey performed by Stone and Webster in August 1977; and (4) determine if an investigation into the matter was warranted.

The results of the inquiry are presented below. Technical evaluation of the North Anna settlement monitoring program, including S&W surveys and Moore, Hardee and Carrouth Associates (MH&C) surveys is addressed in the report of the special inspection (IE Report No. 50-338/79-13) to which this Summary of Inquiry is appended.

II. SCOPE

This inquiry included the following activities:

- a. Review of 10 CFR 50.55(e) reporting requirements.
- b. Review of North Anna Unit 1 Technical Specification reporting requirements.
- c. Review of: (1) Correspondence between VEPCO and the NRC; (2) the transcript of the ASLB hearings for the Unit 1 operating license;

- (3) the North Anna Unit 1 and 2 Safety Analysis Report; and (4) the North Anna Units 1 and 2 Safety Evaluation Report including supplements, to determine whether VEPCO had made any commitments beyond the settlement monitoring and reporting requirements of the Unit 1 Technical Specifications.
- d. Review of files related to settlement in the possession of the S&W Construction Group at the North Anna site and discussions with the S&W Site Construction Project Engineer on March 5, 1979.
 - e. Review of files related to settlement in the North Anna Station Records (VEPCO) and discussions on March 6, 1979, with the engineer on the North Anna operating staff assigned responsibility to evaluate settlement data.
 - f. Review of files in the possession of and interviews with VEPCO's Supervisor of Civil Engineering Services and the Chief Surveyor at the Corporate Offices in Richmond, Virginia on March 7, 1979.
 - g. Review of files in the possession of and interviews with S&W's Lead Geotechnical Engineer for the North Anna project and a previous Engineering Project Engineer for North Anna Unit 1 at S&W's Corporate Offices in Boston, Massachusetts on March 13, 1979.
 - h. Discussions with the current and prior Licensing Project Managers and the Leader of the Geotechnical Engineering Section in the Office of Nuclear Reactor Regulation.
 - i. A telephone discussion with the official of the NAEC who had written the letters to the Commissioners and the ACRS.

III. DETAILS

- a. Review of Monitoring and Reporting Requirements and Effective Dates

Paragraph 50.55(e) of 10 CFR 50 was reviewed for applicability to the situation. Based on this review, it would appear that VEPCO's telephone notification to Region II on April 16, 1975 and their subsequent written report to the NRC dated May 15, 1975 concerning settlement of the Unit 1 and 2 Service Water Pump House satisfied the reporting requirements of 50.55(e). The purpose of 50.55(e) is to ensure that the NRC is made aware of any significant problems identified during construction of a facility so that the problems can be evaluated and monitored to assure appropriate resolution. Periodic status reports are not required by 50.55(e) after initial notification is made.

The monitoring and reporting requirements of the North Anna Unit 1 Technical Specifications became operative on November 26, 1977 when the operating license was issued, and therefore, no report could have been required thereunder, before that date. The question as to whether a sixty-day report on the S&W survey results of August 1977 would have been due on: (1) the day the license was issued (since more than sixty days had elapsed since the surveys had been made), (2) sixty days following issuance of the license, or (3) sixty days from the time VEPCO became aware of the results, requires a legal interpretation of the Technical Specification. However, based on the information obtained during this inquiry, the answer to this question does not appear to have any bearing in this matter.

The investigator reviewed VEPCO/NRC correspondence on this issue and discussed it with both the current and prior NRR Licensing Project Managers, and the Geotechnical Engineer who had been involved to determine if any special reporting requirements had been imposed on VEPCO regarding settlement survey results. The review and discussions did not disclose any special requirements; however, a letter from VEPCO to the NRC dated July 11, 1975 was found to contain the following statement:

" Monitoring of the settlement will be continued on a monthly basis throughout the construction and initial operation of Units 1 and 2. These observations will be reviewed at that time to determine if a less frequent monitoring sequence can be justified. The staff will be consulted prior to any change in the monitoring schedule."

This statement was contained in VEPCO's response to a question from NRR which requested a discussion of proposed Technical Specification limitations. The investigator was unable to locate any subsequent NRC/VEPCO correspondence regarding monitoring frequency until the proposed Technical Specification with a six-month surveillance frequency, was submitted in October 1977. This response was also discussed with the three individuals from NRR and none could recall the letter or a discussion of a one-month frequency. They further stated that there was never a requirement that surveys be accomplished monthly.

It should be noted that between June 11, 1975 and the submittal of the proposed Technical Specification, additional structures had been identified as requiring monitoring for settlement. The Technical Specification which was eventually issued required a much more extensive program than was being considered when the earlier letter was written.

b. Responsibilities for Performing Surveys

The investigator interviewed several individuals to determine the relationship between S&W surveys and those performed by MH&C. The Supervisor of Civil Engineering Services (VEPCO) stated that monthly settlement measurements were initiated in December 1972 due to the appearance of cracks in the SWPH wing-wall. At that time S&W was instructed by VEPCO to perform the necessary surveys for what was believed to be a temporary program. However, the Supervisor said that in 1975 it became apparent to VEPCO that the NRC would require a long-term monitoring program, possibly lasting the life of the plant. The Supervisor explained that since S&W would eventually leave the site when construction was completed, VEPCO decided that it would be better to hire a local company to perform the surveys. MH&C had been performing survey work for VEPCO in other areas since 1967 and VEPCO decided that they should perform the surveys required by the Settlement Monitoring Program being developed at that time.

The investigator reviewed the "open-ended" service contract between VEPCO and MH&C and determined that it had been entered into on September 1, 1967. The investigator also reviewed a letter from VEPCO to MH&C dated September 23, 1975 which authorized MH&C to initiate a survey program to monitor the North Anna Service Water Reservoir dam and pump house under the service contract. The letter specified that upon completion of the original surveys, the alignment-settlement markers were to be monitored when the water-level in the reservoir reached certain specified levels and once each year after the reservoir was filled.

The investigator found several S&W and VEPCO letters in the various files reviewed which clearly establish that S&W was assisting VEPCO in the development of the Settlement Monitoring Program and the proposed Technical Specification, including the identification of structures and components to be monitored, the frequency of monitoring and the limits on differential settlement. The letters and various internal memoranda also indicate that it was VEPCO's intent to have a single monitoring program which satisfied the informational needs of VEPCO, S&W and the NRC, and that the surveys would be performed by MH&C.

The individuals interviewed were unable to state why the S&W pump house settlement surveys continued after MH&C was contracted to perform the settlement surveys; however, it was pointed out to the investigator that S&W surveys did not include but five of the many points required by the Technical Specifications and were never intended to satisfy those requirements.

c. Procedures for Accumulating, Evaluating and Reporting Settlement Data

The S&W Project Engineers for Construction (site) and Engineering (Boston), and the Lead Geotechnical Engineer were interviewed to determine the normal procedure for handling the settlement survey data within the S&W organization. At VEPCO's Corporate Office the Supervisor of Civil Engineering Services and the Chief Surveyor were interviewed to determine the normal procedure for handling the settlement survey data within the VEPCO organization. Discussions were also held with the engineer on the North Anna operating staff responsible for evaluating the survey data and discussions had been held previously with the S&W survey party chief who had been involved in the August 1977 surveys. These interviews and records reviews disclosed that prior to October 11, 1977 there were no formal written procedures within S&W or VEPCO covering this area, but the descriptions provided by these individuals as to how the data was handled were all in general agreement.

With regard to S&W surveys, the S&W surveyors would make the surveys and enter the raw data in a field book. At some later time the survey party chief would transfer the raw data to a form which was then forwarded to S&W-Boston. The records indicate that from initiation of the survey program in late-1972 until late-1975 this form with the raw data was sent only to one individual at S&W-Boston by telecopier. In late-1975 (around August) a standard transmittal form was introduced and the distribution of the raw data was expanded to include several individuals, including VEPCO employees. From this point in time on, the data was mailed to the recipients, except for special requests which were sometimes telecopied. The transmittal sheet was revised at least once and the distribution was changed. The transmittal sheets contained no data themselves and merely served as "routing" forms. For this reason, the transmittal sheets were not retained with the data sheets, if at all, and the investigator was unable to identify from the records those individuals who received any particular set of raw data or when they received it.

The records available did indicate that between February 1973 and mid-1975 the S&W survey data was being received by S&W-Boston within one to two weeks from the time the survey was made. After mid-1975, the records indicated a continuing trend of increase in the time between the survey and receipt of the data in Boston. Beginning in late-1976 it appears that the S&W survey data was forwarded to S&W-Boston and other persons on distribution only after a data sheet was full; the time required being dependent on the frequency of surveys. Generally, it appeared that S&W-Boston received the data within one to two months after the first survey on the data sheet was made.

Regarding MH&C data, normal flow of the raw survey data was from MH&C to VEPCO's Chief Surveyor, who passed it on to VEPCO's Supervisor of Civil Engineering Services. The Supervisor of Civil Engineering Services then forwarded copies of the data to S&W-Boston, and following issuance of the operating license, to the operating staff at North Anna.

The various individuals interviewed indicated that prior to licensing of Unit 1, S&W's Lead Geotechnical Engineer was responsible for reducing and evaluating the survey data from both S&W and MH&C. Within VEPCO, the responsibility for the Settlement Monitoring Program was assigned to the Supervisor of Civil Engineering Services. Upon issuance of the operating license, responsibility for evaluating the data for compliance to the Technical Specifications was assigned to an engineer on the North Anna operating staff. This engineer only received and evaluated the MH&C data. He did not normally receive S&W data.

The Lead Geotechnical Engineer stated that raw S&W data would sometimes be received regularly, but that at other times, no data would be received for quite a while and then several sets of the raw data would be received at one time. He explained that it depended on the workload of the Survey Party Chief and when he could find time to transfer the raw data from the field book to the data sheets. At times, the Lead Geotechnical Engineer would call the S&W Survey Party Chief and request the data be forwarded. The Lead Geotechnical Engineer further stated that there was no specific schedule established for him to reduce the raw data and determine settlement and that he did it at irregular intervals.

The Supervisor of Civil Engineering Services (VEPCO) stated that he normally received copies of the S&W data, but that he only glanced at it, as S&W was responsible for reducing the data and informing VEPCO if any problems were encountered.

d. Handling of S&W Survey Data for August 1977

The Lead Geotechnical Engineer (S&W) stated that he did not believe that he received any S&W survey data from the field between May 1977 and January or February 1978. He explained that he had requested the data from the S&W Survey Party Chief several times, but that the Survey Party Chief was busy and had not gotten around to sending the data. He stated that he was out of the office for three weeks in January 1978 and when he came back he started reviewing MH&C data and bringing his settlement plots up to date. He further stated that around the end of February 1978 he was reviewing and plotting the data for the MH&C pump house survey of December 12, 1977 and noticed a significant change, but did not know if it was

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an actual settlement or a bad survey. He then notified VEPCO's Chief Surveyor of the possible problem and requested that the Survey Party Chief send all S&W survey data not previously received by S&W-Boston from the field. An internal memorandum from the S&W Survey Party Chief to the Lead Geotechnical Engineer indicated that S&W survey data was forwarded to S&W-Boston on February 28, 1978.

A memo from the Lead Geotechnical Engineer back to the Survey Party Chief indicated that S&W surveyors performed an additional survey on March 1, 1978 and that the field books were reviewed to determine the validity of the bench marks. The memo also indicates that the Lead Geotechnical Engineer had reached the conclusion that the MH&C data for December 12, 1977 survey was valid.

The Lead Geotechnical Engineer stated that he prepared a letter to VEPCO and on March 6, 1978 he notified VEPCO's Supervisor of Civil Engineering Services that the MH&C data for December 12, 1977 indicated that the pump house had attained 65 percent of the average allowable total settlement and that S&W survey data confirmed the validity of the measurement.

VEPCO subsequently requested MH&C to perform additional surveys. An MH&C survey performed on March 15, 1978 indicated that the pump house settlement had exceeded the 75 percent limit and a special report to the NRC was required within 60 days. This required report was provided on May 31, 1978; however, the NRC had been notified of the settlement and members of NRR had visited the site as early as April 13, 1978 to review the matter. A Licensee Event Report was submitted on April 28, 1978.

e. Discussion With NAEC Official

In reviewing the draft of this summary, it was noted that the phrase "from information available to the NAEC" which appeared in the NAEC's letter to the Commissioners dated November 1, 1978, could imply that they had information beyond that which they addressed in the letter and which might not be known to the NRC staff. The NAEC representative who had signed the letter was contacted by telephone on March 28, 1978, and was asked if the NAEC had any information that had not been made available to the NRC. The individual stated that she did not believe they had any information beyond that available in the documents in the Public Document Room.

With regard to the allegation that VEPCO was aware of the settlement on August 3, 1977, the individual stated that this was based on the information contained in VEPCO's special report dated May 31, 1978. Regarding reportability of the settlement, she stated that

the NAEC had contacted the consultant to the ACRS after reading his report to the ACRS dated July 19, 1978 and that he had said he felt the settlement should have been reported in August 1977.

IV. CONCLUSIONS

- a. The records available clearly indicate that VEPCO intended that there be one monitoring program and that VEPCO expanded an existing contract with MH&C to accomplish the necessary surveys.
- b. Prior to issuance of an operating license, VEPCO relied on S&W to evaluate the survey data and forwarded the results of MH&C surveys to S&W.
- c. Subsequent to issuance of the Unit 1 operating license, responsibility for evaluating survey data to determine compliance with Technical Specifications rested with the plant operating staff and only MH&C data was forwarded for their evaluation. However, VEPCO continues to forward the MH&C results to S&W for further evaluation.
- d. When reduced and evaluated, the results of the surveys performed by S&W on and after August 3, 1977 indicated that the service water pump house settlement had exceeded 75-percent of the limit; however the investigator could not conclusively establish the date that S&W-Boston or VEPCO became aware of the August 3, 1977, and subsequent S&W survey results, but there was no indication that either received the raw data for these surveys until near the end of February 1978.
- e. There did not appear to be any significant differences in the handling and processing of S&W data of August 3, 1977 and later, when compared to the handling and processing of earlier S&W data.
- f. The allegations are not substantiated and no further investigative effort is warranted with regard to this matter.

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1 MR. MC GURREN: I have one question on direct,
2 Mr. Chairman.

3 BY MR. MC GURREN:

4 Q I direct this question to Dr. Heller. Will you
5 please indicate why the staff believes that the monitoring
6 of settlement near the pump house should be conducted every
7 31 days, rather than every 6 months?

8 A. (Witness Heller) The reason we're asking for the
9 settlement monitoring to be conducted every month for the
10 next three years, which will make a total time span of five
11 years from the issuance of the license for Unit 1, is that
12 the ground water levels and the piezometers are read at
13 this frequency, the flow rates from the drains are read at
14 this frequency, and it's necessary to get a good correlation
15 between all of these measurements to assure ourselves that
16 we have in fact found the cause of the rapid settlement that
17 occurred in 1974 and 1975.

18 We propose that after a five-year span has
19 elapsed, that it would be reasonable to reassess the
20 frequency of monitoring at that point in time.

21 MR. MC GURREN: Thank you, Mr. Chairman. The
22 panel is available for cross-examination.

23 CHAIRMAN ROSENTHAL: As I recall it, the order
24 that was agreed upon would have Mr. Christman proceeding
25 first.

1 MR. CHRISTMAN: You'll be happy to hear, I don't
2 have any questions.

3 CHAIRMAN ROSENTHAL: Very good, Mr. Christman.
4 Your restraint is commendable.

5 Mr. Foster, I'm sure you have a few questions.

6 MR. FOSTER: I'm going to have to disappoint
7 you, Mr. Chairman.

8 CROSS-EXAMINATION

9 BY MR. FOSTER:

10 Q Dr. Heller, in the staff's view, is further
11 settlement a function of soil problems, or ground water
12 problems, or both? Or some other factor? You don't have
13 to limit it to those two.

14 A (Witness Heller) I think we'd have to say both,
15 because it's hard to have the groundwater without the ground.
16 And so they would have to be considered both at the same
17 time.

18 Q Let me come back to that, but preliminarily, is
19 rapid settlement your primary concern from this point
20 forward? That is, if rapid settlement occurs, you're worried
21 about rapid settlement possibly occurring and what the
22 ramifications of that would be? Is that correct?

23 A Perhaps I wouldn't say "worried." I would say
24 that it should be something that should be watched and
25 would be of concern. I don't know that "worry" is the correct

1 word for that.

2 Q Can I interpret from that that you think rapid
3 settlement in the future is a possibility?

4 A I don't believe we can rule out any possibility
5 at this point, at least not until we have completed five
6 years of monitoring from the date that the Unit 1 was
7 licensed, until we have more experience.

8 Q You heard Vepco's testimony this morning, in
9 particular Mr. Lucks' testimony about future predicted
10 settlement. Are you in agreement with that testimony?

11 Specifically, I believe Mr. Lucks stated that
12 Vepco's prediction was that there would only be an additional
13 .05 feet of further settlement throughout the life of the
14 plant. Do you reach a similar conclusion?

15 A I haven't attempted to reach a conclusion of that
16 kind.

17 Q I'd ask you to look at page 56 of the staff's
18 testimony, please.

19 You're referring to settlement that occurred in
20 your staff response to a coalition question, the first full --
21 or the second full staff response on that page, toward the
22 bottom of the page -- you're referring to an 11-month period
23 between October 1976 and September 1977. And you refer to
24 the settlement that took place during that time.

25 And there's a sentence in here which says: "Of

1 the 0.08 feet of additional pump house settlement that
2 occurred during this 11-month period, about one-third can
3 be attributed to time effects (ordinary expected settlement)."

4 Do you have a definite figure in mind of
5 "ordinary expected settlement" from here on out? Or were
6 you just referring to the ordinary expected settlement
7 during that time period? Or what?

8 A I'll have to answer the question in the context
9 of the entire paragraph. The first part of that paragraph
10 says that, in a 10-month period from December of '75 to
11 October of '76, which was 10 months, we had about .025 feet
12 of settlement.

13 One could consider -- one could interpret that
14 as being ordinary settlement over a 10-month period. Now
15 for the 11-month period between October of '76 to
16 September of '77, it's certainly conceivable that, had
17 nothing happened -- like drains being installed or rainfall
18 or anything else -- that settlement not unlike that would
19 have occurred, regardless of the situation, just due to
20 time.

21 So it's that general range of settlement that
22 I'm referring to as "ordinary expected settlement."

23 Q All right, now, starting today -- whatever date
24 this is -- June 19th, do you also have a prediction of
25 ordinary expected settlement from this time period on? Can

1 you give us a figure for that?

2 A No, I cannot. I haven't attempted to come to
3 any number.

4 Q Would it be substantially different from the
5 figure "0.025 feet" or thereabouts?

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6 A It could be, yes.

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1 Q More or less? So I don't beat around the bush, what
2 I am really trying to find out is whether you agree with Vepco's
3 figure, which is really, the settlement, really .75 feet over
4 the life of the plant. Obviously, if the figure were .025 feet
5 per year, that would be a substantially greater amount of
6 future settlement than what Vepco was talking about. I want
7 to know what your view is on future settlement.

8 A I would have to admit that none of these figures
9 given in this paragraph probably apply to the conditions and
10 the soil stress conditions that you have heard about in the
11 last day or so, that probably none of these conditions are use-
12 ful in establishing future settlement from this point in time
13 until the plant is worn out.

14 Q So, is it true to say that you don't either disagree
15 or agree with Vepco's projections or Stone & Webster's pro-
16 jections, that you just have no opinion?

17 A I think that would be a fair classification, yes.

18 Q Do you intend to reach some opinion at some time
19 in the future? Is the staff accepting Stone & Webster's pre-
20 dictions, or do you want to try to come up with some independent
21 verification or some other analysis, or what are your inten-
22 tions there?

23 A Our intentions are really to not focus on what the
24 predictions will be, but to focus, rather, on eliminating any
25 safety problems caused by the settlement.

1 DR. BUCK: Could I follow that up, or are you going
2 on to another question?

3 MR. FOSTER: Yes, sir, I am.

4 DR. BUCK: On the basis of your last statement,
5 Mr. Heller, I don't quite understand how you could have an
6 ordinary expected settlement stated in your staff response on
7 page 56. If you had an expected settlement at that time, why
8 can't you have one now?

9 WITNESS HELLER: Because the conditions are much
10 changed now than they were at the time that these records were
11 being made.

12 DR. BUCK: What's changed?

13 WITNESS HELLER: For one thing, the drains have been
14 in place for going on two years now, so the ground water condi-
15 tions are much different than they were at the time they were
16 being installed and at the time the reservoir was being filled a
17 couple of times.

18 DR. BUCK: But at that time you apparently thought you
19 could foretell the expected drop when you had the water level up
20 at a certain point to ground water level. Now, why can't you
21 do the same thing now?

22 WITNESS HELLER: I am sorry, I don't follow the
23 inference that I have made a prediction here.

24 DR. BUCK: You made a prediction on the basis of the
25 water level and the conditions of the soil at that particular

1 time. You had an expected settlement.

2 WITNESS HELLER: An hypothesis, yes.

3 DR. BUCK: Now, all that's happened, as I understand
4 it, is a drain has been put in, the water level has been lowered.
5 Now, have you no expectation as to what the change is and what
6 the expected settlement would be after this period of time?

7 WITNESS HELLER: No quantitative value, no, sir.

8 DR. BUCK: Well, did you have a quantitative value
9 when you knew where the original ground water was?

10 WITNESS HELLER: No. I am only comparing what had
11 happened in the past to what had happened during a particular
12 time period when the drains were installed. That's what this
13 response is about.

14 DR. BUCK: Let me read this for a moment.

15 You said that "An .08 feet of additional pump house
16 settlement had occurred during this 11-month period, about one-
17 third can be attributed to time effects (ordinary expected
18 settlement)."

19 Now that tells me that you had an expected settlement
20 in that period of time. If you hadn't touched it yet --

21 WITNESS HELLER: Right. And that expected settlement
22 was determined during the 10-month period preceding it, sir.
23 The basis for that estimate -- if you want to call it an esti-
24 mate -- is the 10-month period preceding it, not based on the
25 fact that I had made a separate independent assessment of what

1 that settlement would be.

2 DR. BUCK: Well, I am sorry. How could you have
3 said that it was an expected drop if you didn't know, if you
4 didn't have an expectation to begin with?

5 WITNESS HELLER: I certainly didn't expect the pump
6 house to rise.

7 DR. BUCK: Let's not be smart about this, sir. That
8 is not a called-for remark at all.

9 You have a figure, a definite figure in here, of an
10 expected .08 feet, due to ordinary circumstances, so you say.
11 Now, I am asking you if you had enough data at that point to
12 give an expected settlement, why can't you do it now?

13 WITNESS HELLER: The reasons I can't do it now is
14 that the conditions of the soil and the loading conditions of
15 the soil at this point in time and from this point in time
16 forward are different than and can be expected to be different
17 than they were during the time period that these measurements
18 were made and the time period on which the expected settlement
19 value was stated.

20 DR. BUCK: Well, you know, the difference in loading,
21 if you had a theory that could tell you what the settlement was
22 at that time, could you apply the various loadings that you
23 have here and make another forecast?

24 WITNESS HELLER: That's not a part of my duties, sir.
25 And I did not do that, sir.

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1 DR. BUCK: Well, you have an expected settlement here,
2 sir. It's in your testimony.

3 WITNESS HELLER: That's correct.

4 DR. BUCK: Let's go on. Go ahead, Mr. Foster.

5 MR. FARRAR: Mr. Foster, wait a minute.

6 Dr. Heller, I am looking at that same paragraph, and
7 I haven't come right out and said it, but I seem to hear in
8 what you're saying that you never did make a prediction that -- at
9 one point you said something happened; at one point you looked
10 backwards and said over one 10-month period X happened, over the
11 next 10- to 11-month period Y happened, and part of Y was the
12 same X that happened during the first period.

13 In other words, you never predicted in advance, but
14 simply looked back and tried to figure what one of the compo-
15 nents, what happened in one period was in relation to what hap-
16 pened in a prior period.

17 WITNESS HELLER: Yes, sir, that is correct.

18 MR. FARRAR: Thank you.

19 BY MR. FOSTER:

20 Q Dr. Heller, one more question on that: How is it
21 that Mr. Lucks can predict future settlement if you cannot?

22 A (Witness Heller) Dr. Lucks, as part of his duties
23 with Stone & Webster, has available to him a considerable por-
24 tion of information that is not available to me. He is the
25 designer, he is the person responsible for establishing the

1 settlement values.

2 My duties are somewhat different. My duties are only
3 to assure that the plant is safe, at least in terms of the
4 responsibilities, the small isotheric work that I do.

5 Q Isn't what this hearing about a tech spec in which we
6 are going to be setting settlement limitations, and don't those
7 settlement limitations deal with plant safety?

8 A Yes, sir, they do.

9 Q Wouldn't a relevant factor to setting those limita-
10 tions be an idea of what future settlement is going to be?

11 A Only secondarily.

12 CHAIRMAN ROSENTHAL: Could you elaborate on that
13 answer? Why is it only secondarily?

14 WITNESS HELLER: Yes, sir. The reason it's only of
15 secondary importance is stated in the early part of our testi-
16 mony, and it has to do with the stresses in the pipes generated
17 by the settlement and not by the actual settlement itself. So,
18 the focus that we have taken in our testimony is to assure that
19 the pipes are not overstressed and not to assure that some pre-
20 dicted value of settlement is exceeded.

21 CHAIRMAN ROSENTHAL; Don't you regard it as signifi-
22 cant from your standpoint to determine, if at all possible, what
23 the settlement is going to be, as part of the overall considera-
24 tion of safety?

25 WITNESS HELLER: That would be an approach, yes, sir.

1 CHAIRMAN ROSENTHAL: It is "an approach"? I am asking
2 you, really, whether it's the staff's approach. You say it's of
3 "secondary importance," and what I am getting at is "secondary
4 importance" can mean various things. It can mean that it's a
5 very important consideration but not as important as other
6 considerations; or it could mean that we don't regard it as
7 being very important at all.

8 I am just really curious as to what level of
9 importance staff attaches in terms of the overall safety deter-
10 mination to the probable -- if it can be determined -- future
11 settlement level?

12 WITNESS HELLER: The context in which I was using
13 the word "secondary" is that our first concern is for the
14 safety of pipes; our first concern is that all the pipes remain
15 within stress levels that have been accepted by authorized coding
16 agencies, mechanical engineering codes, boiler codes, and so
17 forth. Our first concern is for the condition of the pipes and
18 their ability to carry water.

19 Our secondary concern is the matter that the pump
20 house, whether it settles a quarter of an inch or half an inch
21 or two inches, is not our main goal. Our main goal is to
22 assure that the pipes are not overstressed.

23 CHAIRMAN ROSENTHAL: All right. Now, does that mean
24 that it's, in the final analysis, a matter of indifference to you
25 whether the pump house settles one inch, two inches, three

1 inches, or five inches, that you feel that without regard to
2 what might be the future settlement level, that you can assure
3 safety by looking at other matters?

4 WITNESS DROMERICK: May I have a moment, please,
5 Chairman?

6 CHAIRMAN ROSENTHAL: Yes.

7 WITNESS DROMERICK: I believe, sir, what Mr. Heller
8 is trying to say that he does look at the settlement, and the
9 staff does look at the settlement, from the viewpoint of how it
10 will affect safety-related equipment necessary to perform their
11 required functions. On that basis, we have come up with the
12 limits that we have and the technical specifications to make
13 sure that the integrity of those systems will not in any way be
14 affected.

15 CHAIRMAN ROSENTHAL: You are not terribly, I would
16 gather, concerned with predicting it in advance. You are con-
17 cerned with being able to deal with whatever measure of settle-
18 ment there may actually be.

19 WITNESS DROMERICK: That is our concern, that we
20 deal with settlement. That is the whole purpose for the monitor-
21 ing of settlement program. That is why we came up with the
22 monitoring of settlement program.

23 MR. FARRAR: Let me make sure I have got that, and
24 let me put it in my own words, and you can tell me if I am cor-
25 rectly characterizing your position.

1 Is what you are saying the following:

2 If Dr. Lucks comes to you and says, "I predict 12
3 inches of future settlement," and your safety analysis says two
4 inches is okay, then you will put in a limit of two inches, and
5 you don't care about his prediction of 12. You will watch it
6 until it gets to two inches, and when it gets to two inches he
7 gets shut down.

8 WITNESS DROMERICK: That's right. He's shut down.

9 MR. FARRAR: And that's the same as if he came to you
10 and predicted two inches of future settlement, and you thought
11 two inches was all right; you'd watch until it gets to two inches
12 and then you'd shut him down?

13 WITNESS DROMERICK: That's right, sir.

14 CHAIRMAN ROSENTHAL: Mr. Foster, you'll excuse the
15 interruption.

16 MR. FOSTER: That's perfectly okay.

17 BY MR. FOSTER:

18 Q Mr. Dromerick, you say that the tech spec is written
19 in terms of settlement's impact on safety structures. In this
20 case, we're talking about the pipes. In what terms was the
21 first technical specification, the one that's currently in
22 existence, written? Wasn't that tech spec or doesn't that tech
23 spec speak in terms of "absolute settlement," rather than in
24 terms of "differential settlement" in its impact on the service
25 water piping?

1 A. (Witness Dromerick) Yes.

2 Q. Isn't it true that during the time that first tech
3 spec was developed and when it was adopted, that the expansion
4 joints that are currently in place were also in place then?

5 A. They were in place, yes.

6 Q. Then my question is: If this is your concern now to
7 write the tech spec in terms of what the impact of settlement
8 on these pipes is going to be, why wasn't that concern -- or was
9 it -- when you wrote the tech spec in the first place?

10 A. That was a number, that 15. We looked at it. That
11 was a number proposed by Vepco. We reviewed it, we analyzed it,
12 and we felt that it was conservative enough to meet our criteria,
13 which it did.

14 Now they have come back with another number. We are
15 looking at that. And what we do is assure that that number,
16 whatever we put in the tech spec, meets our criteria for those
17 systems.

18 Q. Did your criteria at that time -- that is, in Octo-
19 ber and November of '77, when the tech spec was being developed
20 -- did those criteria include this whole analysis of the impact
21 on expansion joints?

22 A. Yes. The expansion joints were in there, and they
23 did meet the criteria, that the piping system would meet the
24 ASME code.

25 Q. So, all of the analyses that we were talking about

1 this morning that were done by Vepco's contractor, the contractor
2 that produced the expansion joints, all that was taken into
3 account by the staff when they wrote the original tech spec,
4 that .15 feet in the current tech spec.

5 A Well, some of the additional information was dis-
6 cussed today in Vepco's testimony. They went back and did this
7 after the original tech spec was written. That's my under-
8 standing.

9 Q All right. I understand that.

10 . But what I am getting at is: Isn't it true that the
11 existing tech spec is written in terms of average settlement?
12 It seems to me that all the testimony that we've had so far on
13 this new proposed tech spec says that we have to look at it in
14 terms of differential settlement, because that's what's the key
15 to this expansion joint. Why wasn't the first tech spec written
16 in those terms, if that was your concern, if expansion joints
17 were your concern at that time?

18 A (Witness Heller) If I recall, the technical speci-
19 fications were proposed by Vepco, and essentially written by
20 Vepco. True, they were published by the NRC.

21 With respect to the average settlement value of .15,
22 since December of 1975, which is the number that's in question
23 now, that number was so obviously conservative, even though it
24 was an average value, that it was the staff's judgment that
25 there should be no adverse safety problems with that small

1 amount of settlement.

2 Q But how could it have been conservative if it didn't
3 take into account differential settlement between the pump house
4 and the service water piping expansion joint?

5 MR. FARRAR: Mr. Foster, I am going to have to inter-
6 rupt at that point. This went by twice, and nobody said any-
7 thing. I thought I asked the other panel this morning. I was
8 under the same impression you were, and they told me -- and I
9 have looked it up since -- that, in fact, there was a differen-
10 tial settlement limit in the original tech specs.

11 Now, I don't want to testify, but is that or is that
12 not the case?

13 WITNESS DROMERICK: There is an original differential
14 on that expansion joint, the .25, if I remember.

15 MR. FARRAR: All right. I will apologize. I didn't
16 want to keep going with that line without getting the straight.

17 BY MR. FOSTER:

18 Q Then, going at it from the other direction, for the
19 new tech spec, what you're saying to me is that there is no
20 need to have an absolute or an average settlement limit in there
21 because really the key concern is this differential settlement;
22 therefore, where the first tech spec had both the total
23 settlement limit and a differential settlement limit, the cur-
24 rent tech spec only has a differential settlement limit. Is
25 that right? I may be wrong on that current tech spec proposal,

1 as well.

2 A. (Witness Heller) The proposed one that I think is
3 before you has been submitted, has only differential settlement.

4 Q. I guess my question now is: Why isn't there an
5 average settlement limitation in the current tech spec?

6 A. The average settlement value in terms of limiting is
7 no longer necessary.

8 Q. Why is that?

9 A. Because that value of average settlement is not neces-
10 sary to establish the stresses that the pipes will undergo, only
11 the differential settlement between the pump house and the pipes
12 and the total settlement of the pipes.

13 Q. Okay. Fine. Now, we've also had some testimony
14 about other concerns with the settlement besides the service
15 water pipes; namely, the turbine problem -- I am sorry -- the
16 pump problem within the pump house -- that is the shimming of
17 the pumps. Also, I believe, the spray piping outside of the
18 pump house and into the lagoon. The current tech spec limita-
19 tions, which only talks about the differential settlement between
20 the pump house and the service water piping, how does that take
21 into account these other two problems caused by settlement of
22 the pump house?

23 A. (Witness Kiessel) It's my understanding that the
24 proposed tech spec does have a differential settlement figure
25 between the pump house and the pedestals upon which the piping

1 is sitting. And if I remember correctly, that's 0.175 feet.
2 The question of pump tilt is handled by the pump in service
3 inspection program which on a monthly basis monitors the pump's
4 performance, and therefore need not be put into a tech spec.
5 That is written around a different program.

end#12

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1 Q I wanted to come back to the tech specs a little
2 bit later, but I didn't want to get too far afield from the
3 settlement itself. I want to talk about that a little bit
4 more.

5 Dr. Heller, you had an opportunity to read Vepco's
6 supplemental testimony, submitted to this proceeding. The
7 cover letter is dated May 31st, 1979.

8 A (Witness Heller) Yes, sir I have.

9 Q Could you just quickly give me your view of how that
10 testimony -- the position of that testimony, which is -- as I
11 understand it, basically deals with water and its affect on
12 settlement, how Vepco's position differs from your own, as
13 expressed in the staff's testimony.

14 A Basically, the testimony retracts the previous
15 hypothesis that rainfall and increases in ground water level
16 can contribute to settlement.

17 Q Is it true that the Vepco position essentially is
18 that while the reduction in ground water can contribute to
19 settlement, an increase in ground water cannot? Is that your
20 understanding?

21 A Yes, sir, it is.

22 Q What is the Staff's position on that question?

23 Can an increase in ground water -- well, let's take
24 the first part first, that I think you agree on -- so you
25 agree that a reduction in ground water can contribute to

1 settlement?

2 A Yes, we do.

3 Q Do you agree that an increase in ground water cannot
4 contribute to settlement?

5 A I have no basis on which to conclude that an increase
6 in ground water level cannot in any way contribute to settle-
7 ment. I don't have a data base as this site on which to make
8 that conclusion.

9 Q So you disagree with the Applicant on that part?

10 A I guess the facts are -- I don't have the facts to
11 form a basis on which to either agree or disagree. The facts
12 that we have don't support a position either way.

13 Q Now, is it also that in Vepco's supplemental testi-
14 mony they made an effort to try to understand why the staff
15 was over the view that an increase in ground water could
16 contribute to settlement, specifically by referring to your
17 analysis of statements that had been made by a Vepco consultant
18 by the name of Dr. Ralph B. Peck; is that correct?

19 A That's correct.

20 Q Did you rely on Dr. Peck's analysis in coming to the
21 conclusion that an increase in ground water could contribute
22 to settlement?

23 A In part, yes, sir.

24 Q Could you explain briefly what it is that you relied
25 on, and why you think that an increase in ground water might

1 conceivably contribute to settlement?

2 A There are at least two mechanisms that are responsible
3 for the theoretical settlement of a structure constantly
4 loaded with an increase in ground water levels. The contribu-
5 tion of buoyancy -- in other words, if the ground water level
6 comes up, the swell will be buoyed up. We've covered that in
7 the past day and a half, and that does not contribute to
8 settlement, because it decreases the effective stress.

9 The other contributor is the soaking of the soil
10 itself and the change in compressability of the soil.

11 Now, if the ground water level changes are dominated
12 by the changes in compressability, as opposed to changes in
13 load, then one could get settlement under increased ground water
14 levels.

15 On the other hand, if the buoyancy effects -- in
16 other words, the reduction in load is the major contributor to
17 the settlement, then, of course, you will not experience
18 settlement under an increase in ground water level.

19 So, it's a matter of which is the dominant con-
20 tributor to settlement.

21 Q Do you have any views with respect to the type of
22 soil that underlies the North Anna pump house, the Unit 1,
23 Unit 2 pump house, as to which effect would be dominant by an
24 increase in ground water?

25 A I don't have test results to give me that judgment.

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1 Q So you have no professional view on that?

2 A I have a view, based on the results of some tests
3 that the Corps did for us. I have a view based on what we know
4 happens in wind-blown deposits. I have a view based on the
5 comparative densities of the in situ saprolites, as compared
6 to, in this case, normally deposited, transported soils.

7 All of these judgments would lead me to believe that
8 there is a possibility -- I'm not saying a likelihood, but a
9 possibility that settlement, compressability of those materials
10 could be changed, and perhaps changed enough to cause settle-
11 ment due to the rise in ground water.

12 Q Now I believe there was some testimony earlier
13 regarding saprolite and halloysite, in general, as to whether
14 or not increasing ground water -- that is, full saturation of
15 that kind of soil could cause a weakening of the bonds, which
16 would then result in -- well, a weakening of the structure so
17 that additional settlement could occur if there was a structure
18 on top of that soil.

19 It seems to me that there's been testimony saying
20 that that would not happen with that kind of saprolite. Do
21 you have a contrary view? In other words, would the mechanism
22 in the soil be a weakening of the bonds due an increased
23 saturation of the saprolite?

24 A I really don't know the answer to that.

25 Q You have no opinion on that?

1 A No, I don't.

2 Q This morning I think Dr. Lucks said if he had it to
3 do over again he would see nothing wrong with putting the North
4 Anna pump house on the same site. Do you concur in that opinion,
5 as a geologist?

6 A I think you could put that same pump house on the
7 North Anna site; yes.

8 Q But would you do it if it were your choice? Would
9 you make that recommendation to go ahead and build on this
10 site, this saprolitic soil?

11 A Yes, I would.

12 Q Dr. Heller, I'd like you to look at the Vepco
13 document, Figure 7, which is part of the plot -- Figure 7F in
14 particular, part of the plot of settlement over time.

15 Now, is it your conclusion that the rapid settlement
16 that occurred in July of 1977 was due to the installation of a
17 Drain 4 underneath the pump house?

18 A Yes, it's certainly due to the effects of the
19 installation of Drain 4, those effects being to remove the
20 ground water from under the pump house and under the dike; yes,
21 sir.

22 Q Do you have any idea what the weather patterns were
23 during this period of time in 1977? Vepco has plotted periods
24 of heavy rainfall. I'm thinking in terms of periods of
25 extremely light rainfall, such as drought.

1 A No, I do not know what the rainfall was.

2 Q Mr. Dromerick, would you have any recollection of
3 or know whether there was a period of drought at that time?

4 A (Witness Dromerick) No, I have not.

5 Q Have you ever plotted, Dr. Heller, settlement versus
6 drought for the North Anna site?

7 A (Witness Heller) No, sir, I have not.

8 (Pause.)

9 Q Mr. Dromerick, I'd like you to take a look at this
10 memorandum. It's from you. I want you to identify it, first.

11 A (Witness Dromerick) It's March 28th, 1978, memoran-
12 dum. It's in regard to a summary of March 16th, 1978, meeting
13 to discuss matters related to the service water pump house and
14 piping.

15 Q I'd like you to direct your attention to the second
16 page. Why don't you just read that paragraph to us?

17 A "Mr. Robinson had previously indicated that the
18 ground water level was below the drains during their installa-
19 tion. He said that the past summer's drought resulted in
20 low piezometric levels. L. Heller indicated that settlement
21 of the same pipe had been experienced by the pump house
22 previously."

23 Q Is L. Heller Dr. Heller, who is on this panel?

24 Now, there are a couple of things in that paragraph
25 which I'd like to ask you about. One is a reference to the

1 ground water being below the drains during their installation.
2 There's been a lot of testimony where the water was, whether it
3 was above or below the drains. Is this statement still true?
4 Was the water below the drains or above the drains at the time
5 of their installation?

6 A (Witness Heller) My understanding is that the ground
7 water was above the drains, and the reason for that is that
8 water came out of the drains when they were completed.

9 Q So if that's correct then Mr. Robinson was incorrect.
10 You're quoting Mr. Robinson in this letter; is that right,
11 Mr. Dromerick?

12 A (Witness Dromerick) Yes, that's correct.

13 Q Who was Mr. Robinson?

14 A Mr. Robinson is the representative from Vepco. I
15 don't know his exact title, but he is responsible for the
16 settlement problems, solving the settlement problems at Vepco.
17 He's a structural engineer.

18 Q Now, there's also reference in this memo to the past
19 summer's drought. I take it that's the summer of 1977; is that
20 correct?

21 A That's my understanding; yes, sir.

22 Q So what I'm trying to get at is is there a possibility
23 that the sudden drop or the sudden increase in settlement that
24 we saw here in July 1977 may have been caused by drought, as
25 well as -- or it could have been caused by drought, as opposed

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1 to being caused by one of the drains being installed.

2 Has there been any investigation of that possibility
3 or do you not consider that a possibility?

4 A Could it be possible, Mr. Foster, that Mr. Heller
5 could read from my minutes of the meeting?

6 Q Certainly; of course.

7 A I'd like him to refresh my memory.

8 A (Witness Heller) Could you repeat the question,
9 please?

10 Q The question is: If that memorandum is correct, and
11 the facts stated by Mr. Dromerick in the memorandum are
12 correct, we had a drought in the summer of 1977, is it possible
13 that the rapid settlement we saw in July of 1977 was caused, or
14 significantly contributed to by the drought, as opposed to
15 Drain 4?

16 A I don't believe it would be a significant effect.
17 There may be some partial effect, a small percentage, but I
18 would consider that probably the drought was not the major
19 contributor to that settlement in that short period of time.

20 Q You do agree though that drought, by lowering ground
21 water could cause settlement? There seems to be no disagree-
22 ment about that; is that correct?

23 A That is correct.

24 Q So what you're saying then is that one drain -- I
25 take it Drain 4 is the one we had water coming out of -- one

1 drain caused all that settlement; the effects of one drain
2 caused all that settlement?

3 A A major portion of it, yes.

4 Q How many drains were installed at that point in
5 time?

6 A I believe there are six drains under the pump house.

7 Q But at that time, I don't believe they'd all been
8 installed.

9 A I believe just Drain No. 1 and No. 6 had been
10 installed prior to Drain 4.

11 Q Okay. And Drain 4 was installed at a lower eleva-
12 tion; is that correct? And that's why that might have been
13 the only one draining at that time?

14 A Drain 1 is located, I believe on the far western
15 side of the pump house. I believe Drain 6 is on the eastern
16 side of the pump house. Drain 4, however, is located nearly
17 directly under the pump house.

18 The influence of Drain 4, therefore, would be much
19 greater than the influence of the other two drains, particular-
20 ly on the settlement, the average settlement of the pump house.

21 Q How much water can flow through one of these drains?
22 What's there capacity?

23 A I don't know the exact value. I think I've seen at
24 least a couple of gallons per minute coming out of a drain,
25 that much.

1 Q And how long did Drain 4 drain for during that
2 period?

3 What I'm trying to get at, Dr. Heller, is doesn't it
4 seem at all surprising to you that one drain draining several
5 gallons per minute could cause settlement from 0.444 feet to
6 in excess of 0.49 feet?

7 A May I ask a question? Am I correct is assuming that
8 the dashed line on Figure 7F has been interpreted as the rate
9 of settlement, average rate of settlement of the entire pump
10 house during the two-week period or so that's indicated on
11 that figure?

12 Q I think our assumption all along has been that these
13 graphs are average settlement, so I think that you would be
14 correct there.

15 Perhaps Mr. Christman could clarify that for us.

16 MR. CHRISTMAN: That's what I understand.

17 WITNESS HELLER: It was my understanding, in reading
18 the reports related to this, that the figure, as shown there,
19 is an interpretation and not necessarily based on consistent
20 data from surveyor to surveyor.

21 The rate of settlement, I think, has been stated
22 could be even more rapid than indicated. Conversely, one
23 might interpret it as the possibility at least that the
24 settlement occurred more slowly than is indicated on that
25 figure.

1 Q This is almost a vertical drop, is it not, Dr. Heller?
2 Even if the exact slope is not known, it's going to be pretty
3 close to vertical. It's a pretty substantial drop in a short
4 period of time, is it not, between monitoring dates?

5 A Yes, it is. But there is one other aspect, if I may
6 volunteer.

7 Q Certainly.

8 A The amount of water that's necessary to squeeze out
9 from under this pump house in order to allow the pump house to
10 come down is also very small. And one drain -- I haven't made
11 the calculation, but I would assume that one drain, over a
12 period of a week or two, flowing 24 hours a day, could indeed
13 remove an appropriate volume of water from the soils and allow
14 the pump house to go down as rapidly as has been indicated here.

15 I have not done that calculation, but I would judge
16 that it could happen.

17 Q Who was it that observed the water coming out and
18 measured it? Is that information all taken from Vepco records
19 and monitoring at the time, monitoring of the drains?

20 A Vepco was in charge of all monitoring; yes, sir.

21 Q So it's Vepco observations of the water coming out of
22 Drain 4?

23 A The observation that I alluded to a moment ago -- I
24 did see the drains running. I was down in the gallery, where
25 the water was collected, so I did see water running from the

1 drains, but on this particular date.

2 Q On other dates that you've seen the drains running,
3 has there been rapid settlement?

4 You just said to me, I believe, that if there's
5 even a small amount of water coming out of one of these drains,
6 it can cause a lot of settlement. It doesn't take the removal
7 of much water to cause settlement.

8 Are these drains dry most of the time?

9 And if not, when they're running, is there a lot of
10 settlement?

11 A I really don't have the basis to answer that question.
12 It had best be asked perhaps of Vepco, since they were the
13 ones watching them.

14 The thing that has to be considered here is that the
15 water will run from the drains constantly and not cause any
16 settlement, because the ground water level has stabilized.
17 Therefore, there's no change in the ground water level. It's
18 only the changes in the ground water level that are associated
19 with the settlement phenomenon.

20 Q So in other words, if the ground water isn't
21 constantly replenishing itself at a given level, while the
22 drains are draining, that's ground water out. If it's not
23 replenishing itself, then you'll have settlement?

24 A That's correct.

25 Q Isn't that the type of thing that would happen

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1 during a drought?

2 A Not necessarily.

3 The reason I say that, the drains may flow more
4 slowly during a drought simply because the gradient to the
5 drains is reduced. I think there's some testimony in Vepco's
6 response to Intervenor Arnold's questions that indicates that
7 total flow rates in the drains have fluctuated by roughly a
8 factor of 2, which means that, in effect, ground water levels
9 in the vicinity, near the drains have changed considerably,
10 and this is reflected by more water coming out of the drains.

11 Q Every time that that has happened, that the ground
12 water has fluctuated, shouldn't we see a very sharp drop, a
13 very rapid settlement?

14 A No, sir.

15 Q I don't understand that then, because you just said
16 it takes a relatively small removal of water from the ground
17 water level to affect a drop or an increase in settlement.

18 A To answer that question, could we look again at
19 Figure 7F?

20 The settlement that's indicated there was an
21 initial settlement, meaning the ground water was at a high
22 elevation and was reduced to a low elevation. A change in
23 ground water level could -- now, during periods of drought,
24 during periods of monsoons, let's say, true, the ground water
25 would change in the areas outside of that affected by the

1 drains.

2 But in the area in which the drains are installed,
3 the ground water level would remain constant. It would remain
4 constant, because the rate of level of flow from the drain
5 changes, and it would be maintaining a constant ground water
6 level at the pump house.

7 Q You mean during a drought, while the ground water
8 all around the level of the plant is going down, the ground
9 water underneath the pump house is going to stay constant?

10 A Hopefully, that's what has happened; yes. Hopefully,
11 that's what would happen in the future.

12 Q How is that possible? Doesn't water seek it's own
13 level?

14 A Yes. It's seeks the level of these drains, and
15 these drains have had such a location that that level is below
16 the normal seasonal change in the ground water levels.

17 Q During a drought, couldn't ground water go below the
18 drains?

19 A Yes, sir, it could.

20 Q Drains don't do anything to prevent the ground water
21 from going below. They only prevent ground water from getting
22 above them; isn't that correct?

23 A Yes, sir.

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25

1 Q Therefore, the drains will not maintain the ground
2 water level at a particular height when it's going down all
3 around the plant?

4 A As I understand the conditions that have been
5 experienced in the only short period of time the drains have
6 been in, there has always been a flow from some drains. I can
7 be corrected and contradicted on that, but it's my understanding
8 that there has been flow at all times. And since there has
9 been flow, the ground water has not dropped below the drains
10 yet.

11 Some time in the next 40 years, it's possible that
12 it could drop below the drains.

13 Q One other question on this March 28th memo,
14 Dr. Heller. At that same paragraph on the second page, it
15 indicates that "L. Heller indicated that settlement of the same
16 type had been experienced at the pump house previously."

17 Doesn't "same type" refer back to the fact that the
18 ground water level was below the drains during their installa-
19 tion? He said that the past summer's drought resulted in low
20 piezometric levels. What is "settlement of the same type"?

21 A I'm sorry, I can't answer that. I don't remember
22 the context in which that conclusion was written.

23 Q Do you, Mr. Dromerick? You're the one that wrote
24 this memorandum reporting what Dr. Heller had said.

25 A (Witness Dromerick) May I see that memorandum?

1 Q You've got it.

2 A (Witness Heller) I'm trying to recall context of
3 the meeting in which this memorandum is summarized. As I
4 recall, there was the question of the accuracy and again, the
5 ability of one survey, one set of surveyors to ascertain the
6 exact elevation of the pump house and the average elevation of
7 the pump house. And if memory serves me correctly, I believe
8 that it is in the context that a number of measurements have
9 been made that, when averaged, would indicate a rather large
10 change in settlement.

11 Let me correct that. A change in settlement that
12 would be of concern when you look at it in terms of the small
13 settlement involved. Here we're talking about settlements of
14 .10 feet, perhaps an inch and a quarter. At this point I guess
15 there was some worry that the settlements might increase
16 rapidly again. And my interpretation was that settlement
17 readings of this type had been experienced in the past, not
18 that it was necessarily related to the drought. That's my
19 recollection.

20 Q All right.

21 Dr. Heller, yesterday I asked the Vepco panel if they
22 had had an opportunity to read Dr. Mueller's limited appearance
23 statement. Were you present when that colloquy took place?

24 A Yes, sir, I was.

25 Q Have you had a chance to read Dr. Mueller's limited

1 appearance statement?

2 A Very rapidly.

3 Q Would you care to comment on his remarks concerning
4 viscous fluid behavior, specifically, whether viscous fluid
5 behavior is a phenomenon which could occur here at North Anna?

6 A I think the testimony has at least two interpreta-
7 tions of what he means by viscous fluid behavior. There have
8 been at least two interpretations in this testimony of viscous
9 fluid behavior. When I read it, I'm assuming that he's thinking
10 about the kind of behavior we might have in a large body of
11 clay, such as the San Francisco Bay clays or other clay
12 deposits, in which there is actually some what's called
13 lateral spreading involved with settlement.

14 It would be my opinion that that would be most
15 unlikely for the saprolites under the pump house.

16 Q Why is that?

17 A The reason for that is because of the large porosity
18 of the saprolite. The saprolite does not have the pores
19 completely filled with water, at least that portion of the
20 saprolite immediately under the pump house. We need to remember
21 here that the saprolite is not saturated for about 20 feet
22 under the pump house, and the possibility of lateral spreading
23 of that dry saprolite is very small, because of its ability to
24 compress rather than to spread laterally.

25 Q All right. Dr. Heller, I'd like to get some reading

1 on what that final staff position is on the settlement.
2 Specifically, do you agree with my understanding of the Vepco
3 conclusions or what I understand those conclusions to be, that
4 all the major drops in the pump house that have occurred up
5 until now are due to the added compression factor of weight on
6 top of the soil?

7 A. I can't say that all of them have. Certainly, there
8 have been obvious correlations between the addition of weight
9 to the soil and settlement. I'm not sure that they are all
10 related to increases in level.

11 Q. What else might they be related to, if not that?

12 A. Again, the only other hypothesis one can forward is
13 that there is some change in compressibility of the soils
14 themselves.

15 Q. Due to what? Could that be due to ground water?

16 A. Due to the effects of the water on the saprolite.

17 Q. Is it safe to conclude that the staff really isn't
18 sure exactly what is causing this settlement and what the
19 mechanism of the settlement is?

20 A. That's a fair statement.

21 Q. Mr. Dromerick, when did the staff first become
22 concerned about pump house settlement? At what point in time?
23 Was it back in 1972?

24 A. (Witness Dromerick) I do not have knowledge
25 previous to June of '76, when I became project manager of

1 North Anna. However, I understand that they did become aware
2 of this problem some time in '74 or '75.

3 Q Did the staff monitor the installation of the drains?

4 A (Witness Lenahan) No, there was nobody there from
5 the staff during their installation. An I&E inspector
6 verified that they had been installed. I'm not sure I can give
7 you an exact report of that. It's shown in Appendix A of the
8 report.

9 Q I have a few questions that may seem unrelated, but
10 I want to get through them and then get into the tech spec in
11 more detail.

12 First of all, you corrected your testimony in the
13 beginning about the date when the expansion joints were
14 installed. And I understand now everybody seems to agree it
15 was August to October 1976. What I would like to know is,
16 why have there been so many documents that give a much earlier
17 date? There have been both applicant documents and staff
18 documents that say January or March, 1976.

19 Can anybody answer that question?

20 A The only one I can address is the report which I
21 corrected. That was a mistake on my part. I don't remember
22 where I got that. I don't know if I was talking to somebody
23 or I could have seen something at the site. But as far as I'm
24 concerned, that was a mistake on my part. I got some inaccurate
25 information.

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1 Q Does anyone else have any -- you're clear in your own
2 mind, Mr. Dromerick, that they were installed in August to
3 October 1976? You were there at the time?

4 A (Witness Dromerick) No, I was not there.

5 Q Oh, I'm sorry.

6 A I'd just like to make one correction. I said that
7 I became project manager of North Anna 1 and 2 in June. It
8 was probably more like April of '76.

9 Q So when you became project manager, did you go down
10 there and see them install the expansion joints?

11 A No, I did not and I have not seen the installation
12 of the expansion joints.

13 Q There was a lot of discussion this morning about
14 the analysis of expansion joint failure assuming that the
15 plant's in a cold shutdown state. Mr. Dromerick, can you tell
16 me why the staff has not required Vepco to do an analysis --
17 maybe they have, but do an analysis of the failure with the
18 plant in an operating state?

19 A (Witness Wermeil) We have already, in our previous
20 evaluation and approval of the system, accounted for a single
21 failure of any component within the system. This would have
22 included an expansion joint, a pump or anything. And we
23 concluded that adequate redundancy existed to maintain plant
24 safety at that time, and that's still our conclusion.

25 MR. FARRAR: Mr. Foster, I'm sorry, I was doing

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1 something when you asked the question. Could I have the
2 reporter read the question back? I heard the answer, but not
3 the question.

4 (The reporter read the record as requested.)

5 MR. FARRAR: The answer woke me up to the fact that
6 I missed a question I was very interested in hearing or I was
7 going to ask myself. Go ahead.

8 BY MR. FOSTER:

9 Q My next question is, though: Vepco did do an
10 analysis of what would happen if they had simultaneous failure
11 of all four joints in a Mode 5 shutdown. Does your analysis
12 include an evaluation of the mode of failure of all service
13 water lines in an operating state?

14 A (Witness Wermeil) We considered such an event to be
15 so unlikely and incredible that, even in the cold shutdown
16 condition, that further analysis wasn't warranted. It's not
17 part of the design basis for the system in the first place and
18 it's not part of our normal licensing evaluation and review
19 to postulate such an occurrence.

20 Q So you didn't even think it was necessary for Vepco
21 to do the analysis of failure of all four joints in a Mode 5?

22 A Not that it was not necessary, just that it was
23 postulating a very extreme case and something that we just
24 don't consider very likely.

25 Q Is all the staff's knowledge about operation of

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1 expansion joints -- or do you have any knowledge of the
2 operation of expansion joints other than that that the
3 applicant has given you through its manufacturer?

4 A (Witness Kiessel) The knowledge of the particular
5 expansion joints was obtained exclusively from Vegco. I do
6 have prior knowledge of the use and design of expansion joints
7 in general.

8 Q Now let me ask you about that. Have expansion
9 joints of this size and type been used in any other nuclear
10 installation over which the staff has regulatory authority?

11 A I cannot say.

12 Q Anyone else on the staff?

13 (No response.)

14 Q None of you have any personal knowledge of them
15 being used anywhere else, is that correct?

16 A (Witness Kiessel) Of this particular type?

17 Q Not necessarily this particular manufacturer, but
18 expansion joints of this general design type and of this size.

19 A I know that expansion joints are used in the main
20 circulating water, the water that is used for cooling of the
21 turbine exhaust. I don't know if they are the same type. I
22 doubt sincerely that they are.

23 Q So you don't have any previous experience with this
24 kind of joint in these kinds of plants, to compare and make
25 some evaluation of this joint?

1 A As I say, I have no experience of this particular
 2 type of joint. I do have experience with similar ones in other
 3 applications.

4 Q Okay. Just two quick questions on other settlement,
 5 and I promise the staff that I will not belabor that subject.
 6 But, Mr. Dromerick and Dr. Heller, did you hear the testimony
 7 yesterday by the staff witnesses on settlement of other Class 1
 8 structures at the North Anna plant?

9 A (Witness Dromerick) You mean of Vepco's witnesses?

10 Q I'm sorry.

11 A (Witness Heller) Yes, sir.

12 Q Are you in substantial agreement about both the
 13 magnitude and the causes of that settlement?

14 A I believe so, yes.

15 Q Now, is your understanding of the causes -- let me --
 16 I just want to clarify the question.

17 My understanding is that the other settlement we
 18 were talking about yesterday was primarily of structures that
 19 are on similar soils to the soil under the pump house. And
 20 that included, I guess, the turbine building, the service
 21 building, the dam -- would it include the dam, by the way?

22 A (Witness Heller) I believe it does, yes, sir.

23 Q It does include the dam, because it's on saprolite?

24 A Yes.

25 Q And it's a Class 1 structure?

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1 A The dam is highly resistant to earthquakes.

2 CHAIRMAN ROSENTHAL: Dr. Heller, would you make more
3 use of your microphone.

4 WITNESS HELLER: The dam on Lake Anna is the one
5 that you're referring to?

6 BY MR. FOSTER:

7 Q Yes.

8 A (Witness Heller) That is a highly seismic-resistant
9 dam. I'm not sure it has been classified as a Category 1 dam.

10 Q In terms of settlement of these other structures
11 that are on saprolite, has the information which you've gotten
12 regarding the settlement, does that change your views in any
13 way about the mechanism and the causes of the settlement under
14 the pump house?

15 A No, sir, it doesn't.

16 Q In other words, you don't understand the other
17 settlement, either, the settlement of the other Class 1
18 structures, completely?

19 A No, we don't have adequate information to make an
20 analysis or any kind of prediction.

21 MR. FOSTER: I'd like to spend the rest of the time
22 talking about tech specs and recording requirements. Perhaps,
23 if the Chairman would like to take a break, this would be a
24 good time to do it.

25 CHAIRMAN ROSENTHAL: Could you provide some estimate

1 as to how long?

2 MR. FOSTER: I think I could do this in less than
3 an hour.

4 CHAIRMAN ROSENTHAL: I think we'll take our
5 mid-afternoon break now, 15 minutes.

6 (Brief recess.)

7 CHAIRMAN ROSENTHAL: Mr. Foster, you may proceed.

8 MR. MC GURREN: Mr. Chairman, we have one housekeeping
9 matter, if we may. In our letter of June 14th, we had indicated
10 we had deleted certain pages of our testimony. We also indi-
11 cated Mr. Bivins, the author of that portion of the material,
12 would be available here today. Mr. Bivins does have other
13 duties. I was wondering if there are any questions, so that
14 he would determine whether he should remain or not. I checked
15 with the intervenor. They have indicated that they have
16 nothing. I'm wondering if we could have him excused.

17 MR. FARRAR: I have been planning to ask him
18 something, because I had wanted to ask Mr. Wermeil first about
19 his change in testimony, which struck me as having something
20 lurking, something important lurking behind it. And I wanted
21 to ask Mr. Bivins the same thing.

22 Do you want to put him on for two minutes?

23 MR. MC GURREN: Whatever. We can keep him here
24 until you're ready.

25 MR. FARRAR: He can come back at the end of the week.

1 MR. MC GURREN: I don't know what his schedule is
2 for the rest of the week.

3 CHAIRMAN ROSENTHAL: How pressing is his other
4 obligations or commitments this afternoon?

5 MR. MC GURREN: I could check with him and find
6 out what his schedule is like the rest of the week.

7 CHAIRMAN ROSENTHAL: Mr. Farrar indicates he has
8 one question for him.

9 MR. FOSTER: I have no objection to him going ahead
10 now.

11 CHAIRMAN ROSENTHAL: Is he immediately available?

12 MR. MC GURREN: He's available.

13 MR. BIVINS: Yes, Mr. Chairman.

14 CHAIRMAN ROSENTHAL: Why don't you, Mr. Bivins,
15 come up, and maybe we can find another chair for you.

16 MR. FARRAR: Mr. McGurren, do you have your cover
17 letter? In anticipation of this, I have been looking for it
18 and I can't find it.

19 CHAIRMAN ROSENTHAL: Would you raise your right
20 hand, Mr. Bivins?

21 (Witness sworn.)

22

23

24

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1 Whereupon,

2 WILLIAM S. BIVINS

3 was called as a witness and, having been first duly sworn,
4 was examined and testified as follows:

5 DIRECT EXAMINATION

6 BY MR. FARRAR:

7 Q Mr. Bivins, all I wanted to ask you was --

8 MR. MC GURREN: If the record would, I would like
9 to have the record indicate that we do have prepared profes-
10 sional qualifications for Mr. Bivins, and if the Board would
11 like, I would be glad to qualify the witness.

12 CHAIRMAN ROSENTHAL: No, I don't think so.

13 MR. MC GURREN: I will not do that, then.

14 BY MR. FARRAR:

15 Q Mr. Bivins, I think I know Mr. Wermeil wanted to
16 change his testimony, and I see from Mr. McGurren's cover
17 letter, what he said your problem was, that he didn't want your
18 testimony misunderstood as applying particularly to the pump
19 house as opposed to the site as a whole.

20 My question is: Was there something else lurking
21 beneath this that bothered you, that caused you to want to
22 withdraw the whole testimony rather than simply modify it and
23 add qualifiers, as appears in Mr. McGurren's cover letter?

24 A (Witness Bivins) No, sir, there's nothing lurking
25 or devious. It simply seems to me that, looking at the question

1 from the Board and the answer that was initially proposed, that
 2 the relationship of the information taken from the SER dealing
 3 specifically with the area of the four units could be misleading
 4 with respect to the various numbers in there. I felt that,
 5 rather than have it mislead the Board or provide information
 6 that may be out of context, that it would be better to delete
 7 it.

8 Q Just delete it entirely?

9 A Yes.

10 CHAIRMAN ROSENTHAL: Does anyone have any further
 11 questions?

12 (No response.)

13 CHAIRMAN ROSENTHAL: Mr. Bivins, you may be excused.

14 WITNESS BIVINS: I appreciate the courtesy of the
 15 Board, sir.

16 CHAIRMAN ROSENTHAL: Mr. Foster, you may now proceed,
 17 sir.

18 MR. FARRAR: Let the record reflect, Mr. Foster,
 19 before you start, that I said one question at the start and,
 20 unlike most lawyers, it was one question.

21 CHAIRMAN ROSENTHAL: The record will duly note this
 22 extraordinary occasion. It may almost be described as an
 23 incredible event.

24 (Laughter.)

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1 BY MR. FOSTER:

2 Q Mr. Dromerick, I'd like to ask you some questions
3 now about the technical specifications proposal. So that we
4 understand we're all talking about the same thing, what I
5 propose to do is -- it seems to me we have three documents that
6 I want to talk about, and I would like to refer to the tech
7 spec that now is in effect as the current tech spec, if that
8 would be all right with you.

9 I would also like to refer to the staff proposed
10 tech spec, which has been submitted as part of the staff's
11 testimony in this proceeding. I would also like to refer to
12 the Vepco proposal which has been submitted as part of Vepco's
13 proposal.

14 A (Witness Dromerick) Could I ask for just one
15 clarification. When you say our proposed tech spec, do you
16 mean the January 9th?

17 Q I think that's what I mean, Mr. Dromerick. But I
18 picked up the wrong document.

19 Here I have it. January 9, 1979. Excuse me. That
20 is the latest staff technical specification?

21 A As supplemented by our testimony of April 27.

22 Q All right. Now, the first question I'd like to ask
23 you is: When did the current technical specification go into
24 effect? Was that in the fall of 1977, before the license was
25 issued, or did it go into effect when the operating license

1 was issued in April of 1978?

2 A. It went into effect when an operating license for
3 North Anna Unit 1 was allowed to load fuel. That was November 26,
4 1977.

5 Q. Okay. Now, what I would ask you to do, Mr. Dromerick,
6 to save time, I'll just give you the questions that I'd like an
7 answer to, and if you could just give us a narrative. What I
8 would like to know, at first, is, what is it that the staff-
9 proposed tech spec does? What does it control, number one?

10 Number two, how does the proposed, staff-proposed
11 tech spec differ from the current technical specification that's
12 in effect?

13 Number three, how does the current staff technical
14 specification proposal differ from Vepco's technical specifica-
15 tion proposal?

16 Okay. You can take it from there.

17 A. Would it be okay if Mr. Heller answered?

18 Q. Anyone.

19 A. (Witness Heller) The existing technical specification
20 calls for an average pump house settlement, an allowable
21 average pump house settlement since December of 1975 of .15 feet.
22 I believe you'll find that in Table 3.7-5 on the second page.
23 The existing specification for the differential movement between
24 Point 7 on the service water pump house and the exposed ends
25 of the service water piping that come out of the dike is on

1 page 1 of that same table, and that value is .25. That's the
2 existing technical specification.

3 The difference between that technical specification
4 and the one that we have drafted in our letter of January 9th
5 is that we have proposed, rather than the average pump house
6 settlement, we have proposed that the differential settlement
7 value limit be established between any point -- let me correct
8 that statement -- between either Point 7 or Point 10, which
9 are located on the north wall of the pump house, and the same
10 ends of the exposed pipe. And we have proposed a value of
11 .23 -- excuse me, .22 feet for that differential settlement
12 value, measured from July of 1977.

13 Q Before you go on from there, Dr. Heller, I'm looking
14 at Figure 6 of Vepco's drawings, which shows the pump house,
15 the piping and all the settlement marker points. When you
16 referred to the exposed ends of the service water lines, are
17 those points shown on this drawing?

18 A Yes, sir, they are. Those are settlement points
19 marked SM-15, 16, 17 and 18 at the upper corner of the drawing.

20 Q And are those points just a little north of a point
21 above the expansion joints?

22 A Yes, sir.

23 Q One other question before you go on. You said that
24 the current staff proposal says the differential settlement
25 between either SM-7 or SM-10 is that you have to take the

1 lowest of those. In other words, whichever one of those
2 points shows -- is that the lowest?

3 A. Whichever point gives you the maximum differential
4 settlement will be the one that will be used to establish the
5 limit.

6 Q. Fine. Now, the last part of my question, I believe,
7 was, how does the staff-proposed technical specification
8 differ from the Vepco proposal that's been submitted in this
9 proceeding, if at all?

10 A. For this particular point, it doesn't change it a
11 lot. The only difference is that we have a different date
12 from which we begin the settlement measurement. I think that
13 one that we proposed was July of 1977 and I think --

14 A. (Witness Dromerick) Can we have a point of
15 clarification, Mr. Foster? When you say Vepco's proposed
16 specification, are you saying their proposed specifications
17 of May 31, 1978, or their specification that they just
18 submitted recently, June 11th?

19 Q. The one I'm talking about is the one I received with
20 a cover letter, dated June 11, 1979, a letter from
21 Mr. Christman.

22 A. Okay, fine.

23 A. (Witness Heller) I don't think I finished answering
24 your question, at least in sequence of the development of the
25 different technical specifications. I was comparing the one

1 that is now in existence to the one that we had proposed, that
2 is, in the letter of January 9th to the Board. I think the
3 only real difference there in terms of the differential
4 settlement between the pump house and the pipes that goes
5 across the expansion joints is that we have included one more
6 point on the pump house, in order to get the most conservative
7 value with respect to differential settlement between the
8 pump house and the pipes.

9 Q That would be either Point SM-7 or SM-10.

10 A That's correct.

11 MR. FARRAR: Dr. Heller, you started to say there
12 was a difference in the date. You picked July '77. Why did
13 you pick that date instead of the date that the expansion joints
14 were put in?

15 WITNESS HELLER: The reason for that date is that
16 that is the date that markers were established by the surveying
17 crew on the pipes, which are the settlement monuments 15 through
18 18. Prior to this date, no absolute value was established for
19 the elevations.

20 The reason for the difference between the .25 and the
21 .22 is simply to accommodate the settlement that had occurred
22 up to the July 1977 point in time.

23 BY MR. FOSTER:

24 Q Dr. Heller, I'm sorry, where does this .25 come
25 from? I think I may have missed what you were saying was the

1 difference between the Vepco proposal and the staff proposal.

2 A (Witness Heller) I at least have not yet gone
3 to the Vepco proposal. I'm still comparing the existing
4 specification to the specification that we proposed in January
5 of 1979.

6 Q So when you refer to .25, you were referring to the
7 old differential settlement?

8 A Yes, sir.

9 MR. FOSTER: Incidentally, I would invite anyone to
10 interrupt, so we can get -- I think all these questions are
11 important to anyone. If the Board would care to interrupt,
12 fine.

13 BY MR. FOSTER:.

14 Q You say July of '77 is the date you're measuring
15 from. As we know, there's been a lot of settlement from July
16 of '77.

17 What date in July in particular are you referring to?

18 A (Witness Heller) I don't know the exact date --
19 just a moment, please. I believe we do have it.

20 Q I'm interested in knowing whether it's before or
21 after the settlement ostensibly caused by the installation of
22 drain 4.

23 A That would be the 14th of July is the date on which
24 the elevations were measured on the pipes. That's given in
25 Table 3 of Vepco's testimony.

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1 Q If I look at Table 7-F, it looks to me as though
 2 July 14th was before we had the approximately .05 feet of
 3 settlement; is that correct?

4 A I want to try to answer the question, perhaps, by
 5 painting a picture here. But it really doesn't matter what
 6 date you choose here as long as you're sure of the absolute
 7 elevation of that particular pipe on that particular day.
 8 Whether it was July 11th or July 14th is not important. The
 9 point is that July the 14th was the date on which the markers
 10 were established and the absolute elevations were established.
 11 So that would be the date from which one would measure the
 12 differential settlements.

13 Q I guess you're also saying that since we're
 14 measuring differential settlements, the absolute settlement
 15 of the pump house isn't all that important, the absolute
 16 settlement that occurred in July of 1977?

17 A That's correct.

18 MR. FARRAR: Mr. Foster, you invited me to interrupt.

19 Dr. Heller, I can see what you just said about the
 20 date, that it doesn't matter, because the date, because that's
 21 the zero date. But in picking the amount .22, you said you
 22 picked that amount because that accommodated the settlement
 23 that had taken place, roughly accommodated the settlement that
 24 had taken place since the expansion joints went in.

25 WITNESS HELLER: Yes, sir.

1 MR. FARRAR: If you're trying to accommodate it,
 2 then you've got, in my humble opinion, looking at the thing,
 3 you've got to know which side of that precipitous settlement
 4 you're talking about, whether you're talking about before it or
 5 after it, if you're going to pick a figure that's going to
 6 accommodate it.

7 WITNESS KIESSEL: If I might interject, the way we
 8 arrived at that value was to subtract from the allowable
 9 lateral displacement that the expansion joint would take. Now,
 10 whether we pick a date before or after this precipitous settle-
 11 ment does not matter, because all that does is determine where
 12 this precipitous amount goes, whether it goes in the tech spec
 13 limit or in the amount that was used to reduce the design value
 14 to the tech spec.

15 It would not make any difference on which side it
 16 went, as long as it was accounted for.

17 MR. FARRAR: Right. But in order for you to
 18 account for it -- I mean, I don't care which side you put it
 19 on, but you have to tell Mr. Foster and us which side you're
 20 putting it on, don't you?

21 WITNESS KIESSEL: We pegged off of a date. The
 22 reason why we used that date was we knew the absolute elevations
 23 on that date. Whether that was before or after this drop that
 24 can be gleaned from the historic record is not really important.
 25 We had accounted for differential movement prior t. that date.

1 The tech spec accounts for the differential movements on the
2 other side of that date, since that date.

3 DR. BUCK: The date you picked is not one of the
4 dates that was shown on this chart.

5 WITNESS KIESSEL: According to Table 2 of Vepco's
6 testimony, Moore, Hardy & Carrouth established SM-7, 8, 9 and
7 10 on 11 July, 1977. On 14 July, 1977, they established the
8 zero marks for SM-15, 16, 17 and 18, these latter figures
9 being shown on Table 3. So that we do have observations
10 within a three-day period.

11 MR. FARRAR: What you're assuming, then, is that the
12 July 11th and the July 14th are the same?

13 WITNESS KIESSEL: I think they're close enough.

14 MR. FARRAR: That's fine that you're doing it, but
15 I just want all of the assumptions out on the table. And if
16 you look at the next line, if you treat July 11th as being
17 the same as July 14th, your precipitous drop occurs afterwards,
18 because then you've got your four-hundredths reflected in the
19 December 12th, '77, reading.

20 DR. BUCK: It's in between.

21 MR. FARRAR: In other words, March and July are
22 pretty much the same. So then a big drop shows up by
23 December.

24 WITNESS KIESSEL: That's correct. But also, if
25 you'll take a look, between the July and December dates from

1 Table 3, you'll see that when we go to a differential, that
2 most of that is lost, since you have a precipitous drop there,
3 also, of nearly five-hundredths.

4 DR. BUCK: That doesn't mean they occurred at the
5 same time, does it? I mean, how do you know?

6 WITNESS KIESSEL: No, sir, it does not mean that
7 they occurred at the same instant in time, merely that they
8 occurred over the same time period.

9 DR. BUCK: Between July and December?

10 WITNESS KIESSEL: That's correct, sir.

11 MR. FARRAR: So then the way you've set the thing
12 up, you're treating this precipitous drop as having occurred
13 afterwards.

14 WITNESS KIESSEL: Yes, sir.

15 MR. FARRAR: In other words, part of the .22 has
16 already been eaten up.

17 WITNESS KIESSEL: Part of the .22 has already been
18 eaten up, yes, sir.

19 MR. FARRAR: There's a gradual decline, but that
20 big chunk has been eaten up.

21 WITNESS KIESSEL: What big chunk, sir?

22 MR. FARRAR: The four-hundredths in July.

23 WITNESS KIESSEL: Sir, the .22 is a differential
24 reading.

25 MR. FARRAR: Yes, you're right. Sorry.

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1 WITNESS KIESSEL: One absolute reading has gone up,
2 but so has the other one.

3 MR. FARRAR: Right, right.

4 DR. BUCK: Unless they occurred at the same time.

5 MR. FARRAR: Yes.

6 What's your differential reading on July 14th?

7 WITNESS KIESSEL: It would be zero, sir.

8 DR. BUCK: Why?

9 WITNESS KIESSEL: Because that is our starting date,
10 sir. We assumed -- excuse me. On July 14th, we had an assumed
11 differential of .03. That is explained in our testimony as to
12 how we arrived at that.

13 MR. FARRAR: That's what you think had happened
14 between the installation of the expansion joints and July 14th?

15 WITNESS KIESSEL: And the installation of the markers,
16 yes, sir.

17 MR. FARRAR: Okay.

18 DR. BUCK: I forgot in your testimony how you said
19 you arrived at that .03.

20 CHAIRMAN ROSENTHAL: It appears on page 37.

21 WITNESS KIESSEL: Yes, sir.

22 (Pause.)

23 DR. BUCK: If this is an estimate, how did you
24 estimate it?

25 WITNESS HELLER: Okay. The estimated differential

1 here is taken as the maximum value that was recorded on these
2 different points. In other words, we need to establish the
3 settlement of the ends of those pipes between December of 1975
4 and July of 1977. We have a marker on the top of the dike near
5 the location of markers 15 through 18. We're assuming that
6 those pipes settle the same as that marker during that period
7 of time. That marker did settle 46-hundredths of a foot in that
8 time period -- I'm sorry, the pump house settled 46-hundredths
9 of a foot at Point 7. At Point 10 the pump house settled
10 89-thousandths of a foot. Okay.

11 So now we take both of these values and take the
12 upper limit of those values, and the upper limit of the
13 differential settlement during that time period turned out to
14 be 3-hundredths of a foot. True, it would have been nice had
15 those elevations been established on the pipe in December of
16 1975. Unfortunately, that data was not available. So the
17 best we can do is take a settlement of a point very near those
18 pipes, as a matter of fact, on the dike which surrounds those
19 pipes, use that, the settlement of that marker, as the settle-
20 ment of all the pipes, and then pick a conservative value from
21 those recorded values, and that's what we have done.

22 DR. BUCK: It just seems to me that talking about
23 an exact figure here, which you want to be, and that exact
24 figure varied by .03, which is a considerable amount, one way
25 or the other, depending upon the assumptions which you made

1 and the choice of extrapolation.

2 WITNESS HELLER: What you say is true, sir, yes.

3 DR. BUCK: It would seem to me that another measure-
4 ment would have settled this. I mean, you put a marker in, and
5 this sort of thing. Now, why wasn't the survey gone ahead and
6 done on the marker at that point?

7 WITNESS HELLER: What you're suggesting could be
8 done. One could move the point in time up to the present time,
9 for example, and establish --

10 DR. BUCK: It seems to me that should have been done
11 then. You move it up to the point where you could get a
12 measurement and get an exact value. But what we're doing now,
13 here you've got a variation of, what, 15 percent, in the total
14 amount, that you're just picking out of the air.

15 WITNESS HELLER: That's correct.

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MR. FARRAR: Let me make sure that I understand how you are going to interpret the tech spec that you've proposed.

Let's assume it was in effect on December 12th, 1977, the one you're proposing now. Let's assume that it had been in effect with a limit of .22. Look at Vepco's Tables 2 and 3.

Had they reported their December 12th readings to you, what would they have reported? Let's just stick with -- rather than .7 or 10, let's just take .7, SM-7, and deal with that.

Would it be that they would say point SM-7 has settled 0.039, and point SM-15 has settled 0.051, the difference being 0.012? As opposed -- or namely, 1/20th of the limit?

WITNESS LENAHAN: Yes, sir, that is correct.

CHAIRMAN ROSENTHAL: All right, Mr. Foster.

BY MR. FOSTER:

Q Perhaps this is a repeat of what Dr. Buck asked, but when the expansion joints were installed you knew that a future limiting factor on those was going to -- or the staff knew that a future limiting factor would be differential settlement. Is that correct?

A (Witness Heller) Yes, because the expansion joints have some limited movement.

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1 Q Do you know why a firm marker wasn't established
2 at that time when they were installed, rather than waiting
3 until sometime later? Maybe it's my confusion.

4 Yes, you took the marker -- you established a
5 marker sometime after -- many months after the expansion
6 joints were installed. Or am I incorrect on that?

7 A No, that's correct.

8 Q Then what I'm asking, I guess, is: Why didn't they
9 install the marker at the time the expansion joints were
10 installed if you knew that a limiting factor was going to
11 be settlement and you'd need to measure that settlement?

12 A The reason that the markers were not established
13 earlier is that the technical specification didn't go into
14 force until -- I believe it was given for November of 1977.
15 So there was no need for a marker before that time.

16 Q But would you have expected Vepco to install
17 a marker? I mean, didn't they install the expansion joints
18 to accommodate settlement problems? Wouldn't you have
19 expected that they would have installed a marker, knowing
20 that they were going to have to measure that settlement
21 later?

22 A It would have been a convenient time to
23 establish the elevation for those pipes, yes, sir.

24 Q It would have been more than "convenient,"
25 wouldn't it? It would have made it a lot more accurate?

1 A It would have made our job easier, yes, sir.

2 MR. FARRAR: Mr. Foster, let me follow that up.
3 We've been talking the last couple of days about how these
4 tech specs didn't go into effect un'til, you know, the magic
5 day when the operating license came into effect.

6 And that's kind of troubled me in the sense
7 that here's a problem continguing over time. We have a tech
8 spec that we're thinking about we're going to impose on
9 them, and yet for six months, with everyone knowing this
10 tech spec is in the offing, everyone can freely ignore it
11 because it is not in effect until they day they get their
12 license?

13 I don't understand the system that operates like
14 that, particularly since they did have a construction permit
15 at the time, and I would assume you could have attempted to
16 impose on them any conditions you wanted to as a condition
17 of keeping the construction permit.

18 WITNESS KIESSEL: That is true, sir. But up
19 until the time they load fuel, there is no nuclear health
20 and safety problem associated with the plant, and the tech
21 specs pick up fuel handling from that aspect.

22 MR. FARRAR: If you were going to argue what I
23 thought was the discredited theory that, granted we talked
24 about this with the rebars, and the cadwells, and stuff,
25 granted you can put the worst welds in the world, the worst

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1 concrete in the world, in your containment and that's not
2 dangerous. Today that's not dangerous because you haven't
3 started the plant running. I'll agree with that.

4 But in another sense, that's the most dangerous
5 thing in the world, because over the next 40 years that's a
6 latent defect that can cause you a lot of problems. And I
7 can't understand a philosophy that says that until the
8 plant starts operating, we don't have to worry about these
9 things.

10 And I'm afraid that's what you just said.

11 WITNESS HELLER: I don't believe that's what we
12 said in words. I think that we were referring to at what
13 point in time it would have been more accurate to establish
14 the elevations of the ends of the exposed pipe.

15 MR. FARRAR: That's true, too. Mr. Kiessel just
16 said that you couldn't do anything to them because there
17 was no fuel loaded.

18 WITNESS KIESEL: No, sir, I did not mean to
19 imply that, sir. I meant --

20 MR. FARRAR: Rather than me characterize what I
21 thought I heard, why don't you say what you meant.

22 WITNESS KIESEL: Certainly. I meant that there
23 was no need for measuring this differential prior to that
24 time to ensure that the plant was operating safely.

25 However, I agree with Dr. Heller, it would have

1 been convenient if they would have picked the establishment
2 date to coincide with the installation of the expansion
3 joint.

4 MR. FARRAR: Why wouldn't it have also been
5 necessary, in the sense that later on during the 40 years
6 you were going to have to measure that differential, and
7 you can't measure that accurately during the 40 years unless
8 you have measured it accurately from the day they started
9 construction, or the day they put in the expansion joints?
10 And therefore, it's not enough to say, you know, it wasn't
11 necessary.

12 It seems it's necessary to do a good job during
13 the operating license stage that you measure it accurately
14 during the construction permit stage.

15 Now where am I wrong in that statement?

16 WITNESS LENAHAN: I'd like to clarify something.
17 I think there's a misunderstanding here. I wasn't involved
18 in this thing, but from my review of the documents it appears
19 to me that the NRC staff was concerned about monitoring
20 settlement, because the baseline dates go back to before
21 the operating stage.

22 In performing my inspections at the site, and in
23 my discussion with various personnel, the best I could
24 determine was that there is no requirement, NRC requirement,
25 for the applicant to measurement settlement on those

1 expansion joints. Therefore, they did not do it until they
2 were requested to do it by NRC.

3 MR. FARRAR: When you say there is no NRC
4 requirement, you mean there was nothing in the construction
5 permit tech specs?

6 WITNESS LENAHAN: From what I vaguely remember
7 looking at tech specs, the proposed tech specs, it was in
8 the amendment in draft form prior to that, about June or
9 July 1977.

10 MR. FARRAR: I'm sure I can concede, for purposes
11 of this argument, that there were not tech specs.

12 WITNESS LENAHAN: This was not even addressed in
13 the draft. It somehow was overlooked.

14 MR. FARRAR: The question is: Shouldn't it have
15 been in there? Don't you have legal authority to have it
16 in there? And shouldn't it have been in there?

17 That the day they get the construction permit,
18 you say to them: You people "will" during the course of
19 your construction measure all these points, because we're
20 going to need them later on during the operating license
21 stage.

22 Are you telling me you can't do that?

23 WITNESS DROMERICK: No. We can do that. We did
24 not do that, sir.

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1 BY MR. FOSTER:

2 Q All right, Mr. Dromerick, I guess we're at the
3 third part of the original question. Which is: I'd like
4 you to compare and tell us what the difference is between
5 the staff proposed tech spec January 9th, 1979, as amended
6 by your testimony, and the Vepco testimony of June 11th,
7 1979.

8 A (Witness Dromerick) Are you just specifically
9 asking for the service water pump house? Or are you asking
10 for the whole list?

11 Q I'm asking for the service water pump house.

12 A On settlement point 7 and 10, and settlement
13 points 15, 16, 17, and 18, there's no difference.

14 Q Are you telling me that the Vepco proposal is
15 that the limit for differential settlement between either
16 SM-7 or -10, and the four ends of the exposed pipe -- that
17 is, points 15, 16, 17, and 18 -- the limit for that is
18 .22 feet as measured from July 14th, 1977?

19 A As measured from July 1977.

20 We do not have the date July 14th, but July '77.

21 Q So in that sense, the proposals are identical?

22 A Yes, sir.

23 Q Now with respect to the service water pump house
24 tech spec, either in terms of numbers or reporting requirements
25 or anything else, do the tech specs, the proposed tech

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1 specs -- that is, the staff's and Vepco's -- differ in any
2 way?

3 A They differ in the period of time and reporting
4 requirements for certain settlement points.

5 Q And what is the staff's reporting requirement?

6 A That these certain points -- and I could define
7 them, if you'd like -- that they must be monitored every
8 31 days.

9 Q And in Vepco's proposal?

10 A They said six months for everything. So they
11 did not specifically bring out these certain points.

12 Q Is that the primary difference between the two
13 tech specs, as far as the service water pump house is
14 concerned?

15 A Yes, that is the primary difference.

16 Q I do want to ask just one question about other
17 Class 1 structures. This morning I asked the Vepco panel
18 if this proposed tech spec made proposed changes in the
19 allowable limits for other Class 1 structures. I'd like
20 to ask you the same questions. And are those limits
21 increased? Are they asking for an increased allowable
22 limit in either absolute or differential settlement for
23 other Class 1 structures?

24 A From the present, existing?

25 Q That's correct.

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1 A Not our proposed.

2 Q From the present one, the presently existing.

3 A On settlement point 130, they're decreasing the
4 allowable differential from 13.12 that is between settlement
5 point 2-23. On settlement point 130 and settlement point
6 129, they are decreasing that to .12 from .13 to .12.

7 Q Could you identify which buildings these are
8 associated with?

9 A Sure. Containment Unit 1 is the settlement point
10 130. And settlement point 223 is the fuel building.
11 Settlement point 130, Containment Unit 1. And settlement
12 point 129 on the auxiliary building. That was the second
13 one that I discussed. They're decreasing that to .12.

14 The next one is on settlement point 143, which
15 is the containment Unit 1. And settlement point 142, which
16 is the Unit 1 safeguards area. The allowable differential
17 settlement remains the same.

18 Q Mr. Dromerick, I don't want you to go through the
19 whole list. What I'm only interested in --

20 A The differences?

21 Q Not even all the differences. The ones where
22 they're asking for an increase.

23 A An increase?

24 (Pause.)

25 Q Mr. Dromerick, perhaps to save time, someone else

1 could be checking that, and then I could ask you some other
2 questions. Would that be more convenient?

3 A. All right.

4 Q. Is the new tech spec, the new staff proposal,
5 does it have any additional requirements to deal with the
6 problems with the pumps inside the service water pump house?
7 That is, the shimming, either in terms of what shimming is
8 required, or the reporting requirements for problems that
9 may exist with the shimming?

10 A. No, the technical specs do not. But as
11 discussed by Mr. Kiessel previously, he said that those
12 pumps fall under the in-service testing program, Section 11
13 of the ASME.

14 Q. So obviously if they're out of plumb, they won't
15 pass that test, perhaps? Is that correct?

16 A. (Witness Kiessel) Not "obviously," sir. They
17 may get far enough out of plumb that they may not pass the
18 test, but simply because they're out of plumb does not mean
19 that they will not pass

20 Q. How about the spray piping? The other problem
21 that was identified, which was created in part by the
22 settlement of the pump house? Does the new tech spec say
23 anything about that?

24 A. (Witness Dromerick) Their new tech spec? Or
25 ours? Our new tech spec, yes.

1 (Pause.)

2 Okay, it's settlement point 8 on the service water
3 pump house, and settlement point H-569, and H-584, pipe
4 hanger and reservoir, and our requirement is .17 allowable
5 differential settlement.

6 Q What happens if that limit is reached? The same
7 requirement? Do you reach 75 percent of that limit, there's
8 a reporting requirement, and then 100 percent, shut down?

9 A Yes.

10 Q Mr. Dromerick, how important -- or Dr. Heller,
11 how important are the settlement markers to the monitoring
12 that you are requiring in these technical specifications?

13 In other words, aren't the markers the key to
14 the whole thing?

15 A (Witness Heller) Yes, they are.

16 Q Now have there been any problems in the past with
17 markers being destroyed, or moved, or anything like that?
18 Mr. Lenahan?

19 A (Witness Lenahan) Yes, there have been.

20 Q Could you describe that for us?

21 A They had several that were broken off, or
22 apparently damaged. What they consisted of -- the best way
23 to describe it would be a 20-penny nail driven into the side,
24 or the top of the structure. There were some problems where
25 some of them were bent. About half a dozen points, they

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1 were damaged slightly during the construction.

2 Q I take it that this destruction or alteration of
3 the markers was unplanned?

4 A It was not planned. It was done -- it happened
5 during construction, during construction activities, as best
6 I can determine.

7 Q Were any of these markers those that are needed
8 to measure settlement of the pump house or the piping?

9 A None in the pump house area or the piping.

10 Q There was also a settlement requirement, is there
11 not -- Mr. Kiessel, maybe I should ask you this -- an
12 absolute settlement requirement in the new tech spec covering
13 the service water pipes on the north side of the expansion
14 joint? Is that correct?

15 A (Witness Kiessel) That's correct, sir.

16 Q And that's an absolute settlement value, right?

17 A Yes, sir, that's an absolute value.

18 Q I'd like to ask you why that is there. And, number
19 two, whether settlement of that part of the line is in any
20 way affected by settlement of the pump house, why that tech
21 spec limit is there for those pipes?

22 A The tech spec is there to limit the stress in
23 the buried pipes themselves.

24 The second part of your question as to whether
25 or not settlement of the pump house influences the stresses

1 in those pipes, it may, but it would be to a very slight
2 extent, since the expansion joint itself acts as a filter
3 to try and remove any of the settlement effects of the pump
4 house from the buried pipe.

5 Q All right, so is the absolute settlement limit
6 placed on those pipes any different from the settlement
7 limit in the existing tech specs? Has that been changed
8 as a result of new problems with settlement in the pump
9 house?

10 A To the best of my knowledge -- let me check with
11 Mr. Dromerick a minute.

12 (Pause.)

13 A (Witness Heller) I don't believe that there is
14 a limit on the absolute settlement of the pipes that go down
15 to the dike and towards the main plant pipe structures at
16 the present time. This is a new requirement, and as
17 Mr. Kiessel said, it assures us that allowable stresses are
18 not exceeded as the dike settles.

19 Q That's a new requirement. What are your measuring
20 points? How do you know how much settlement has occurred
21 already, whether there's been any stress in those pipes?

22 A The explanation for the .22 foot limit that we
23 have proposed and is also in the revision one that Vepco
24 is proposing now, is contained in our testimony.

25 Q Could you summarize it in a sentence or two?

1 A Yes. That value, as we finally concluded, is a
2 very conservative value and was arrived at in the following
3 manner:

4 We assumed that when the pipes were buried in
5 the dike, that they were buried at the same elevation as
6 shown on the construction drawings for the pipe connection
7 to the pump house.

8 We realize now that that is a very -- actually
9 unrealistic elevation. Nevertheless, we did use it. And
10 then we obtained from Stone & Webster and Vepco the actual
11 elevations that were measured from the tops of those pipes
12 in August 1978.

13 We assumed that the dike had settled and bent
14 the buried pipes the full amount from the design elevation
15 of those pipes to the actual measured elevation of those
16 pipes. And we found that even at that deflection they
17 were still capable of settling absolutely another .22 feet
18 without exceeding the code allowable stresses in those
19 pipes.

20 Q All right, Mr. Dromerick, has the staff proposed
21 to set any limitations on how soon Vepco must calculate
22 measurement data once it's taken by the surveyor? How soon
23 they must calculate it and have it reported to a particular
24 person?

25 A (Witness Lenahan) They have what's called a

1 "performance test requirement" as part of their procedures
2 which are written to meet the requirements of the
3 technical specifications. And they have to be completed
4 every 31 days.

5 Q That's the same 31-day period that you were
6 talking about for reporting before? They have to take the
7 measurements every 31 days? Is that right?

8 A Yes. In other words, they can't take a series
9 of measurements, say, for three months, and then sit down
10 and compute them all at once. They have to do it every
11 31 days. They have to complete the test.

12 Q What I'm getting at is, suppose they take a
13 measurement on January 30th and it takes them four weeks to
14 figure that out and write it down and get it up to channel?
15 So when you get your report in February, it's really reflecting
16 the January measurements, and when you get your report in
17 March, it's reflecting the February measurements, and so
18 forth?

19 What I'm asking is: Is there any requirement that
20 a measurement be taken on January 25th and the results will
21 be known and reported to someone in a position to do
22 something about it within a few days?

23 A Okay. They have seven days. I've reviewed that
24 procedure. They have seven days from the time the work is
25 completed in the field for a surveyor to transmit the data

1 to the plant.

2 Q Is that part of the tech spec?

3 A That's not a tech spec requirement. That's an
4 on-site procedure.

5 Q How good have they been in the past at performing
6 that procedure?

7 A As of around April or so, up until April this
8 procedure really didn't take effect I think until March or
9 so. Their performance as reflected in Appendices B and C
10 in the past has been very slow in doing this.

11 Since their new procedure went into effect, which
12 was around March the 1st, or April the 1st, they have
13 improved. They've been getting that data within 7 days.

14 Q Mr. Lenahan, does Vepco's performance either in
15 terms of the timely gathering of these data in the past, or
16 what we were talking about previously -- that is, the fact
17 that it might have been convenient, I believe to use the
18 panel's terms, if they had put in a marker at the time they
19 installed the expansion joints -- if they didn't do that,
20 does any of that performance suggest to you that perhaps these
21 requirements, the seven-day requirement or even a lesser
22 requirement, should be included in the tech spec, rather than
23 left to internal procedures?

24 A Now they're obligated to follow their internal
25 procedures. That's part of Criterion 5 of Appendix B to

1 10 CFR 50. They had to establish procedures, and they're
2 obligated to follow those. They can't deviate from those.

3 Q So does that mean an internal procedure, as far
4 as Enforcement is concerned --

5 A We will enforce them to their internal procedures.

6 Q Well, is violation of an internal procedure as
7 serious as violation of a technical specification, assuming
8 the technical specification is giving them the same subject
9 matter, say, reporting?

10 A I'm not sure. I can't really say which is more
11 serious.

12 Q Can anyone on the panel -- I guess you're the only
13 person with I&E, and you do the enforcement.

14 A I would have to pass that to the attorneys. I'm
15 not sure.

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1 Q I don't think they want it. Mr. Lenahan --

2 MR. FARRAR: Mr. Foster, let me ask Mr. Lenahan:

3 Are you saying that for violations of their own internal manuals,
4 you can hit them with a civil penalty?

5 WITNESS LENAHAN: They are drawing up the internal
6 procedures to comply with Appendix B. They're required to
7 establish procedures for anything affecting quality and safety,
8 health and safety of the public.

9 So, it would depend. They could be a serious viola-
10 tion. It would depend on how serious it is.

11 MR. FARRAR: I am not talking about the particular
12 case, but one of the options available to you would be a civil
13 penalty for a violation of one of their own?

14 WITNESS LENAHAN: I am not really an expert in that
15 area. I can't say for sure.

16 DR. BUCK: I believe they can if it's something --
17 I believe they can.

18 BY MR. FOSTER:

19 Q Mr. Dromerick, who is in charge of writing the tech
20 specs originally? Was that primarily the applicant's respon-
21 sibility, or the staff's responsibility? I am talking now
22 about the tech specs that are in existence now, the ones that
23 were developed back in October, November 1977.

24 A (Witness Dromerick) The final responsibility for the
25 issuance of the technical specifications is the NRC's. However,

1 it is the applicant who comes in and proposes the technical
2 specifications. We review that specification, and then we make
3 whatever necessary changes that we see fit.

4 Q Now, were you -- meaning "you," the staff -- working
5 with Vepco during the fall of 1977 to develop the current tech-
6 nical specifications?

7 A The staff was involved with Vepco.

8 Q And during that time, did you ask for the latest
9 settlement figures on the pump house from Vepco?

10 A No, we did not.

11 Q That seems a little surprising to me, and I will ask
12 you to comment on that. Settlement was obviously a key problem
13 at the pump house. You were talking about setting a settlement
14 limit which, if they reached, would require them to shut down.
15 It seems surprising to me that you wouldn't have wanted to know
16 exactly where they were, settlementwise, at the time you were
17 developing the tech specs.

18 A When we develop tech specs, we come out with a matter
19 of reporting which we feel comfortable with from a safety point
20 of view. In those technical specifications, we had a value of
21 75 percent to report. If they were to hit that value, they have
22 to report it to us. We felt that that 75 percent limit would
23 give us enough time to take whatever action we had to take.

24 Q So it really wasn't necessary for you to know whether
25 they were at that 75 percent, whether it was realistic; it was

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1 whether it was a realistic figure in terms of the tech spec or
2 not.

3 In other words, supposing you had information at the
4 time you were developing the tech spec that they were already at
5 the 75 percent limit. Then what would you do?

6 A. If they were at the 75 percent limit?

7 Q. This is before the operating license was granted.

8 A. We would review that matter individually on that
9 specific point.

10 Q. Can you elaborate on that a little bit?

11 A. This license position in November -- that's when the
12 tech specs became available -- at that time we had no evidence
13 to see that they were, you know, past 75 percent. They had not
14 reported -- they did not report that.

15 The first inkling that I had that they were approach-
16 ing that value was somewhere in March.

17 But what is important here is that we have estab-
18 lished this value of 75 percent, where we feel that we must know
19 what that value is, that they must report it to us within 60
20 days.

21 Q. How about you, Dr. Heller; were you involved in the
22 tech spec development at this time?

23 A. (Witness Heller) Not in the writing of the tech
24 specs. I was involved and I did know that all the Class I
25 structures would be monitored and there would be a tech spec

1 prepared to assure that piping was not overstressed. But I
2 wasn't involved any more than that.

3 I am advised that -- yes, I did review the numbers
4 when they were turned in before they were published and accepted
5 by NRC.

6 Q Had you asked for any current data at the time you
7 were doing this review? Had you asked for any current data on
8 settlement, particularly in view of the whole controversial
9 questions of precisely what effect the drains were having, the
10 drains that had been installed sometime before?

11 A No, sir.

12 Q Mr. Lenahan, are you, in general, satisfied with
13 Vepco's history of reporting the kinds of things that we're
14 talking about in this tech spec; that is, settlement limits,
15 referring to Appendices B and C of the testimony which you
16 sponsored?

17 A (Witness Lenahan) Do you mean am I satisfied that
18 they've met the requirements or not? Is that what the question
19 was?

20 Q Yes.

21 A As I summarized in the report, I was satisfied that
22 they had met the requirements of the technical specifications.

23 Q Were you present in the room yesterday when I went
24 through a long discussion with Mr. McIver regarding Appendix B
25 to your testimony, and the figures that appeared on page 5 of

1 that Appendix?

2 A Yes.

3 Q Okay. Now, I don't want to go through all of this
4 again, but I do want to ask you some of the same questions that
5 I asked Mr. McIver.

6 Isn't it true, looking at that figure, that the survey
7 data that Stone & Webster had in August of 1977, in that data
8 it indicated that Vepco had already exceeded 75 percent of the
9 limit that was going to appear in the tech spec in November and
10 that ultimately appeared in the tech spec in November?

11 MR. MC GURREN: Mr. Chairman, I am going to object
12 to this line of questioning. We went through it yesterday, and
13 now we're going through it again today.

14 Yesterday, I objected that it was not relevant to the
15 issue at hand, which was settlement. I again object to it on
16 that basis, and on the additional basis that we're going through
17 it one more time.

18 CHAIRMAN ROSENTHAL: Mr. Foster?

19 MR. FOSTER: Mr. Chairman, I certainly think the
20 questions are relevant. Obviously, one of the issues here, it's
21 clear that monitoring is the key to the whole success of any of
22 these technical specifications. And if the applicant's monitor-
23 ing history is in question -- and I think it is, and I think the
24 staff documents show they are; the staff put this document into
25 evidence; I did not -- I think this document does bring their

1 monitoring history into question. And if it is in question,
2 then that suggests to me that maybe the technical specification
3 is going to have to have some changes to ensure that any moni-
4 toring problems are avoided.

5 As far as the redundancy, I am going to try to avoid
6 taking the amount of time that I took yesterday, but I think
7 that we need to get I&E's opinions on these events.

8 CHAIRMAN ROSENTHAL: The objection is overruled.
9 Anything, though, that you can do to expedite the line of
10 inquiry will be appreciated.

11 BY MR. FOSTER:

12 Q Mr. Lenahan, you have page 5 in front of you.

13 A (Witness Lenahan) Yes, I do.

14 Q Isn't it true that in August of '77, that Stone &
15 Webster showed figures of 0.114, which was in excess of the 75
16 percent of the tech spec limit -- I believe it was in excess or
17 it's very close to it?

18 A This data does reflect that.

19 But I think I want to bring out some things that are
20 contained in the report and explain the data and explain the
21 limitations of the data.

22 Q That's exactly what I want you to talk to.

23 A For one thing, the average settlement of the pump
24 house was required to be based on an average of four points.

25 This data, from August 3 through January 5, 1978, all those data,

1 those seven points in there, they were based on averaging of
2 three points only. There was one missing point which was
3 reestablished by my interpolation of the data.

4 Q Who said they had to be averaged on four points?

5 A That's what the technical specification requirements
6 are: average pump house settlement, which I would assume would
7 be four points.

8 Q Okay. Did Vepco have any procedures, or did staff
9 have any procedures at the time, saying how many points these
10 measurements had to be taken on?

11 A Well, I am not sure about this, but I think if we
12 deleted one point that was deleted, it would be much lower than
13 is shown here. You had to use the same system throughout to
14 have anything meaningful. You can't, you know, use four points
15 for several months, then go to three points and go back to four.

16 So, we had, to have any meaning at all, we had to
17 use the same system.

18 Q The reason I asked you that question, Mr. Lenahan, is
19 I believe there has been reference in the past, looking through
20 the Vepco testimony on page 53, it refers to a Vepco document
21 entitled "Surveying Procedure for Settlement Monitoring," and
22 said it was issued on January 23, 1979.

23 What I would like to know is: What were they using
24 before then? The plant had already been in operation for some-
25 time on January 23 of 1979. What are all these figures based

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1 on?

2 A. I am sorry. What page of the testimony is that?

3 Q. Page 53 of Vepco's original testimony.

4 A. As far as I know, they really didn't have a firm
5 procedure. They had a performance test requirement, which
6 addressed surveys and the handling of data. In other words, it
7 was a matter of filling in the blocks. They had a table, 3.7-5
8 of the tech spec read-throughs, and they have the blocks in
9 there. They had a place to put the data in and then compare it
10 to what the limitation was. And they had to act from that.

11 As far as the actual handling of the data and the
12 surveyors, surveyors are bound by a contract which I looked at
13 on sort of an open-end type service type contract. They are
14 performing a Class II second-order survey.

15 Q. How frequently did that contract call for them to
16 monitor?

17 A. It started out in detail, in the appendix to Appen-
18 dix C, the summary of inquiry. It goes into quite a detail.
19 Briefly, it started out, really, for something else, and then it
20 sort of expanded into doing second-order Class II. It was just
21 the legal requirements for them. The contract did not address
22 that they were doing it to meet the tech spec or any particular
23 thing.

24 Q. But did it say: You shall measure, do monitoring
25 every four months?

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1 A No, it did not address that. It was done at the
2 request of Vepco.

3 Q Okay. It was done at the request of Vepco. Is it
4 also true of the Stone & Webster monitoring, to your knowledge?

5 A The Stone & Webster monitoring program started back
6 -- I believe it got started about 1975, when they noticed
7 cracking in the wing walls and the service water pump house.
8 And I have to say this from memory; I am a little vague on
9 this. But I believe they started out doing it every month; then
10 they went to a frequency of every two weeks, I believe.

11 Q Okay. Going back now to page 5, you say that that
12 August 3, 1977 figure that Stone & Webster came up with must be
13 suspect because they only use three points and they should have
14 used four?

15 A They only used three points.

16 The only thing that bothered me is that they didn't
17 do what's called "closing the survey loop." In other words,
18 they went off -- instead of -- in surveying, you do what's
19 called "closing the loop." In other words, you run your points
20 from point A to, say, point B and then back to point A again,
21 just to verify that you haven't made an error going in one
22 direction. This had not been done in these surveys, either.

23 Q Okay. How many points did they use on the May 23,
24 '77?

25 A That would be the average of all four points.

1 Q They did four points. How many did they use on the
2 August 29 survey?

3 A That would be again three points.

4 Q How about -- let's go from August to December: Did
5 they use three points on every one of those surveys?

6 A Yes, they did. Right up until January 5, they used
7 only three points.

8 Q It seems to me -- you tell me if I am wrong -- that
9 if I used three points on August 3, 1977, and I came out with a
10 figure that showed almost double the amount of settlement from
11 the readings from the previous May -- admittedly more accurate
12 because they used four points -- it seems to me that next time
13 I did the survey I would want to use four points and see what
14 was the story: Do I really have twice as much settlement or am
15 I off because I only used three points. Am I wrong in that?

16 A Now, wait, let me clarify one thing: We could
17 establish -- we established the fourth point by interpolation,
18 the relationship between the others. I figured we could do that.

19 Q Does that mean, this 0.114 was not their figure, but
20 yours through extrapolation?

21 A That's mine through extrapolation, which agrees very
22 closely with theirs within a couple of thousandths.

23 Q So, for all practical purposes, can we look at these
24 figures on page 5 as being the Stone & Webster figures, or do
25 we need to clarify that each time?

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1 A. They're my figures. But in comparison to what was
2 in the testimony, in figure 7-F, I believe, they're very close.

3 Q. Okay. So, now, as to my previous question about my
4 sort of surprise, it seems to me if I were doing this and I
5 got that figure on August 3, the next time I measured, I would
6 want to check, because I got a figure twice as much as what the
7 May reading had been.

8 A. I agree with you. And just to summarize what hap-
9 pened there. The data was discussed, I think, in quite some
10 detail in the summary of inquiry attached to this. What hap-
11 pened is: The data was recorded by Stone & Webster surveyors.
12 It was put into a field book, which I had copies of, that I
13 reviewed, and for some reason or another there was a loss in
14 communication or a lack of communication between the Stone &
15 Webster field office and the Boston office for several months.
16 The data was transmitted all at once. This is what we deter-
17 mined during our inspection. what I, in turn, determined during
18 my inspection.

19 It was overlooked, I guess is my answer.

20 Q. Is that also true of the August 29, October 6 -- all
21 the readings?

22 A. I believe all the readings from August 3 through
23 January 5 were recorded and kept at the site in the book, but
24 they were never reported. I never found any evidence that they
25 were reported to anybody at Vepco or Stone & Webster.

1 Q All right, Mr. Lenahan. Before we leave that, this
2 morning, I believe, there was a question by the Board about what
3 responsibility the surveyors had in terms of did they take the
4 readings and have any idea what it is they're looking at, in
5 terms of the limits. And I believe the statement from
6 Mr. McIver was that they really don't, the surveyors don't.

7 Is that your understanding as well?

8 A Okay. We have two groups of surveyors here. To the
9 best of my understanding, the Stone & Webster surveyors just
10 did taking the readings, recording the data, and somehow they
11 had a very informal system of transmitting it to various people
12 in Vepco and within Stone & Webster.

13 The Moore, Hardy & Carrouth people do much the same
14 thing. The people who are doing the actual work don't have any
15 understanding of what the figures mean, and I don't think they
16 would recognize a sudden change. They do nothing but record
17 the data.

18 Q How about the survey party chief?

19 A In the case of Stone & Webster, the survey party
20 chief, what he did was compute the actual elevations of the
21 points. He did not do any analysis. He didn't even compute
22 elevations. The data which was transmitted to the Boston Stone
23 & Webster office was the actual elevations of the points. It
24 was not settlement. It was the elevation of a point for
25 points.

1 Q So nobody on site really had any idea what the
2 significance of any figures they were getting was?

3 A No, nobody on site did.

4 Q All right, now, putting aside the Stone & Webster
5 data for a minute, let's go over to Moore, Hardy & Carrouth data.
6 Now, theirs, I take it, are the monitoring figures that are most
7 accurate, as they used the National Oceanic and Atmospheric
8 Administration criteria.

9 A Yes.

10 Q Okay. Now, isn't it true here that on December 6,
11 1976, they showed average settlement of the pump house as 0.031
12 feet; is that right?

13 A You're referring to Moore, Hardy & Carrouth?

14 Q Yes.

15 A .031 feet, right.

16 Q And on March 3, 1977, and again on July 11, 1977,
17 they had data showing that that amount had doubled approxi-
18 mately, that the amount of settlement had doubled?

19 A Yes, that's correct.

20 Q And that the amount of settlement there was .063
21 feet, which is approximately 42 percent of the tech spec that
22 would be in effect in November; is that right?

23 A Yes.

24 Q All right. And isn't it also true that this table
25 shows that suddenly -- well, strike "suddenly" -- that following

1 July 11, 1977, although they have done monitoring anywhere from
2 two weeks to one month, two months, three months, period inter-
3 vals, previously, that they didn't do any monitoring again fol-
4 lowing the July 11, '77 survey until December 12, 1977? Is that
5 right?

6 A That's correct. That's what the data shows.

7 Q And did that figure show -- well, okay, is that
8 surprising to you? Here they had data in July showing a doubling
9 of the settlement, and yet they suddenly stopped monitoring and
10 they went on a much more infrequent basis than they had previ-
11 ously?

12 A Okay. Now, I will be very frank about this. The
13 July data was not received and analyzed on site until about
14 November of '77.

15 Q What about when it was received by Moore, Hardy &
16 Carrouth?

17 A Moore, Hardy & Carrouth doesn't mean anything to them.
18 They were doing nothing but reviewing; they did nothing but
19 record the elevations. In fact, the party chief, in the case
20 of Moore, Hardy & Carrouth, does not even compute elevations;
21 that's done in their office.

22 Q Who is going to be doing this measurement from now
23 on?

24 A Who's going to be doing --

25 Q Who is going to be taking the surveys? Do you know?

1 A. I can't say. The applicant would be responsible for
2 picking a contractor to do the work.

3 Q. Okay. Do I take it, from your testimony, that the
4 thing that's going to keep something similar to this from hap-
5 pening is the seven-day requirement that Vepco has in its own
6 internal procedures; they will require that contractor to take
7 the survey and get the information back to Vepco within seven
8 days?

9 A. Yes.

10 Q. And that's satisfactory to you, even in light of this?

11 A. At this point, yes.

12 Q. As far as you knew back then, there were no other
13 requirements, no internal Vepco procedures saying we have to
14 have this data promptly because we've got a settlement problem
15 here and we're trying to develop tech specs and we need to see
16 how far we can go with this thing?

17 A. Okay. I spoke of the periodic test procedure, but
18 besides that, that didn't become effective until the plant
19 became operating, the operating license was issued. Prior to
20 that, I saw no written Vepco procedures as far as the collec-
21 tion of data.

22 Q. Do you find that surprising, in light of the settle-
23 ment history and the problems they were experiencing after the
24 installation of the drains and so forth?

25 A. Well, I don't find it really surprising. I think

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1 they were following the normal construction techniques.

2 Q For this applicant, or in general?

3 A I would say, just from general experience.

4 Q When you did this investigation which is the subject
5 of this report, did you take any sworn depositions?

6 A This was an inspection, okay? Let me clarify. No,
7 we didn't take any sworn depositions.

8 Q Is that a normal practice, or is that an unusual
9 practice?

10 A Not during inspections.

11 If I may add something: I don't know if we're even
12 allowed to do that, an inspector.

13 Q Mr. Lenahan, on page 7 of the staff's testimony,
14 there is reference to the fact that during the period of set-
15 tlement from 1972 to 1975 -- let me get the testimony, so I
16 can have this quote.

17 All right. Isn't it your testimony, the staff's
18 testimony, as given on page 7, that an inspection of the North
19 Anna site, which, I take it, took place in April of 1975 or
20 sometime in 1975, that that inspection showed that the settle-
21 ment that had occurred between 1972 and 1975 had exceeded the
22 preliminary safety analysis report predictions?

23 A Okay. I didn't write this portion, but I am familiar
24 with the inspection.

25 Q Mr. Dromerick or Dr. Heller, is that yours?

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1 A. This inspection, this was concerning -- I believe
2 this inspection was conducted on April 29, and it was conducted
3 as the result of a phone call to the principal inspector by
4 somebody from the applicant, and they mentioned this over the
5 phone, that they were having -- the settlement had exceeded the
6 PSAR estimate.

7 And so, two inspectors were dispatched to the site
8 to look into this. This was April '75.

9 Q. What was the finding of this inspection? Was Vepco
10 cited for any violations as a result of this inspection?

11 A. This is past history. I think they were cited for
12 failure to report on their 515-E.

13 Q. Isn't it true that a fine of \$140,000 was recommended
14 by staff inspectors for that violation?

15 MR. CHRISTMAN: I have an objection here.

16 CHAIRMAN ROSENTHAL: I don't see the relevance of
17 this.

18 MR. CHRISTMAN: That's not the objection, sir.
19 Unless I am wrong, this was all asked and answered two years ago.
20 Am I wrong?

21 MR. FOSTER: I don't remember. You may be right.

22 MR. CHRISTMAN: I may be wrong, but I think Mr. Foster
23 cross-examined on this episode for sometime. Of course, we
24 could check that. I could be wrong.

25 MR. FARRAR: How does that help me, Mr. Christman?

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1 I wasn't there.

2 MR. CHRISTMAN: It's already in the record, of course,
3 in the transcript, part of the record in this proceeding.

4 MR. FARRAR: In the operating license proceeding?

5 MR. CHRISTMAN: Yes. That's my belief.

6 CHAIRMAN ROSENTHAL: Beyond that, I have, frankly,
7 considerable problem with the relevance of all this. It had
8 nothing to do, did it, with any of the matters.

9 MR. FOSTER: Again, it seems to me that the relevance
10 is the fact that a relevant issue is performance in monitoring
11 settlement. That's exactly what this violation dealt with:
12 monitoring the settlement of the pump house.

13 CHAIRMAN ROSENTHAL: Is Mr. Christman right, that
14 in the record of this very proceeding, this matter was previously
15 explored?

16 MR. FOSTER: Except for the magnitude of the fine
17 proposal. That's correct.

18 CHAIRMAN ROSENTHAL: You've gotten that out of him.
19 Can we pursue some other line?

20 MR. FARRAR: Was the witness at that point Mr. Lenahan?

21 MR. FOSTER: No, I don't believe so.

22 CHAIRMAN ROSENTHAL: You've finished that line, I
23 take it?

24 MR. FOSTER: Yes, sir, I am finished questioning.

25 CHAIRMAN ROSENTHAL: You're finished?

1 MR. FOSTER: With this panel, yes.

2 CHAIRMAN ROSENTHAL: All right. Now, let's see. I
3 think maybe we will have a bench conference at this point for
4 scheduling purposes. If the counsel will come to the bench,
5 we will go off the record.

6 (Discussion off the record.)

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end# 17

1 CHAIRMAN ROSENTHAL: We will recess for just five
2 minutes, for the benefit of the reporter. We are going to make
3 a concerted endeavor to finish this issue this evening if we can
4 do it in the framework of 6:30 or so. We will take just five
5 minutes.

6 (Brief recess.)

7 CHAIRMAN ROSENTHAL: If we can resume seats, please.

8 EXAMINATION BY THE BOARD

9 BY MR. FARRAR:

10 Q I have got a few questions here again in no particu-
11 lar order of importance.

12 I had been looking for Dr. Moeller's statement, which
13 I can't seem to find.

14 Let me ask the same questions I asked the Vepco panel.

15 Are any of you -- and I suppose it would be princi-
16 pally Dr. Heller -- do you know who Dr. Moeller is?

17 A (Witness Heller) I have seen the name on a number
18 of documents included with questions from the Intervenor, yes,
19 sir. I am not personally acquainted with him.

20 Q You're not aware of his standing in the professional
21 community?

22 A No, sir, I am not.

23 Q Anybody else?

24 A (Witness Dromerick) No, I am not.

25 Q Do any of you have any comments you would like to

1 make on the statements or assertions that he has in his limited
2 appearance statement?

3 BY CHAIRMAN ROSENTHAL:

4 Q Have you read the statement?

5 A (Witness Heller) I have read the statement. I don't
6 have any particular comments on it, no, sir.

7 BY MR. FARRAR:

8 Q He does say that the analyses, for example, that Veeco
9 relies on are shockingly narrow, rigid, and incomplete, and so
10 forth. I would take it that if you disagreed with that, you
11 might have a comment. You know, he's made these statements,
12 and somebody ought to say whether they agree with him or if
13 they disagree with him, why it is that he's wrong.

14 A I could comment on that, that particular phraseology
15 here. We have had our consultants look at the work that's been
16 done. We've looked at it rather carefully and talked it over
17 with a number of people, and we feel that, at least at present,
18 that the work in the pump house and the dike area is well
19 documented and is supportable, and certainly it comes very close
20 to top-quality work in any kind of installation of this type.

21 So, I would not agree that it has been --

22 Q Whatever those words mean.

23 A Whatever those words mean to him. I disagree with
24 that general picture.

25 Q Dr. Heller, as long as I am talking to you, there

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1 was some question of you that dealt with the fact that the 75
2 percent limit in the tech spec, depending on how you look at
3 the facts, may or may not have been exceeded during the very
4 time you're talking about putting the tech spec into effect.

5 I am concerned about the system, particularly as it
6 affected or might have affected the licensing board at that time.
7 If I was a licensing board member in an operating license hear-
8 ing and one of the issues in front of me was pump house settle-
9 ment and people were talking about a tech spec and a 75 percent
10 limit and I wrote a decision saying everything was fine, I might
11 be upset if later on I learned that during that very time the
12 facts were that they were at 77 percent of the limit or, let's
13 make it even worse, that I had awarded them an operating
14 license when they were at 102 percent of the limit, and maybe
15 they'd report that to you in 60 days and so forth and so on.

16 But I might be upset as a licensing board and as an
17 outsider, a plain old ordinary member of the public. I might
18 wonder what kind of operation is being run at the Commission
19 when that kind of thing -- you know, you can talk about one
20 thing, putting it on evidence in a hearing, and meanwhile no one
21 is bothering to check to see what the facts are as they're
22 developing.

23 Can you help me with that? I am concerned. We've
24 had a number of decisions that we've written about the need to
25 keep licensing boards informed. And maybe the answer is, you

1 know, you people didn't know about it, Vepco knew about it.
2 Somewhere something fell through the cracks that doesn't make
3 the system look like it was functioning any too well.

4 A. (Witness Dromerick) To the best of my knowledge,
5 pump house settlement was not a contention in the operating
6 license.

7 Q The licensing board ended up writing something about
8 it in its opinion; whether they raised it themselves or the
9 intervenors did, I can't tell.

10 MR. CHRISTMAN: Mr. Farrar, I can address it, very
11 shallowly, from what I remember of it. Virtually every issue
12 that could be thought of by the intervenor was examined in that
13 proceeding, the issue was essentially: Has anything that has
14 happened in the past reflected badly on Vepco's commitment and
15 technical qualifications? There was a considerable amount of
16 cross-examination on the pump house settlement.

17 We had Mr. C. M. Robinson, Jr., as we said earlier
18 today, who is responsible for that issue, testify for several
19 pages in the transcript on pump house settlement. That's per-
20 haps in addition to the issue we talked about earlier, which was
21 the pipe stress analysis and the disclosure matter which was
22 also cross-examined in a different part of the transcript.

23 BY MR. FARRAR:

24 Q I guess Mr. Dromerick was less a question than I
25 tried to put it in terms of a question, and I am not sure it

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1 came out that way. But it's a concern I have, and we can't let
2 things happen like that. I have asked a lot of people a lot
3 of questions these two days, and I can't really point the finger
4 at anybody and say, you know, here's where the responsibility
5 was; it just seems to fall through the cracks.

6 A (Witness Dromerick) I think, as I responded to
7 Mr. Foster, Mr. Farrar, that when we write these technical
8 specifications, we come up with a number where we feel that the
9 safety of the public will not be affected, that with that num-
10 ber and the applicant is obligated to reported to us, that we
11 feel that is sufficient to protect the health and safety of the
12 public. That's why the reporting number came up, and it was 75
13 percent.

14 A (Witness Heller) May I comment, before you leave
15 that? For Unit 1, anyway, the ACRS followed this settlement
16 issue quite carefully. They convened at least one special com-
17 mittee and drew from the help of their consultants. I think
18 they had satisfied themselves that the issue had been properly
19 treated, and perhaps that is why it did not appear in the
20 licensing hearings, at least in a detailed context.

21 Q Of course, the problem is they didn't have all the
22 information, either.

23 DR. BUICK: I might say, I have gone through that
24 transcript, and that's the most confused hearing I have heard
25 in a long while. But they did have their consultants there.

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1 They spent a considerable amount of time just on miscellaneous
2 items that had nothing to do with anything. But I know they
3 had a hearing.

4 BY MR. FARRAR:

5 Q One quick question. I heard about the 20-penny nails.
6 That's not what these -- I keep forgetting the initials -- the
7 -- I take it that's not what they're measuring off of for this
8 Class II?

9 A (Witness Lenahan) Let me clarify this. They are
10 equivalent to about 20-penny nails. They mention measuring some
11 of them, the majority of the points in that main plant area,
12 the main unit area, consists of this type of point. These are
13 the ones that they're talking about were damaged. The balance
14 are Category I structures, the ones in the pump house, service
15 water pump house, are brass monuments, which are grounded into
16 the floors. There is very low possibility of them being
17 damaged.

18 Q Wouldn't that be the acceptable professional way to
19 go about doing things?

20 A Well, not exactly the same system. I believe
21 they're still evaluating a way of coming up with a little bet-
22 ter system to replace some of those 20-penny nails. They're up
23 on the walls of buildings in some cases. In other words, the
24 monuments are grounded into the floor; the brass monuments are
25 grounded into the floor of the pump house.

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1 Q But even the things on the walls of the buildings,
2 from what I have heard is, that the Stone & Webster people, you
3 know, they do a very rough kind of surveying; these other guys
4 are doing, you know, a real professional job. But I can't see
5 how you can be so excited about their accuracy if what they're
6 looking at is 20-penny nails, or the equivalent.

7 A Where they're driven into the side of the building,
8 it takes quite some force to bend them.

9 Q They're all the way in?

10 A They're in maybe an inch and a half, sticking out.
11 They're in a pretty good distance. I don't believe that you
12 could just take your hand and bend them. I think you have to
13 purposely hit them with a hammer. That's apparently what hap-
14 pened. You hit them with a hammer or drop something on them.

15 Q It just seems to me that they ought to have been
16 embedded in some ways.

17 A I have discussed this with them, and as far as I
18 know, I discussed it during my last inspection, which was early
19 this month.

20 BY DR. BUCK:

21 Q While we're on that, might I ask a question. What
22 about the markers on the four pipes.

23 A There are points that are inscribed into the pipe.

24 Q How did the surveyors see these?

25 A There is no problem. When you take the manhole

1 cover off, they're not actually inscribed; they're Magic Marker
2 marks which they have to keep --

3 Q But how are they getting a reference to those things?
4 How do they proceed to get a reference for another point?

5 A They have to run a series of levels, actually run
6 the level on down the manhole. They take their instrument down
7 into this service water pipe enclosure, and they set their
8 instrument up down there, and they measure it and take them down.
9 They actually measure down. They run a line of levels down into
10 the enclosure and measure it and then go back out to the first
11 point. It's a very difficult measurement.

12 Q If you get any accuracy within a foot of that --
13 I am exaggerating, but the accuracy on that sort of thing is
14 terrible.

15 A I don't think it's terrible, because I have checked
16 a couple of them, and they are closing within their required --
17 they have to close the survey. They go from a point up on the
18 ground, they go down into the opening, and then they go back up
19 again. And the measurement going from, shall we say, point A
20 to point B, point B would be down in the enclosure. The dif-
21 ference between going down and coming back up has to be very
22 close.

23 Q You've got one manhole here. You've got me con-
24 fused here.

25 A It's a manhole about three foot in diameter.

1 Q It's about three foot in diameter, but it's off to
2 the side where the markers are.

3 A It's removed about --

4 Q A different distance from each marker?

5 A I guess about 10 feet.

6 Q All right. Now, how do you proceed to get a line
7 of sight or a line of something from the marker up across and
8 out the manhole?

9 A I have never seen them do it, but from discussions
10 with the surveyors, they actually set the instrument up down in
11 the manhole itself. In other words, they can take -- they
12 establish a point down in the manhole within the enclosure.
13 They can do that from up on the ground surface.

14 Q This is an unpaved ground surface?

15 A Well, they're not using an unpaved point. They're
16 using one of the settlement points, one of the other settlement
17 monuments on the dam.

18 Q Which is inside the enclosure?

19 A No. It's a settlement point on the crest of the dam
20 which is very near the service water pump house.

21 Q How do they get out of the enclosure, first?

22 A When they go down in the enclosure, they go down to
23 a point right near the manhole. These pumps run right by the
24 manhole. You step down onto one of the pipes, and they establish
25 a point on one of the tie rods, on one of the four tie rods. I

1 believe that's where you establish it, a temporary bench point
2 or a turning point. That gives them a very accurate measurement.
3 They haven't had any problems in closing on that.

4 Q All right. This is on -- if I look at figure 8, this
5 is on somewhere up on top of the pipe. The pipe bends and you
6 look at section B(b) of figure 8, the pipe bends, goes down.
7 They're measuring something on that length; is that right?

8 A Yes, on section B(b).

9 Q They're probably somewhere up on top of that pipe.

10 A Yes, they're on the top of that pipe.

11 Q But the left of the flanges for the expansion joint.

12 A Yes.

13 Q All right. Now, to measure the differential deflec-
14 tion, if you want to go on and horse around doing that, can't
15 they measure, establish some sort of equipment on top of those
16 things so as to measure across the top of the expansion joint
17 over to the pipe that comes out of the wall so that you get
18 accurate measurements on the differential joint, differential
19 movement?

20 A Are you referring to going from one side to the
21 other on the pipe of the expansion joint?

22 Q Yes.

23 A In other words, instead of trying to go --

24 Q No, I am talking about making a differential
25 measure.

1 A. Between the north side and the south side to the
2 expansion joint?

3 Q. Yes.

4 A. I think it's probably more meaningful what they're
5 doing.

6 Q. You mean it's more meaningful for somebody, some
7 surveyor type measurement, in which it has to go up through a
8 manhole and relate to a marker on top of the dam is more mean-
9 ingful to give that measurement three weeks later than to go
10 down and get a measurement in an hour right down in the pipe
11 itself?

12 A. (Witness Kiessel) Dr. Buck, may I interject for a
13 moment? I agree with you that were that the only measurement
14 that we wanted, that that would perhaps be the simplest way of
15 doing it.

16 Q. You need settlement, too.

17 A. We also need to know the settlement of the pipe as
18 it comes, or we need to know the elevation of the pipe as it
19 comes from the ground there, also. So, we would still have to
20 make the run in to determine that elevation.

21 Q. Why do you need the elevation of the pipe as it
22 comes in from the ground?

23 A. Because we're also worried about the stresses within
24 the buried pipe, sir. And one of the tech spec limits is the
25 amount of settlement of that and the pipe.

1 Q If you measure an accurate differential, then can't
2 you measure the level of the pipe inside relative to one of
3 your markers inside the building?

4 A Yes, sir, assuming that we also know the difference
5 between the pipe and that it is going through the wall hori-
6 zontally or the angle at which it goes through the wall.

7 Q But you don't find that. It just seems to me that
8 one of our worries here is having surveyors who are told to go
9 out and do a job, they don't know the full meaning of this
10 thing, they don't get the actual differential measurement, they
11 get a reading on their instruments. They don't know the actual
12 height; they just get a reading. And it appears that even at
13 the best of times, some two weeks later, Vepco and the staff
14 get a report as to what this is. And when that report comes
15 in, the way the tech spec is now written, if it's over a cer-
16 tain limit by a matter of thousandths, Vepco shuts the plant
17 down, by definition, on this.

18 Now, it seems to me that we're, one, using in a
19 sense, a lower level of measurement, and a long time period,
20 when we could go in here and get a direct measurement, at least
21 on the differential. If the differential changes, you should
22 be able to know about that in a hurry.

23 A (Witness Lenahan) May I comment, one thing about
24 the surveying. It's the standard practice in all major types
25 of structures to do surveying to monitor performance. It's

1 done continually on dams and bridges.

2 Q I know it is. I know it is. It's a perfectly
3 standard thing. But they're not dealing there with the differ-
4 ential on an expansion joint, which, if it changes too much,
5 it shuts the plant down or becomes dangerous.

6 The thing -- the two things don't relate, in my
7 mind, to have a measurement taken by a surveyor reached two,
8 three, or four weeks later, and you say, "Oh, my gosh." You do
9 it in six hours. You go to hot shutdown at six hours and cold
10 shutdown is more time. So, bang, bang, bang, you force the
11 company to do that when you've allowed measurements to be taken
12 that you don't get a report for two or three weeks. It just
13 doesn't make sense.

14 A The only thing I would say about one area is they
15 are required to perform an engineering study when they reach 75
16 percent of the limit, and this is reviewed by the staff.

17 Q I know. And the staff does an evaluation.

18 A Well, the last time they did this for the May 31,
19 1978 report, they increased the frequency of monitoring. This
20 was part --

21 Q My point isn't in increasing the frequency of the
22 monitoring; it's that you can do this darned thing right down
23 in the pump house in a half-an-hour measurement and do it once
24 a week or once a month with very little labor. Take your
25 surveys once every six months if you want to.

1 A (Witness Heller) I think your comment with respect
2 to the flexible joint is certainly appropriate. But we're
3 looking here at a very large program that covers all Category I
4 structures. Many of these types are buried. Many of the
5 motions of those pipes have to be interpolated from measurements
6 above the ground.

7 Q Do they involve the critical item of an expansion
8 joint?

9 A They involve settlements that are certainly much less
10 than that.

11 Q I am asking a question: Do they involve the criti-
12 cal item of an expansion joint?

13 A No, they do not, sir.

14 Q Do they involve a very distinct finite measurement
15 which might have some determination on safety?

16 A Yes, sir.

17 Q A total settlement, not a differential?

18 A A differential, sir.

19 Q Where?

20 A These items are given in Table 3.

21 Q Can you read one or two of them and tell me what
22 items are critical and how critical they are with regard to
23 time?

24 A Okay. The first part on the page I have here is
25 settlement point 228, decontamination building, compared to

1 settlement point 50; the structure that's involved is a pipe
2 tunnel. The allowable differential settlement is .06 feet.
3 And I could go down the list as far as you'd like.

4 Q How close are they to that at the present moment,
5 and what would happen if you exceeded them, in the way of immedi-
6 ate danger?

7 A What would happen if they exceeded it is that that
8 pipe would be in operation outside of the boiler and pressure
9 code limits that have been established for these pipes; in
10 other words, the operating specifications.

11 Q All right. Fine. Now, what would happen if the pipe
12 would crack?

13 A I can't tell you the answer to that, sir.

14 Q As far as the public safety is concerned.

15 A I don't know.

16 Q Thank you.

17 I make a very strong suggestion to the staff, and I
18 do it on my own. I don't know what my colleagues are thinking
19 about here. But it just seems to me that this combination of
20 measurements is just outside of the scientific approach.

21 Go ahead, Mike.

22 BY MR. FARRAR:

23 Q Let me change the subject slightly. Thank you for
24 the follow-up.

25 Mr. Lenahan, I guess this one comes to you, and I am

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1 afraid I have to give it a little bit of a preface.

2 We have all sat here for a number of years writing
3 all these opinions and deciding what's safe and what isn't safe.
4 And speaking for myself and perhaps for my colleagues -- perhaps
5 not; I haven't cleared these remarks with them -- I have always
6 thought that the real key to the situation is you people,
7 inspectors. We can write all the things we want, and we can get
8 all the plans we want. But unless things are done the way
9 they're supposed to be done, we're just writing on sand. There
10 is no sense to it. I have said this a number of times, in ask-
11 ing questions: We don't have enough inspectors to go around;
12 I wish we had more.

13 CHAIRMAN ROSENTHAL: Well, they're getting some more.

14 BY MR. FARRAR:

15 Q. All this is by way of telling you the dependence we
16 have on you and the dependence I have on you in asking the next
17 question: Without restating a great many years of history,
18 this particular company has had problems in the past with
19 reporting requirements. We've touched today on two or three
20 items dealing with reporting requirements on the very subject
21 we're talking about now, whether it was the last question to you
22 about the recommendation of several years ago, the problems with
23 the July '77 data, and whether that, you know, how that got
24 in its place, and my reading of the report that accompanied
25 Mr. Stallings' letter, and the tone that I saw, that was rather

1 than just a report -- I was trying to say it wasn't really their
2 fault.

3 You've inspected them. You've watched them. Are you
4 really satisfied yourself that to the extent that the technical
5 specification or whatever it comes out that we're debating here,
6 to the extent that that relies on their prompt reporting, their
7 prompt taking action, as you heard Mr. Cartwright say you would
8 do today, do you personally have confidence that we can count
9 on them to live up to those responsibilities?

10 A (Witness Lenahan) I can only comment about the set-
11 tlement.

12 Q I am asking you only from the experience you per-
13 sonally have had.

14 A Another thing I would like to say, I have only been
15 with I&E for a year; I don't have a great deal of experience.
16 I think, with the emphasis that we've put on this in the last
17 few months on this one particular item and the emphasis it's
18 been given, I don't think I would have too much problem in them
19 reporting it promptly.

20 I think they realize the seriousness of the issue,
21 and I would say that they're very prompt in the past year or so.
22 The documents I have reviewed concerning this, they're very
23 concerned about telling us everything and being very open with
24 us. When I say "us," I mean NRC. That's my interpretation.
25 I am not giving that as NRC's official position; that's just my
personal interpretation.

1 Anybody else on the panel? I am singling out
2 Mr. Lenahan, of course, because of his affiliation with I&E.
3 But the rest of you may have had -- certainly have had --
4 dealings with the company in a different respect. Are there any
5 of you who, because of the past, lack confidence in their up-
6 holding their end of the bargain?

7 A (Witness Dromerick) No, I do not.

8 Q Could I have a negative from everybody, if that's
9 the case?

10 A (Witness Kiessel) I haven't had that much dealing
11 with them, sir.

12 Q Dr. Heller?

13 A (Witness Heller) Well, we did swear to tell the whole
14 truth; didn't we?

15 Q Yes.

16 A I have been with NRC now about five years. I can't
17 say that I have reviewed a lot of plants that Vepco has been
18 involved in. I have reviewed a number of plants that Stone &
19 Webster has been involved in. And as you are aware, a lot of
20 the plants have been different grades from time to time, from
21 A, B, and C, with respect to all sorts of things. Stone &
22 Webster does not get a flunking grade. Neither does Stone &
23 Webster get an A. I don't think I can say much more than that
24 without going into the specifics of each item.

25 Q Okay. Thank you.

1 Mr. Wermeil, your testimony, can you -- I read the
2 reasons you gave for making sure that we understood your testi-
3 mony in the proper context. Did you answer Mr. Foster or some-
4 body else earlier today, do you recall, when I woke up to the
5 answer and hadn't heard the question. Were you saying that the
6 rupture or break of a service water header has, in fact, not in
7 the context of this particular proceeding, but has in the past,
8 in fact, been analyzed for its safety consequences as a design
9 basis accident?

10 A (Witness Wermeil) That's correct.

11 Q It passed muster?

12 A Yes.

13 Q If that's true, why were you unwilling -- okay. Let
14 me back up. Their testimony in this particular proceeding was
15 in terms of the pipe breaking after they'd been on notice, as
16 it were, and, you know, gone to mode 5 or whatever they call it.
17 You took particular pains to point out that that's all you were
18 talking about. Didn't you want to rely on what your colleagues
19 had done a year or two or five years ago? Enlighten me on that.

20 A Yes, I can rely on that part of it. With respect to
21 just a single failure. If the testimony includes a postulation
22 of all four joint failures, that is not something that we had
23 previously looked at.

24 Q That has not been analyzed in this proceeding or
25 previously. But the single failure --

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1 A It has been analyzed in this proceeding with respect
2 to being in mode 5 cold shutdown.

3 Q But not with it operating full power.

4 A No.

5 Q But the single failure has been analyzed at full
6 power, although not by you people right now.

7 A Well, it's been done, and I verify that it had been
8 done, yes.

9 Q Okay. So, in effect, you recall I asked Mr. Bradbury
10 why this accident was more incredible than some of the others,
11 loss-of-coolant accident that we worry about. In effect, it's
12 not any more incredible. In other words, as far as the design
13 basis is concerned, it's been analyzed the same as other pipe
14 ruptures.

15 A That's right. The single failure. That's correct.

16 MR. FARRAR: Thank you.

17 CHAIRMAN ROSENTHAL: All right.

18 Mr. McGurren, do you have some redirect?

19 MR. MC GURREN: Mr. Swanson would like to say some-
20 thing maybe in response to Mr. Farrar's expression of concern.

21 MR. SWANSON: It's really a question, since the staff
22 really didn't get a chance to respond to your question regarding
23 the impact or effect on the Board of possibly finding out at
24 some later time that it didn't have relevant information. Was
25 your concern resolved by the statement by Mr. Christman? I am

1 wondering if there is need for a further statement by the staff.

2 CHAIRMAN ROSENTHAL: I gather that the facts are as
3 they were stated with respect to the degree to which the pump
4 house settlement matter was considered in the operating license
5 procedure before the licensing board. I suppose the facts
6 speak for themselves.

7 MR. SWANSON: That's an extensive record. I raise
8 this point because it's just a matter of very grave concern,
9 obviously. If there is a feeling that perhaps maybe there's a
10 deficiency in the record --

11 MR. FARRAR: Not a deficiency in the record. I take
12 it Mr. Christman didn't have, at the time of the hearing, he
13 didn't have the figures in his back pocket, since Mr. McIver
14 didn't have them. So, I certainly wasn't pointing a finger.

15 CHAIRMAN ROSENTHAL: I don't think there has been any
16 suggestion of willful concealment of information, if that's
17 the concern you have, Mr. Swanson, that there was some implica-
18 tion of that.

19 MR. SWANSON: It would go to a much lower degree,
20 including negligence, yes.

21 MR. FARRAR: Somehow, you know, this data existed.
22 Mr. McIver has explained why it didn't happen to fall into the
23 right hands. There is also, you know, the position that it
24 wasn't the official survey, and I was just trying, even with
25 all those excuses or justifications or rationalizations, that a

1 licensing board might have been troubled. But, I think, you
2 know, there is no need for any further development of it.

3 CHAIRMAN ROSENTHAL: Mr. McGurren, I gather you have
4 some questions.

5 MR. MC GURREN: I have one question, Mr. Chairman.

6 REDIRECT EXAMINATION

7 BY MR. MC GURREN:

8 Q This question concerns the staff's justification for
9 the differential motion limit. There was some questioning by
10 Dr. Buck of Dr. Heller regarding the value of .03 foot, and I
11 think it finished on the note where Dr. Heller said that, "Yes,
12 you're correct, Dr. Buck, I pulled the figure out of the air."

13 To me, I don't know if this has some technical con-
14 notation, but just so that we're clear and the record is clear,
15 I would like to ask Dr. Heller now: What do you mean when you
16 agree with Dr. Buck that this figure .03 was pulled out of the
17 air?

18 A (Witness Heller) I interpreted Dr. Buck's comments
19 to be a figure of speech, and not a speech of quantitative
20 evaluation.

21 The way that we determined the .03 feet is explained
22 in our testimony, and I consider that we were in bantering
23 terminology, and not quantitative information. That was my
24 interpretation.

25 Q But you did do a calculation?

1 A Yes, sir.

2 Q And do you believe, as you state in your testimony
3 on page 37, that this was a conservatively estimated figure?

4 A Yes, I do.

5 MR. MC GURREN: Thank you. That's all I have,
6 Mr. Chairman.

7 CHAIRMAN ROSENTHAL: Is there any recross-examination,
8 Mr. Christman?

9 MR. CHRISTMAN: No questions.

10 CHAIRMAN ROSENTHAL: Mr. Foster?

11 MR. FOSTER: No, sir.

12 CHAIRMAN ROSENTHAL: I take it, in that circumstance,
13 that we have brought to a close the portion of this hearing
14 which is devoted to the pump house settlement issue.

15 On behalf of the Board, I wish to express apprecia-
16 tion to both the applicant's panel and the staff's panel for
17 their endurance and forbearance and whatever.

18 We will, on that note, recess for the night. We
19 resume at 9:00 tomorrow morning, at which point we will start
20 with the applicant's panel on the turbine missile issue.

21 MR. FOSTER: Mr. Chairman, I think this can probably
22 be done off the record, but since Intervenor Arnold or I, on
23 behalf of Intervenor Arnold, will not be participating in the
24 turbine missile and therefore will not be here tomorrow, it's
25 necessary to find out what the briefing schedule will be on this

1 issue, and on the little matter of the transcript.

2 CHAIRMAN ROSENTHAL: I think on that we can go off
3 the record, and we'll discuss that with counsel, and there is
4 no necessity to hold up the other individuals.

5 MR. MC GURREN: Mr. Chairman, this panel is excused;
6 is that correct?

7 CHAIRMAN ROSENTHAL: This panel is excused, as well
8 as the Vepco panel.

9 (Witnesses excused.)

10 DR. BUCK: Thank you very much, gentlemen.

11 (Whereupon, at 6:00 p.m., the hearing was adjourned,
12 to reconvene at 9:00 a.m., on Wednesday, June 20, 1979.)

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