

UNITED STATES NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:

DOCKET NO: 50-322-1 (OL)

LONG ISLAND LIGHTING COMPANY

(Shoreham Nuclear Power Station)

LOCATION: HAUPPAUGE, NEW YORK

PAGES: 25981 - 26174

DATE: THURSDAY, NOVEMBER 8, 1984

TR-01

Additional 2 copies to ASLBP, E/W-439

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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In the matter of: :

LONG ISLAND LIGHTING COMPANY : Docket No. 50-322-1 (OL)
(Shoreham Nuclear Power Station):

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State Office Building,
Veterans Memorial Highway,
Hauppauge, New York.

Thursday, November 8, 1974.

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

BEFORE:

JUDGE LAWRENCE BRENNER, Chairman,
Atomic Safety and Licensing Board.

JUDGE PETER A. MORRIS, Member,
Atomic Safety and Licensing Board.

JUDGE GEORGE A. FERGUSON, Member,
Atomic Safety and Licensing Board.

(Not present.)

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APPEARANCES:

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C O N T E N T S

1			
2	WITNESSES		CROSS
3			
4	Spencer H. Bush)		
5	Adam J. Henriksen)		
6	Carl H. Berlinger)		
7			
8	By Mr. Ellis		25987
9	(Continued)		
10	By Mr. Dynner		26045
11			
12	EXHIBITS:	Id.	Evd.
13	Suffolk County Diesel Exhibit 20:	26157	26164
14	SNPS-1 FSAR, Pg 8.3-5 (Rev 26, April 1982)		
15			
16			
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18			
19	Morning recess - 26036		
20	Luncheon recess - 26075		
21	Afternoon recess - 26125		
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P R O C E E D I N G S

JUDGE BRENNER: Good morning.

Whereupon,

SPENCER H. BUSH,

ADAM J. HENRIKSEN,

and

CARL H. BERLINGER

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

JUDGE BRENNER: Mr. Ellis, you can continue, and
hopefully conclude your cross-examination.

MR. ELLIS: Yes, Judge Brenner. I have one
preliminary matter, if I may.

Yesterday morning I guess we got the County's --
I think it is denominated "supplemental" testimony.

JUDGE BRENNER: "Rebuttal" testimony.

MR. ELLIS: Rebuttal testimony. And I'm not sure
that-- We certainly have not an adequate opportunity to
review that. And I believe I recall the Board saying--
Well, first let me ask.

The Board has not yet ruled on the admissibility
of all that.

JUDGE BRENNER: That's correct, we have not.

MR. ELLIS: So the parties still have an
opportunity to address to the Board motions to strike

WRBeb 1 portions of it for one or another reason.

2 JUDGE BRENNER: Correct.

3 When were you planning on doing this if you're
4 going to do it?

5 MR. ELLIS: I would think that we could do it
6 certainly by Monday.

7 JUDGE BRENNER: Tuesday.

8 MR. ELLIS: Monday or Tuesday, yes, sir.

9 JUDGE BRENNER: That will be fine. Friday would
10 be better but Tuesday will be acceptable.

11 MR. ELLIS: All right, sir. Thank you. We will
12 aim for something earlier than Tuesday if we can, your
13 Honor.

14 JUDGE BRENNER: You can do it orally if you
15 want. It's up to you.

16 MR. ELLIS: All right, sir.

17 CROSS-EXAMINATION (Continued)

18 BY MR. ELLIS:

19 Q Good morning, gentlemen.

20 Dr. Bush and Dr. Berlinger, on page 1 of the
21 supplemental testimony, in the final two sentences there
22 you refer to metallographic evidence which confirms that the
23 cracks formed during initial cooling of the casting.

24 You also refer to the absence of evidence of
25 fatigue growth at the crack tip.

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1 Is that metallographic evidence that you're
2 referring to there related to the old 103 block?

3 A (Witness Bush) Yes, it is.

4 Q Given that evidence and given the markedly
5 inferior physical properties of the 103 block, or the
6 superior qualities of the 101, 102 and new 103 as compared
7 to the old 103, doesn't that evidence suggest that no crack
8 growth would be predicted in the 101, 102 and new 103 in the
9 cam gallery area?

10 A I'm assuming you're talking about during
11 operation. Is that correct?

12 Q Yes, sir.

13 A I think that's a good possibility. In fact, the
14 only cracks I think I would worry about particularly in the
15 absence of sufficient data would be those that are extremely
16 deep because I might be concerned about bending moments on
17 the rear face, in other words, the stress distribution.

18 But I would say the cracks that represent 50
19 percent of a thickness or less I would tend to believe
20 would, under most circumstances, be stable.

21 MR. DYNNER: I'm sorry, I didn't hear the last
22 part of the answer.

23 WITNESS BUSH: Under most circumstances would be
24 stable.

25 Obviously one could postulate some kind of a

WRBeb 1 transient or something where you would expect a crack to
2 grow, but under what I would call normal operating
3 conditions, I wouldn't anticipate this to be the case.

4 BY MR. ELLIS:

5 Q Dr. Berlinger, do you agree that that evidence,
6 as far as you're concerned, would predict that no crack
7 growth would occur in the 101, 102 and new 103 during
8 operation?

9 A (Witness Berlinger) Yes, Mr. Ellis, I think that
10 that's a very fair inference to draw from the data.

11 I have a question. On a question such as this if
12 it was not directed to me, am I expected to answer if I
13 agree with Dr. Bush's answer?

14 JUDGE BRENNER: No, not if you agree. But you
15 know there are in-between grounds. You could agree but
16 nevertheless have something to add.

17 WITNESS BERLINGER: I'll take that into
18 consideration. Thank you.

19 BY MR. ELLIS:

20 Q Also, Dr. Berlinger, any time you want to say
21 something, don't hesitate to interrupt me and I'll be glad
22 to give you that opportunity. Just because I don't address
23 a question to you, don't hesitate to ask to be heard on it.

24 A (Witness Berlinger) Thank you.

25 Q While we are on that subject, gentlemen, I guess

WRBeb 1 it would be fair to say, wouldn't it, that another factor to
2 take into account that would assist one in predicting no
3 crack growth in the cam gallery area for the 101, 102 and
4 new 103 is the fact that the old 103 block had over 1,000
5 hours of operation on it, a substantial portion of which at
6 full load and above. Is that correct?

7 A (Witness Bush) That certainly is a factor that I
8 took into consideration because if I don't see much evidence
9 of growth in the form of beachmarks or anything else, or say
10 a change of oxide characteristics at the crack tip in that
11 block where I know the ultimates are essentially about half
12 of the other one, given the same loads I would say that
13 would indicate a definite margin against fatigue crack
14 growth.

15 Q And in this instance, as you indicated in your
16 testimony, you saw no evidence of crack growth. Is that
17 correct?

18 A Obviously I am depending upon the metallographic
19 results of Failure Analysis. The inference is based on an
20 examination of those, yes.

21 Q Dr. Bush, I take it you are familiar with the
22 entire ASME code?

23 A The answer to that is no. That represents
24 probably eight to ten thousand pages and under no
25 circumstances would I be considered.... I'm aware of parts

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1 of Section 3 that I use. I am not a designer so I eschew
2 the portion having to do with design, except I lean on other
3 people.

4 I am pretty familiar with Section 11, and since I
5 am the chairman of the state board, I have to be familiar
6 with -- of boiler rules, I have to be familiar with Section
7 8 and Section 1, to a degree.

8 But if you want to ask me about something like
9 Section 10 and Section 7, you're going to draw a blank.

10 Q No, I understand.

11 JUDGE BRENNER: Dr. Bush, I want to make a
12 suggestion. I think you could keep your answers shorter and
13 more directed to the questions.

14 WITNESS BUSH: I'll do that.

15 JUDGE BRENNER: In other words you answered that
16 question pretty much in the first sentence, and what you
17 said after that was not really much of a substantive
18 explanation of the answer.

19 Mr. Ellis, go ahead.

20 MR. ELLIS: Thank you, Judge Brenner.

21 BY MR. ELLIS:

22 Q As I indicated to your Counsel, it is Section 11
23 that I want to focus on for a minute.

24 You are familiar generally with Section 11?

25 A (Witness Bush) Yes, I'm a charter member of

WRBeb 1 Section 11.

2 Q Section 11, is that applicable to the evaluation,
3 among other things, of indications found once components are
4 in service?

5 A That's the only code that is used for that
6 purpose. That's correct.

7 Q Like ASME 3, Section 3 as you have testified,
8 though, Section 11 is not applicable to diesel generators
9 either, is it?

10 A That's correct.

11 Q With respect to the components for which it is
12 applicable, is it true that Section 11, Appendix A,
13 describes a fracture mechanics analysis of any indications
14 or crack progression that is found?

15 A The linear elastic fracture mechanics analysis,
16 yes.

17 Q And does it also provide that if the analysis
18 predicts sufficiently slow crack growth so that the crack
19 will not extend to a size of concern by the end of the
20 running period that the component is acceptable for nuclear
21 service without monitoring or repair or removal of the
22 crack?

23 A No. You must monitor. That is a requirement.
24 You do not have to remove; you do not have to repair if the
25 evaluation so indicates.

WRBeb 1 Q Is the monitoring specified?

2 A The monitoring is specified in another section of
3 Section 11 that pertains specifically to what must be done
4 with regard to volumetric examination, for instance. In
5 almost every instance the NRC applies supplemental
6 requirements.

7 Q Would Section 11 require any sort of monitoring
8 if the analyses predicted no crack growth over a period of
9 18 months?

10 A Yes.

11 Q So whether or not there is any crack growth
12 predicted, it is your testimony that Section 11 would
13 require monitoring?

14 MR. DYNNER: Asked and answered.

15 JUDGE BRENNER: Mr. Ellis, it sounds like it was
16 to me, too. Unless you can point to something new, I will
17 sustain the objection.

18 BY MR. ELLIS:

19 Q Can you cite to me the provision in Section 11
20 that provides that monitoring is required even if no crack
21 growth is predicted?

22 A (Witness Bush) It's a combination of Section 11
23 and the code. If I use an example I can cite it better.

24 There are a couple of reactor vessels that have
25 known flaws in them. There is a requirement that these be

WRBeb 1 monitored and generally the time interval is shorter.
2 Normally you would not look at the same location more than
3 once in ten years, or even once in twenty years. In the
4 case of a known flaw, any time that you go in for a
5 re-examination usually you look at that.

6 Now there are criteria that apply that say
7 effectively if you can show after, say, three successive
8 examinations that there is no change, then you relax and
9 return to the original schedule. That's the closest thing
10 that comes to it.

11 Q So the monitoring in this instance that might be
12 indicated or required if the code were applicable would be
13 to examine the area or inspect the area perhaps at the first
14 refueling outage. Is that correct?

15 A That's correct. I'm not using it in the context
16 of continuous monitoring or anything of that nature. It is
17 simply that the time interval may be changed, and the fact
18 that the same location is re-examined. That's all.

19 Q Dr. Berlinger, is it the Staff's position then
20 that re-inspection of the cam gallery area at the first
21 refueling outage is the monitoring that the Staff would
22 require in this instance relating to cam galleries?

23 A (Witness Berlinger) Mr. Ellis, yes, the Staff
24 would require that the cam gallery area be inspected at the
25 first refueling outage.

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1 But in addition, within our written testimony we
2 have stated our belief that wire gages should be installed
3 in the cam gallery area on these cracks in order to monitor
4 for any crack opening or crack growth which might occur
5 during operation of these engines in this, say, first fuel
6 cycle.

7 To clarify, we would expect that the existing
8 cracks in the cam gallery area would be so instrumented.

9 Q Is this going to be a requirement for cam
10 galleries of all TDI generators, diesel generators, or is it
11 just a LILCO-specific requirement?

12 MR. DYNNER: Objection. Irrelevant.

13 JUDGE BRENNER: No. Overruled.

14 WITNESS BERLINGER: It will be a requirement on
15 all TDI engines which exhibit cracks. Obviously we are not
16 going to require instrumentation on those engines that have
17 no visible sign of a crack in the cam gallery area.

18 BY MR. ELLIS:

19 Q So in that context then, it would not be the
20 Staff's position that the new 103 block would have to be
21 instrumented?

22 A (Witness Berlinger) I cannot agree with that,
23 with the statement as contained in the question primarily
24 because we would be evaluating the inspection results with
25 regard to existing cam gallery cracks. And to my

WRBeb 1 recollection I don't believe that a formal inspection report
2 with regard to any indications that have been identified has
3 been submitted for Staff review, not at this juncture.

4 There has been information discussed at this
5 hearing.

6 Q Dr. Berlinger, in light of the evidence of no
7 crack growth and the prediction that there will be no crack
8 growth in the cam gallery area, what is the basis for the
9 requirement of strain gaging of existing cam gallery cracks?

10 A The basis is one of conservatism on the part of
11 the NRC Staff and the belief that it is prudent to monitor
12 them to verify, over a period of time, the accuracy of
13 analyses that have been performed.

14 A (Witness Bush) If I may, I would like to expand
15 on that because I think I wrote those words.

16 We have what I consider a metastable situation
17 here with the weldments. I have rather strong opinions that
18 those weldments didn't represent the appropriate procedures
19 for making such repairs, that they will have -- if, as I
20 strongly suspect, they were made, there would be a very high
21 residual stress field. In fact, I would be quite surprised
22 if some of them didn't crack before they even had a chance
23 to put the paint back on.

24 Because of this situation, it is almost certain
25 that you have an undefined residual stress field that I

WRBeb 1 would anticipate would be up around 20-or-so thousand pounds
2 per square inch, at least, and under those circumstances you
3 have a pretty good chance for pop-in. I don't know if it
4 would be very much, but it is undefined and it seems to me
5 that it would be prudent to put such crack opening gages
6 across these areas.

7 A (Witness Berlinger) Mr. Ellis, I would like to
8 supplement my previous answer to indicate that clearly the
9 101 and 102 blocks we would require wire gage installation,
10 and we would evaluate the 103 indications to determine
11 whether indeed we would need wire gages installed 'n the
12 103, but at this point we haven't made that decision.

13 Q Dr. Bush, on page 5 of your testimony you did
14 conclude, didn't you, that pop-in, abrupt crack growth, was
15 improbable, didn't you?

16 A (Witness Bush) I said "relatively" improbable.
17 I hope it won't occur, and one reason I hope it won't occur
18 is that I believe there is enough cracking to have occurred
19 already to relax the stresses.

20 But quite frankly, if there were some weldments
21 there where there was no evidence of cracking whatsoever, I
22 wouldn't be at all surprised if on unbolting there were
23 cracking.

24 Q And pop-in, as you have defined it, would occur
25 if it occurred at all only if the block was unbolted from

WRBeb 1 the heads. Is that correct?

2 A I think that is when the most logical time would
3 be; that's true.

4 Q Or is that the taking off of the through-bolts to
5 the base and not the--

6 A What I am referring to here obviously is taking
7 the bolts out, removing the compressive loads, and as I
8 remove the compressive loads which may tend to a degree to
9 compensate for the residual tensile stresses, you get an
10 accentuation. Under those circumstances, I would consider
11 pop-in as a possibility.

12 JUDGE BRENNER: Dr. Bush, I don't think that was
13 his question. His question is which bolts are you talking
14 about? What components are being bolted and unbolted?

15 WITNESS BUSH: I am talking about the
16 through-bolts that go through that apply the compressive
17 load in the cam gallery region, or the tie rods. There's a
18 diagram, but I think the diagram is in the sacred
19 literature. It is in a part that I can't refer to.

20 JUDGE BRENNER: Well, what things are bolted
21 together? You can describe it simply.

22 WITNESS BUSH: It's the tie rods that go all the
23 way through that connect to the base, and that's the thing
24 I'm talking about.

25 BY MR. ELLIS:

WRBeb 1 Q I think you used in your answer a bit ago,
2 Dr. Bush, the term metastable. Is that correct? Will you
3 tell me what that means, please, and what you intended by
4 using it?

5 A (Witness Bush) It teeters on the edge. It is
6 ready to go either way. It's a quasi-stable situation.

7 This is a metastable situation. (Demonstrating.)

8 JUDGE BRENNER: Ask another question,
9 Mr. Ellis.

10 MR. ELLIS: I am not going to ask another
11 question about that, Judge Brenner. What I am going to ask
12 about is on the same subject matter.

13 BY MR. ELLIS:

14 Q Dr. Bush, so that I'm clear, however, your
15 recommendation that cam gallery cracks be monitored using
16 wire gages is based on your concern about residual stresses
17 in the weld repairs that could have an effect if the block
18 is unbolted. Is that correct?

19 A (Witness Bush) That is one of the major
20 considerations, yes. I still, as I say, need to look at
21 sufficient data to convince me about the compressive loads
22 because obviously if the compressive loads are not
23 sufficient, then it can be even larger or, in other words,--
24 I don't want to say it that way.

25 It is possible that one could have pop-in even

WRBeb 1 during bolt-up.

2 Q Dr. Bush, with respect to a weld repair that does
3 not go all the way to the bottom of a crack,--

4 A Yes?

5 Q -- wouldn't it be true that residual stresses
6 would be positive or tensile in the weld area but negative
7 or compressive in the area of the crack below the weld
8 repair?

9 A That's right, until the weld cracks -- until the
10 heat-affected zone cracks, and then that's no longer true.

11 Q And once that occurs, both those residual
12 stresses go away. Is that correct?

13 A If you get complete cracking, the answer is yes.
14 The extreme case would be where the whole weld falls out,
15 and that has happened in some instances. I wouldn't expect
16 it.

17 I would expect intermittent cracking. And
18 obviously as this occurs there is a dimensional change, and
19 a change in the stresses along the crack, and particularly
20 at the crack tip. In other words what you're doing is
21 you're essentially opening up the crack by this mechanism.

22 Q Given that the residual stresses from the repair
23 weld would be compressive at the crack tip, wouldn't the
24 pop-in then only occur to the depth of the weld repair?

25 MR. DYNNER: Objection. He is again

WRBeb 1 mischaracterizing--

2 JUDGE BRENNER: Sustained. He did not
3 characterize the testimony correctly in one of the
4 subsidiary clauses.

5 MR. ELLIS: May I have my question read back,
6 please?

7 (Whereupon, the Reporter read from the record
8 as requested.)

9 BY MR. ELLIS:

10 Q Dr. Bush, wouldn't the pop-in that you've
11 referred to occur only to the depth of the weld?

12 A (Witness Bush) Not necessarily. Let me
13 emphasize that I don't consider this one, since it is
14 already relaxed, as a high-probability event. This is a
15 conservative approach to use the gages.

16 But to answer the question, if you actually have
17 a high residual stress field around here-- Furthermore I
18 believe that the evidence indicates that the heat-affected
19 zone contains martensite, and I strongly suspect it is
20 untempered martensite although I confess I haven't seen the
21 photomicrographs that definitively confirm it.

22 I would expect that if cracks generate in the
23 weld that you really have an opening-up effect because of
24 the fact that you have high residual stresses, and the only
25 way -- that would get transferred on down to the crack tip.

WRBeb 1 The most effect might be a very trivial one. You might be
2 talking of mills of movement or no movement at all; I can't
3 tell.

4 But you do have a situation with what I strongly
5 suspect to have very high residual stresses in there because
6 of the way I am almost certain that weld was made.

7 Q Dr. Bush, maybe I misunderstood your earlier
8 testimony. You did agree I think that if a weld repair did
9 not go to the bottom of a crack that the residual stresses
10 in the weld area would be tensile but those in the portion
11 of the crack that was not covered by the weld repair would
12 be compressive. Is that correct?

13 JUDGE BRENNER: Mr. Ellis, we're getting a lot of
14 repeat testimony already this morning, and it is only the
15 first half hour. It was asked and answered.

16 MR. ELLIS: I thought so, too, Judge, and I guess
17 I am just going to have to ask for some indulgence.

18 JUDGE BRENNER: Not this time. I want to make
19 some progress here. We have been at this hearing too long,
20 and one of the reasons is that I've given Counsel too much
21 leeway to reask the same questions. That one was asked and
22 answered a few minutes ago.

23 MR. ELLIS: May I-- Judge,.... It is not
24 uncomplicated for me, and I apologize to the Board that I am
25 not as quick in understanding. I thought it had been asked

WRBeb 1 and answered, but then subsequent questions suggested to me,
2 particularly the objection which was sustained,--

3 JUDGE BRENNER: The objection was in your clause
4 where you said "Given that," and you testified yourself that
5 certain stresses were caused below the weld by the weld. At
6 least that was my reason for sustaining it, so I didn't even
7 ask Mr. Dynner for his reason.

8 And that's different than this question.
9 Whatever answer you heard to this question earlier is the
10 same answer, and it was not affected by the objection and
11 the sustaining of that objection. You had a cause and
12 effect in your subsidiary "Given" clause, and that was the
13 problem.

14 BY MR. ELLIS:

15 Q Dr. Bush, is it true then that the tensile
16 residual stresses in the weld must be balanced by equal and
17 opposite compressive stresses below the weld?

18 A (Witness Bush) Very definitely.

19 Q If a crack then formed, Dr. Bush, in the weld or
20 weld heat-affected zone, wouldn't the magnitude of the
21 tensile stresses decrease and the magnitude of the
22 compressive stresses also decrease?

23 A Yes, that's the point I've been trying to make
24 for some time. Obviously I haven't made it very well.

25 You have three conditions, as I see it. One is

WRBeb 1 where you have a balance between tensile and residual
2 stresses and there is no cracking. The situation stays that
3 way so that means that you have a balance between the two
4 forces.

5 The second is you get partial cracking with
6 limited movement and so you get a redistribution of stresses
7 but not much effect.

8 The third one of course is where you get a
9 substantial cracking in which case there is a gross
10 reduction in the tensile stresses, and that has to be
11 balanced by a change in the compressive stresses.

12 Those are the three conditions.

13 JUDGE BRENNER: By "change" you mean by
14 a reduction in the compressive stresses?

15 WITNESS BUSH: That's correct. In other words,
16 what you're doing is both are tending to approach a neutral
17 value.

18 BY MR. ELLIS:

19 Q Dr. Bush, wouldn't the conclusion then be that
20 any pop-in that might occur should not extend below the
21 weld?

22 MR. DYNNER: Asked and answered.

23 JUDGE BRENNER: I don't remember that one,
24 Mr. Dynner, so if it was I've missed it. I will overrule
25 the objection.

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WITNESS BUSH: Let me use an analogy.

JUDGE BRENNER: Can you just answer the question
directly? It would help me.

WITNESS BUSH: All right, I will answer it No.

BY MR. ELLIS:

Q Would the answer to the question be Yes if I said "significantly" below the weld? In other words, given what you have testified to, isn't it true that the stresses are such that you would expect pop-in, if it occurred, not to go significantly below the weld?

A (Witness Bush) Not necessarily.

Q Okay.

Would you explain your basis for that, please?

A If you visualize a V that has a finite length on the thing, and if you clamp at the top and now you suddenly release and push the V open, then obviously those stresses can be transmitted to the crack tip. And if you have a crack that releases suddenly, there can be a movement of many mills near the top, and the only way that that can be handled generally, if there isn't gross restraint, particularly if it has substantial length, is to move down to the bottom to the crack tip.

Q Wouldn't those tensile stresses be compensated by compressive stresses toward the tip?

A When you cracked you got rid of them. When you

WRBeb 1 have cracked the area you effectively have lost the tensile
2 stresses, you've reduced the compressive stresses, and
3 you've tried to open up the V. And the only thing then is
4 that you've changed the stress configuration at the tip of
5 the crack.

6 This will not apply if it's a very short crack,
7 short in the context of length at the surface. If it is a
8 long crack and it releases like that, then it can have a
9 substantial effect.

10 Q If the tensile and compressive, though, were
11 balanced and both go away, there is no net driving force for
12 the crack, is there?

13 A That's not true. I'm sorry. There is a kinetic
14 effect in here. You have quite a bit of stored energy. And
15 I think I used an analogy in an earlier portion of this
16 hearing, where you could have a bar that is on the floor
17 with high stresses and when it breaks the pieces fly all
18 over the room. So that says to me that you could have a lot
19 of energy stored up.

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WRBpp

1 Q Dr. Berlinger, am I correct that the Staff has
2 not yet concluded what sort of wire gaging or strain gaging
3 would be appropriate as a result of the concern over
4 residual stresses and the improbable pop-in?

5 MR. DYNNER: Objection. "Improbable pop-in" is a
6 mischaracterization.

7 JUDGE BRENNER: Sustained.

8 MR. ELLIS: The testimony says improbable on page
9 5.

10 MR. DYNNER: You had better read the --

11 JUDGE BRENNER: Mr. Ellis, just ask the question.

12 BY MR. ELLIS:

13 Q Dr. Berlinger, is it your testimony on behalf of
14 the Staff that the monitoring with wire gages is recommended
15 by the Staff or required by the Staff because of the concern
16 of pop-in which is characterized to be relatively improbable
17 in the Staff's testimony?

18 A (Witness Berlinger) Yes.

19 Q Am I correct that the Staff has not yet concluded
20 on or decided precisely what sort of strain gaging or wire
21 gaging would be appropriate to accomplish this?

22 A Yes. I think that's a fair characterization.
23 But for clarity I think I should add that the Staff would
24 normally, in a situation similar to this, recommend a type
25 of instrumentation, not a manufacturer's name but a wire

WRBpp 1 gage type of instrument to be installed but we wouldn't
2 specify precisely what instrument LILCO should install.

3 Q And there is no decision yet by the Staff on
4 which of the cam gallery cracks on which block should be
5 instrumented; is that correct?

6 A That's correct.

7 Q The unbolting that Dr. Bush referred to,
8 Dr. Berlinger, does that occur only during major maintenance
9 or refueling outages during inspections?

10 A Generally speaking, yes. However, to install the
11 strain gages in the cam gallery area which were done prior
12 to the just completed ten to the seventh cycle testing on
13 the 103 engine, it was necessary to unbolt these specific
14 bolts in order to properly install the strain gages. So
15 that is the situation which has recently existed on the 103
16 engine.

17 Q Wasn't that to measure, that that you just
18 described, to measure the bolt-up stresses?

19 A Yes, that's one way to put it. It was primarily,
20 though, to relieve the bolt-ups stresses so that you could
21 put the strain gages on a -- call it an equilibrium surface,
22 such that you would be able to measure the compressive
23 stresses once the engine was bolted back up and be able to
24 determine if the overall stresses in the area were either
25 compressive or tensile.

WRBpp

1 Q But it wasn't necessary to unbolt for the purpose
2 of installing strain gages themselves, was it?

3 A It was necessary to unbolt in order to properly
4 install the strain gages but it was not necessary to unbolt
5 because there was a physical obstruction to the installation
6 of strain gages.

7 Q Dr. Bush, you had an opportunity, didn't you, to
8 examine visually the cam gallery area of the new EDG 103
9 block?

10 A (Witness Bush) No.

11 Q Did you, Dr. Berlinger?

12 A (Witness Berlinger) Could you repeat the
13 question, I'm sorry.

14 Q Did you have an opportunity to inspect visually
15 the cam gallery area of the diesel generator 103 replacement
16 block?

17 A No, I have not had that opportunity, not as yet.

18 Q Is it also true for you, Mr. Henriksen?

19 A (Witness Henriksen) That's correct.

20 Q Dr. Berlinger, are you aware that visual
21 inspections alone have not detected any cam gallery cracks
22 in the new 103 block?

23 A (Witness Berlinger) Yes, I'm aware of that fact.

24 Q And did those visual inspections also include
25 visual inspections by NRC personnel?

WREpp

1 A I believe a member of the Office of Inspection
2 and Enforcement with the resident inspection, or the actual
3 resident inspector, have observed those inspections.

4 Q Do you know, Dr. Berlinger, whether dye penetrant
5 or magnetic particle inspections have revealed any
6 indications in the cam gallery of the 103 new block?

7 A Yes. Liquid penetrant inspections were performed
8 which indicated that there were linear indications but as
9 reported after further inspection of those cracks I think
10 with mag flux techniques the cracks were not very deep and
11 they were very tight.

12 I might add, Mr. Ellis, that the inspections
13 you're referring to were inspections that were performed
14 prior to the ten to the seventh cycle testing that has just
15 recently been completed and that those cam gallery cracks in
16 saddles two and seven, I think, will be reinspected in the
17 very near future as part of the post-test inspection
18 program.

19 Also, I could add that based on my recollection
20 which I think is tied to an I&E morning report, the depth of
21 the cracks that have been measured previously were somewhere
22 in the vicinity of 15 thousandths of an inch deep.

23 JUDGE BRENNER: Dr. Berlinger, I cannot help but
24 ask at this point, I thought mag particle was one of the
25 tests that can only test for surface indications and not

WRBpp

1 accurately test for depth; am I missing something? You just
2 reported a depth reported to be based on what you think was
3 a mag particle test. 'f I understand your testimony.

4 Anybody on the Panel can help.

5 WITNESS DERLINGER: I think Dr. Bush could give
6 you a very direct answer to that question.

7 WITNESS BUSH: You could do some inferences from
8 it, that's about all. I don't think they could really
9 define it. Usually it is good to about 125 mills, an eighth
10 of an inch. So, if you see the field then you can infer
11 something but that would probably be 15 mills plus or minus
12 10 mills or something of that nature.

13 MR. ELLIS: Let me see if I can clarify this.

14 BY MR. ELLIS:

15 Q Dr. Bush or Dr. Berlinger, does if refresh your
16 recollection that TSI gage measurements were made that
17 resulted in the measurement of 14,000ths of an inch with
18 respect to the new cam gallery or new 103 block?

19 A (Witness Berlinger) Yes, Mr. Ellis.

20 A (Witness Bush) That's a much better way to do it
21 on shallow cracks.

22 Q And you would agree that that would be a reliable
23 way of doing it particularly where there are no weld
24 repairs?

25 A I would say it's a highly reliable way with

WRBpp

1 fairly shallow cracks and I think it is a pretty reliable
2 method if you have a crack that is clearly open and isn't
3 making contact because any place it makes contact, as I
4 indicated yesterday, it will read as if the crack stops at
5 that point. That's the only difference. So if you could
6 show the crack is clearly open then you're all right.

7 Q Given that information, Dr. Berlinger and
8 Dr. Bush, would you agree that these even smaller and
9 shallower indications in the replacement 103 block, given
10 its strength and corresponding fatigue properties that there
11 would be even a larger margin against crack extension in the
12 cam gallery area than you would expect in the 101 and 102
13 and the old 103?

14 A I guess I would reserve judgment until I looked
15 at the results of the ten to the seven test. One would
16 presume that would be the case but I would prefer to see the
17 results then I'd feel more confident in making a statement.

18 A (Witness Berlinger) I would like to add that the
19 fact that there are no weld repairs that have been
20 identified and the fact that the crack has been measured as
21 a shallow crack the representation once the strain gage data
22 is submitted as part of this hearing as well as for Staff
23 review, the surface strain gage measurements will be much
24 more representative of the situation in the crack area at
25 the surface and be less of a need to extrapolate the

WRBpp

1 measurements that were taken to greater depths within the
2 cam gallery wall.

3 Q Dr. Bush, back for a moment to page one of your
4 supplemental testimony where you refer to your statement
5 there that you "agree that the metallographic evidence
6 confirms that the cracks formed during initial cooling in
7 the casting based on the heavy oxide layer on the crack
8 faces."

9 Would you agree with the statement that that
10 heavy oxide layer was caused by graphitic corrosion?

11 A (Witness Bush) I don't believe so.
12 Incidentally, I believe I would feel more comfortable on the
13 oxide if I saw the crystallographic structure of the oxide.
14 I think that would fairly unequivocally establish what we
15 were discussing here rather than to infer.

16 Q Graphitic corrosion is typically associated with
17 soil and water environments; isn't it?

18 A Yes, and it often occurs there or under
19 conditions where anaerobic bacteria occur. That's one of
20 the classic examples where everything -- where all the
21 metals gets chewed away and leaves the graphite behind.

22 Q Well is the appearance of graphitic corrosion a
23 spongy and porous appearance?

24 A If you take all the metal away that would be an
25 apt statement, yes.

WRBpp

1 Q And that was not the appearance that you observed
2 in the metallographic evidence that you observed; is that
3 correct?

4 A No.

5 Q That's ambiguous; am I correct, yes?

6 A You are correct.

7 Q Thank you.

8 MR. DYNNER: Objection. His testimony is he
9 examined photographs of the fractography of cam gallery
10 number 7 which was the crack that was blown open and the
11 oxide air that we're talking about is on that crack. I
12 don't think there has been testimony as to whether he
13 examined personally that crack himself. He said he looked
14 at the photographs and I just wanted the record to be clear
15 that he then later says he looked at metallographic evidence
16 and I just wanted the record to be clear as to whether he's
17 talking about something other than personal inspection of
18 the actual section that was fractographed.

19 JUDGE BRENNER: He said some other things there,
20 too, of course. The short answer is you can't go back and
21 redirect but now that you have made the point it might be
22 useful to get it in the same place if you want to,
23 Mr. Ellis, but I will leave it up to you.

24 MR. ELLIS: I think no matter what I do he's
25 going to go back to it so I will let him do it on his

WRBpp

1 nickel.

2 JUDGE BRENNER: Okay.

3 BY MR. ELLIS:

4 Q Dr. Bush, still on the cam gallery subject based
5 on the location of the cam gallery cracks are the casting
6 stresses, in your view, in the cam gallery largest at the
7 surface and decrease with distance inward toward the water
8 jacket side?

9 A (Witness Bush) Maybe you can clarify for me.
10 Are you talking about the existing stresses; are you talking
11 about the stresses during the casting process, or what? I'm
12 not exactly sure which one you're referring to under these
13 circumstances.

14 Q The stresses as the cracks are forming in the
15 casting process?

16 A I would expect that surface since it's
17 essentially where it solidifies first and therefore you
18 would have a delta T which would represent the highest
19 stressed area. However, we have two surfaces in here that
20 we have to consider, but I think the thicker section of the
21 inside would be where I would anticipate the stresses would
22 be higher.

23 Q Isn't the location of the cracks consistent,
24 then, with the stresses being largest at the surface and
25 decreasing with depth toward the water jacket side?

WRBpp

1 A I think that is what I -- perhaps I didn't say it
2 clearly. I would expect the stresses to be highest at the
3 surface and then tend to decrease. Quite a bit of that is
4 geometry, you realize, because you have a relatively
5 featureless back face whereas you do have geometric
6 discontinuities that would tend to act as LILCO stress
7 risers for that. That's where I would anticipate the
8 stresses to be higher on the inside.

9 Q And would you also expect the stress magnitudes
10 and gradients from surface inward to be essentially the same
11 on the 101, the 102, and the original 103 block?

12 A That will depend on the casting process to a
13 degree. I'm assuming the molds are all the same and the
14 only difference then might be the superheat aspect of the
15 thing which could change the stresses to a degree.

16 JUDGE BRENNER: Dr. Bush, maybe I heard you wrong
17 but in the answer immediately prior to this one you said
18 you'd expect the stress -- I believe you said you would
19 expect the stress to be highest on the inside. Did I hear
20 you wrong?

21 WITNESS BUSH: At the cam gallery surface. In
22 other words that's where I would expect, if the crack were
23 to initiate, the stresses would be highest and there would
24 be a discontinuity which would localize the stresses so
25 therefore it would tend to want to tear apart at that

WRBpp 1 location and then the crack would tend to move in from that.

2 JUDGE BRENNER: All right. You mean inside in
3 terms of the geometry but still on the surface.

4 WITNESS BUSH: Yes. I'm saying inside compared
5 to the water jacket side so perhaps the better language
6 would have been, say, the cam gallery side which is
7 specifically what I meant.

8 JUDGE BRENNER: That's okay; I understand it now.

9 BY MR. ELLIS:

10 Q I think you've indicated in your testimony,
11 Dr. Bush, that as a conservative assumption you assumed that
12 the cracks in the cam galleries of 101 and 102 would be as
13 deep as those found in the original 103. My question is
14 while that may be conservative would a more realistic
15 prediction be that the superior physical properties of the
16 101 and 102 blocks would likely result in shallower cracks
17 in the cam gallery area than in the original 103 block?

18 MR. PERLIS: I object to this question. This was
19 asked and answered a number of times yesterday.

20 MR. ELLIS: I don't believe that's the case.

21 JUDGE BRENNER: I don't remember it from
22 yesterday, Mr. Perlis, so I'm going to overrule the
23 objection. I thought you were going to object on another
24 ground.

25 I think you switched tracks on what you were

WRBpp

1 comparing from the beginning of the question to the end of
2 the question, I believe, inadvertently on your part. It's
3 not clear what blocks you're comparing anymore. At least
4 it may not be clear.

5 MR. ELLIS: I intended in my question to --

6 JUDGE BRENNER: Why don't you ask it again?

7 MR. ELLIS: All right.

8 BY MR. ELLIS:

9 Q Dr. Bush, your testimony indicates that you
10 conservatively assumed that the cracks in the 101 and the
11 102 blocks are as deep as those that were actually found in
12 the original 103 block?

13 My question is given the superior physical
14 properties of the 101 and the 102 block wouldn't it be fair
15 to say that a more realistic assessment or expectation is
16 that the cracks in the cam gallery of 101 and 102 blocks are
17 shallower than those actually found in the old diesel
18 generator 103 block?

19 A (Witness Bush) Not necessarily.

20 Q Well, I understand it is not necessarily but
21 isn't it more likely than not that that's the case.

22 MR. DYNNER: Objection. Argumentative.

23 JUDGE BRENNER: Well, the cross-examiner is
24 allowed to pursue matters a little bit without having his
25 question stopped on the grounds of it being argumentative.

WRBpp

1 So it's overruled.

2 WITNESS BUSH: I think it's extremely difficult
3 to extrapolate roughly 1500 to 1800 degrees and state the
4 degraded properties at room temperature bear any
5 relationship to the properties at perhaps 1800 degrees which
6 is just a little below the solidification temperature. So I
7 have no basis whatsoever, assuming these are hot tears, to
8 infer that there is a marked difference in the properties at
9 that temperature. Therefore, I would tend to believe other
10 factors could play as large a role or even a larger role
11 than the so-called Widmanstaetten structure.

12 BY MR. ELLIS:

13 Q Would it be fair, then, to say that because you
14 can't be sure either way that your conservative approach is
15 to assume that they are the same depth?

16 A (Witness Bush) That's exactly what I did, yes.

17 Q Dr. Bush, with regard to circumferential cracks,
18 you indicate that such cracks will be self-limiting as
19 they propagate away from the area of high stress
20 concentration and that they do not represent a hazard to
21 diesel generator reliability.

22 Would you tell us what you mean by self-limiting
23 and give us the basis for your opinion, please?

24 A Yes, sir.

25 Again, I have to depend on the results of others

WRBpp

1 since I did not do separate calculations but every
2 indication would be that there is a definite negative K
3 field that is generated there. It's rather obvious that
4 that particular landing area has an extremely high stress
5 concentration factor and where it is located it will see
6 thermal gradients. So I would anticipate a very high
7 probability of crack initiation. But there does not appear
8 to be much of a crack driving force so that would say that
9 the crack would move in, I guess what I call my gut feeling
10 would be, approximately 95 degrees because of the loading
11 condition. But I would tend to feel that it would tend to
12 die out rapidly.

13 In other words, there isn't a driving force
14 unless there is a super-position. Obviously if we had a
15 severe transient or something that grossly increased the
16 stresses, the hoop stresses for example, and pushed against
17 it the situation would change. But that would have to be a
18 fairly severe transient in my estimation.

19 Q Dr. Berlinger and Dr. Bush, is it your opinion
20 that the 101, the 102 and the replacement 103 blocks are
21 suitable for nuclear service with respect to the
22 circumferential cracking based on your review of that
23 situation; is that correct?

24 A Yes.

25 A (Witness Berlinger) Yes.

WRBpp

1 Q So, Dr. Bush, when you said that you relied on
2 the calculations of others I take it you don't really feel
3 the need to perform any of your own calculations; you're
4 satisfied?

5 A (Witness Bush) I'm satisfied that there are
6 sufficient differences that that's the case, yes. In other
7 words, that there's a strong enough compressive field there
8 that cracks won't move and I see no reason to do
9 calculations.

10 Q On page 8 -- I think it's Dr. Bush, yes -- you
11 indicate that LILCO and TDI have not provided a
12 three-dimensional finite -- I guess you mean a finite
13 element analysis -- for review; is that correct?

14 A This is in the context of the circumferential
15 cracks. It's used in that context and that is a
16 three-dimensional finite element analysis. If it is
17 available I am unaware of it, I guess, is all I can say.

18 Q Dr. Bush, with respect to the circumferential
19 cracks, at what depth approximately would you anticipate
20 that they would arrest?

21 A I would expect them to arrest at, perhaps, a half
22 to three-quarters of an inch, something of that nature.
23 That's obviously a qualitative judgment. About all I can do
24 is I can look at the compressive stress field generated by
25 the bolt bound and I can look at what the hoop stress can

WRBpp

1 generate and then make a guesstimate; that's about all that
2 is.

3 Q Are you aware that the depths of the cracks, the
4 circumferential cracks, on the original 103 block were no
5 deeper than 3/8 of an inch?

6 A I saw the dimensions.

7 Q Do you recall any that were deeper than 3/8 of an
8 inch?

9 A I don't think I saw very many measurements, to
10 tell the truth.

11 Q Dr. Berlinger, do you recall any that were
12 greater than 3/8 of an inch?

13 A (Witness Berlinger) No. I agree with Dr. Bush in
14 that not many measurements were reported but those
15 measurements that I did see, they were all 3/8 of an inch or
16 less.

17 Q Well let me ask then, Dr. Berlinger, that given
18 that the measurements on the original 103 block were 3/8 of
19 an inch or less after more than 1000 hours of operation with
20 degraded physical properties, would you expect shallower
21 cracks or no cracks on the 101, 102 and replacement 103
22 blocks which have better properties?

23 A Yes. And I might go further to indicate that
24 there have been some changes in the new 103 block which
25 increased the thicknesses in the boss area in which the head

WRBpp

1 studs are located and that this might result in further
2 improvement over the original castings in the 101 and 102
3 blocks.

4 A (Witness Bush) I would like to amplify my
5 personal opinion is that I would not be the least bit
6 surprised to see cracking in any of these blocks unless they
7 decide to change the radius which, to my knowledge, hasn't
8 been done.

9 Now, I would agree that I would expect the cracks
10 to be -- to go to less depth under the circumstances. And,
11 as I say, I would expect cracks to initiate in this area in
12 any of these blocks.

13 Q And in any event, Dr. Bush, even if cracks were
14 to appear which you said would not surprise you, it is still
15 your view that it would not affect the ability of the
16 engines to perform their function?

17 A (Witness Berlinger) That's correct.

18 MR. ELLIS: That completes our questions, Judge
19 Brenner.

20 JUDGE BRENNER: Dr. Bush, just one quick question
21 on on of your recent answers. Which radius did you have in
22 mind?

23 WITNESS BUSH: The landing area radius. It's a
24 very sharp corner that would have a very high stress
25 concentration factor. You also have the maximum thermal

WRBpp 1 gradients at that location and so I would expect an
2 initiation but not much striving force for propagation.

3 JUDGE BRENNER: I'm sorry. Geometry isn't my
4 strong suit along with a whole list of other subjects that
5 aren't my strong suits. I can visualize the area, I
6 believe. When you say radius I think of the radius across
7 the top of the cylinder liner space but I don't think you're
8 talking about that radius.

9 WITNESS BUSH: I'm talking about this little
10 corner right down here. (Demonstrating) In other words, it
11 comes down like that. You have shelf here that's a landing
12 and it's a little corner there and it's very sharp. In
13 other words, the worst case would be a pure 90 degree angle.

14 JUDGE BRENNER: But what radius were you
15 changing?

16 WITNESS BUSH: That's the one. I would -- if I
17 broke that corner, if I rounded that corner off so that I
18 had a substantial radius, the stress concentration would
19 drop by a factor -- severalfold and that would reduce the
20 probability of crack initiation substantially.

21 WITNESS BERLINGER: Judge Brenner, if I may, I
22 would like to try and describe it to you.

23 JUDGE BRENNER: I just want to know what the
24 radius is as applied to that point. I'm probably the only
25 one in the room who doesn't know.

WRBpp

1 WITNESS BERLINGER: Let me see if could give you
2 a better description. In the liner landing area you have a
3 vertical surface that drops down from the block top surface
4 to the liner landing and that corner is a corner that goes
5 all the way around the liner landing area. On cross section
6 of that corner there would be, if there was no radius or
7 zero radius, a perfect 90 degree corner and because of the
8 various small radius that exists due to manufacturing
9 procedures that were used, there's a very high stress
10 concentration factor in that corner. In order to reduce the
11 stress concentration factor, what you would need to do would
12 be to put a more gentle radius in transition for the
13 vertical counterbore surface on to the liner landing
14 surface and that would involved, as Dr. Bush had indicated,
15 some remachining of that area to provide that increased
16 radius.

17 JUDGE BRENNER: I've got it now, thank you.

18 Mr. Dynner, can you pick up right now. It's a
19 little early for the break.

20 MR. DYNNER: Yes, sir.

21 CROSS EXAMINATION

22 BY MR. DYNNER:

23 Q Gentlemen, would you turn to page 26 of your
24 testimony?

25 Dr. Bush, in response to some questions by

WRBpp

1 Mr. Ellis, you indicated that you thought that the fatigue
2 properties of the blocks of EDGs 101 and 102 were superior
3 to the original EDG 103 block. Isn't it true that that
4 conclusion would depend on whether the samples that you
5 refer to in the first answer on page 26 were, in fact,
6 representative of the block material of 101 and 102?

7 A (Witness Bush) That's correct.

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WRBwrb 1 Q Now, are you aware, Dr. Bush, that the samples
2 that were taken from the blocks of EDGs 101 and 102
3 consisted of two small specimens from the flange area at the
4 top of the block and about ten replications from each block?

5 A That's my understanding.

6 Q Did you personally--

7 MR. ELLIS: Judge Brenner, I object to the
8 question. I think it misrepresents the record. I would
9 like a citation to the record where that's the case.
10 Because I specifically asked questions based on something
11 different.

12 JUDGE BRENNER: Well, he put the question to the
13 witnesses and the witnesses gave their answer. So I'm going
14 to overrule the objection. If they're wrong, that's the
15 purpose of examination from other parties.

16 MR. ELLIS: So that I'm clear, may I have that
17 question read back, please?

18 MR. DYNNER: I can rephrase the question to
19 refresh your memory, Mr. Ellis.

20 I asked him whether he was aware that the samples
21 taken from 101 and 102 consisted of two small specimens from
22 the flange area and about ten replications from each block.

23 WITNESS BUSH: I suppose I could refresh my
24 memory, but those are the numbers I remember. I remember
25 there were replications of the surface because of the

WRBwrb 1 discussion that I read. And I also remember a citation
2 there. And I presumably should look to see if the number is
3 2 or 2; but 2 is the number that I recall.

4 That's about all I can say.

5 JUDGE BRENNER: You're talking about from each
6 block of the 101 and the 102 blocks?

7 MR. DYNNER: Yes.

8 WITNESS BUSH: That's the way I interpreted it.

9 JUDGE BRENNER: I overrule the objection.
10 You can ask another question, Mr. Dynner.

11 MR. DYNNER: Thank you.

12 BY MR. DYNNER:

13 Q Dr. Bush, did you personally examine the
14 microstructure of all of these samples?

15 A (Witness Bush) I looked at some of the
16 samples, and I looked at the metallography of a number of
17 them in the part of the atlas. That's the extent to which I
18 have done it.

19 Q Can you please describe what you meant by you
20 looked at the metallography part of the atlas?

21 A There is an atlas of photomicrographs that cover a
22 wide spectrum of things, and I have looked at some of those
23 results.

24 Q You looked at the photographs. My question is,
25 Could you tell me which of the samples, if any, that you

WRBwrb 1 personally physically examined?

2 A If you mean did I put some samples under the
3 microscope at look at them at 50 or 100X, the answer is I
4 haven't.

5 Q Can you tell me, Dr. Bush, whether the
6 photomicrographs which you're talking about are those which
7 appear in LILCO's exhibit book, namely, Exhibit B-36 and
8 B-37 and B-38?

9 A I did not rely on those. Those are replicas, or
10 copies, and they don't show anything. I looked at the
11 original photomicrographs, the pictures. That's the only
12 way one could make a judgment.

13 In other words, I looked at the originals from
14 which those were made: I guess that that's what I should
15 say.

16 Q Dr. Bush, can you testify as to whether the
17 exhibits that I have just referred to -- that's 36 through
18 38 -- are representative of all of the photomicrographs that
19 you looked at of the samples from EDG 101 and 102 blocks?

20 JUDGE BRENNER: I just realized what the problem
21 is.

22 Dr. Bush, in our official exhibits we have the
23 photographs. So that's why I was confused when you said you
24 couldn't tell anything from the exhibits. You meant you
25 couldn't tell anything from the xerox-type copy of the

WRBwrb 1 photographs.

2 WITNESS BUSH: That's correct.

3 JUDGE BRENNER: Will somebody please give him the
4 right, original exhibits?

5 BY MR. DYNNER:

6 Q Do you understand the question, Dr. Bushj?

7 A (Witness Bush) I understand the question.

8 JUDGE BRENNER: We have to back up. Because when
9 he said he couldn't tell anything from the exhibits he
10 wasn't talking about the official exhibits, he was talking
11 about a xerox-type copy of the exhibit.

12 WITNESS BUSH: I have looked at the--

13 JUDGE BRENNER: Wait a minute. I want to get you
14 these exhibits.

15 Mr. Perlis, do you have the exhibits?

16 MR. PERLIS: I'm so. . .; I'm at a bit of a loss
17 here. I don't have a copy of the photographs here. I
18 assume we were given a copy, but I don't know where they
19 are.

20 JUDGE BRENNER: Does anyone have a copy? I will
21 lend him mine if worst comes to worst. But I'd rather keep
22 mine.

23 Next week let's let everybody have the right
24 exhibits, please.

25 You had better take mine, because I am confident

WRBwrb 1 that these are the exhibits.

2 (Document handed to the panel.)

3 WITNESS BUSH: In other words, the ones I looked
4 at were glossies, they were not photographic-type paper.
5 They are certainly not what I have in this book.

6 JUDGE BRENNER: Mr. Dynner, you're going to have
7 to back up to inquire as to the exhibits he looked at.

8 BY MR. DYNNER:

9 Q Dr. Bush, you have in front of you Judge Brenner's
10 copy of the original exhibits of the ones I'm referring to,
11 Exhibit B-36 through 38. Are those the photomicrographs
12 that you relied upon for your conclusion?

13 A (Witness Bush) To a substantial degree, yes. I
14 saw additional ones, but these all had the same general
15 characteristics.

16 Q What's your basis, Dr. Bush, for believing that
17 these and the other similar photomicrographs that you looked
18 at are representative of the entire mechanical properties of
19 the blocks of 101 and 102?

20 A I think you have an unanswerable question.

21 Are you asking me if I believe that the
22 metallography, or the metallurgical structures are
23 essentially the same, and that's the inference?

24 You jumped from this to the mechanical properties,
25 and I want to be sure I understand before I answer.

WRBwrb

1 Q Let me clarify the question for you.

2 Do you believe that the photomicrographs that you
3 have referred to are representative of the block materials
4 of 101 and 102? --the entire block, that is.

5 A I think, as a first approximation, yes. In my
6 estimation, the number of samples taken were sufficient to
7 be statistically relevant, and on that basis I could draw a
8 conclusion.

9 I am including the replicas in here in that
10 context.

11 Q It's true, isn't it, that various parts of the
12 block cool at different rates?

13 A Very definitely. And the place one should look at
14 would be those that have the slowest cooling rates, because
15 that would show -- if there were going to be any
16 differences, that's where one might expect them.

17 However, since that would be taken out of the
18 middle, or something of that nature, that is a little more
19 difficult to do.

20 Q You're aware, aren't you, Dr. Bush, that the
21 samples that were taken are only about 100 grams of material
22 in each block which weighs 24,000 pounds, and, therefore,
23 that the sampling is based upon approximately 10 parts per
24 million?

25 A I recognize that, but I also consider that if I

WRBwrp 1 have a certain number of samples taken from different
2 locations that that still is statically relevant.

3 Q Do you feel that there are a sufficiently
4 statistically reliable number of samples in this case?

5 A I feel reasonably confident that that's the case.

6 If one looks at a series of locations and sees
7 essentially the same microstructure it doesn't rule out the
8 possibility, if one were able to trepan a sample out, say,
9 half-way between the two surfaces, that you might not see
10 some other type of microstructure. But I consider the
11 probability is reasonably low.

12 Q Now, you're aware, aren't you, that the block is
13 cast -- that when the block is cast and cooled that it's
14 upside-down; isn't that right?

15 A That's a fairly common way to do it. But whether
16 this one-- I may have read that, but it didn't register at
17 the time.

18 Q Well, if that were the case, then the top of the
19 block would not be the area that would cool the most slowly,
20 would it?

21 A You're talking about the mold chill effect. That
22 depends upon how it is screwed and risered. In other words,
23 for me to make an opinion on that one I would have to
24 essentially look at the screwing and risering on the mold to
25 draw an opinion. Because what you may do is, you may be

WRBwrb 1 doing a bottom feed, or you may be doing a combination of a
2 side and top feed, something of that nature, which I can't
3 say. I have no data whatsoever on that, quite frankly.

4 Q But that would be a factor which might affect your
5 opinion, then; isn't that right?

6 MR. ELLIS: Objection. It's not clear what
7 opinion he's referring to.

8 JUDGE BRENNER: All right. I think I can guess.
9 But let's not guess. Why don't you put it in the question,
10 Mr. Dynner?

11 BY MR. DYNNER:

12 Q That would be a factor that might affect your
13 opinion as to the samples from the top of the block being
14 representative of all the block materia?

15 A (Witness Bush) I'd say only to a limited degree,
16 in the context that if I pour a very large mass of metal,
17 even if I chill it, a thin layer on there, I'm chilling it
18 in the context of solidifying it but not dropping the
19 temperature very much. And if I were worried about the
20 formation of an abnormal structure I would be much more -- I
21 would feel that the fact that it sits there for many, many
22 hours, literally days as it cools very slowly, is a factor
23 that control, more so than the fact as to whether the metal
24 at the top chills perhaps a limited time before the other.

25 Q You're aware, Dr. Bush, aren't you, that there

WRBwrb 1 were no samples taken from the cam gallery areas of the
2 blocks of 101 and 102 EDGs, aren't you?

3 A That's my understanding.

4 Q And you're also aware, aren't you, that FaAA did
5 observe that in block samples from EDG 102 that there did
6 appear to be some areas that had characteristics of
7 Widmanstaettan graphite? Are you aware of that?

8 A That one must have missed me. Was that introduced
9 into the...

10 Q You don't recall?

11 A That one I don't recall.

12 Q Let me try to refresh your recollection. I will
13 read, if I may, from transcript 24,754.

14 MR. ELLIS: Can we wait until we get that? Maybe
15 this would be a good time -- it's ten-thirty -- to take a
16 break, to get the transcript. If there are going to be
17 other pages he's going to refer to, maybe he could give
18 us those.

19 JUDGE BRENNER: Perhaps you could get some good
20 hints from something called the Rebuttal Testimony of
21 Dr. Robert N. Anderson.

22 MR. ELLIS: I just got it yesterday, and, frankly,
23 I have been preparing the other stuff and focussing on
24 that. But I will look at that.

25 JUDGE BRENNER: He's asking these witnesses many

WRBwrb 1 questions based on Dr. Anderson's rebuttal testimony, which,
2 in fact, was the purpose of getting the testimony in writing
3 before the Staff witnesses testified. And if he had not
4 done this, somebody else would have, I assure you. And some
5 of the transcript-- I don't know; I'm not saying it's the
6 same questions, but following this type of line; that is,
7 putting to this witness some of the bases and conclusions of
8 Dr. Anderson as well as witnesses for LILCO.

9 For example, the first cite he gave you is on page
10 2 -- page 1 of that testimony. And you can look at those
11 for others.

12 But we can break at this time.

13 MR. DYNNER: Yes, sir. And I would -- so that we
14 can save time-- suggest that the witnesses' counsel direct
15 them over the break, if we can save that time, to transcript
16 pages 24,754 and 24,755.

17 JUDGE BRENNER: Okay. Let's break until 10:45.

18 (Recess.)

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AGBeb

1 JUDGE BRENNER: Let's go back on the record.

2 BY MR. DYNNER:

3 Q All right, Dr. Bush. I assume that now you have
4 had a chance to look at pages 24,754 and 55. Is that right?

5 A (Witness Bush) That's right.

6 Q Now when you looked at the photomicrographs of
7 samples from EDG 102, did you see any areas that had the
8 characteristics of Widmanstaetten graphite?

9 A Nothing that was at all marked. Obviously in any
10 microstructure you can see limited abnormalities. It was
11 pretty typical.

12 Q If you were to take a conservative approach then,
13 Dr. Bush, would the disclosure that there were areas that
14 had some of the characteristics of Widmanstaetten graphite
15 raise questions about a conclusion that all of the material
16 on the 101 and 102 blocks were adequately represented by the
17 photomicrographs that you examined?

18 A Is that a hypothetical question? Because of
19 course I haven't seen the photomicrographs of the area you
20 are discussing, so it is really hearsay from my point of
21 view. I have only read the words.

22 Q Yes. Let me repeat the question and maybe make
23 it a little more clear.

24 Given the fact that you did not see the
25 photomicrograph that showed the characteristics of

AGBeb 1 Widmanstaetten graphite in the 102 block, being
2 conservative, doesn't that raise doubts as to whether the
3 photomicrographs that you did see are representative of all
4 of the material on both the 101 and 102 blocks?

5 MR. ELLIS: I object to that question. I think
6 the predicate is not in the record at all. He hasn't said
7 anything at all about the 102 block having shown
8 Widmanstaetten characteristics.

9 JUDGE BRENNER: All right. I'll sustain the
10 objection.

11 You are going to have to be a little more precise
12 about-- Try to be more precise and I will give you leeway,
13 Mr. Dynner. I don't know how far you can go with this
14 witness on the predicate. We're going to have to put the
15 predicate together as a Board, because all this witness
16 knows apparently is what another witness said in the
17 transcript, and different people may draw different
18 conclusions from that.

19 But be a little more precise so that at least the
20 witness has in mind what you have in mind, even if it turns
21 out to be a hypothetical for argument purposes at this
22 point, the predicate so far as you've read the transcript
23 pages.

24 MR. DYNNER: I will try to back up.

25 JUDGE BRENNER: Let's go off the record for a

AGBeb 1 minute.

2 (Discussion off the record.)

3 JUDGE BRENNER: Back on the record.

4 I'm sorry, Mr. Dynner.

5 BY MR. DYNNER:

6 Q Dr. Bush, as I understand your testimony you
7 believe, on the basis of the photomicrographs that you have
8 seen, that those photomicrographs are representative of the
9 entire block material of EDGs 101 and 102. Is that right?

10 A (Witness Bush) I would say that I would expect
11 this to be the predominant microstructure. I would never
12 say that it is the same because in almost any structure, if
13 you look long enough and hard enough, for a variety of
14 reasons you can see differences on the thing. But if it is
15 a very small fraction of the total it is usually
16 inconsequential.

17 Q Now you're aware that Dr. Wachob's testimony on
18 transcript 24,754 indicated that there are local regions of
19 the 102 block where they found characteristics of
20 Widmanstaetten graphite. Isn't that right?

21 MR. ELLIS: I object. He has mischaracterized.
22 It says very clearly on 24,754 something different from what
23 Mr. Dynner represented.

24 JUDGE BRENNER: I don't have the page in front of
25 me.

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MR. DYNNER: Let me repeat. Let me put it on the record.

JUDGE BRENNER: I think I could get the page, Mr. Dynner.

MR. DYNNER: 24,754.

BY MR. DYNNER:

Q "QUESTION: Did you find any evidence of Widmanstaetten graphite at all?

"ANSWER: There were very local regions that have minor characteristics similar to it but I haven't, from all the looking I've done, been able to say quantitatively yes, that was a little area."

MR. ELLIS: I think fairness requires also that he read 24,755, which explains that as well.

JUDGE BRENNER: We're going to put it together, not this witness.

Ask it as a hypothetical and I feel confident that this is a subject we are going to come back to with other witnesses, so let's see what this witness has to say about it, assuming certain things.

BY MR. DYNNER:

Q Dr. Bush, if there were other photomicrographs which showed areas of the 102 block which had Widmanstaetten graphite or character's of Widmanstaetten graphite, wouldn't that indicate to you that the photomicrographs

AGBeb 1 that you did see were not necessarily representative of all
2 of the block material?

3 A (Witness Bush) That's possible.

4 I might add there that if I had sufficient of
5 that then I would obviously want to see more, which would
6 require something such as trepanning at a location where if
7 there was any possibility at all of formation, namely, the
8 thickest section, that's where I would look.

9 But that would be only after a repeated one
10 because as I indicated before, the fact that one sees
11 abnormal structures is the rule rather than the exception.
12 If you look long enough or hard enough you will always find
13 areas where, in a given grain size, there will be different
14 grain sizes; things of that nature. It may not have
15 significance.

16 Q It is true, isn't it, Dr. Bush, that if -- if --
17 one of the small sample areas that have been taken from the
18 block had had the characteristics of Widmanstaetten graphite
19 and been examined -- the photomicrograph of that had been
20 examined by you, your conclusions about the samples being
21 representative might well be very different. Isn't that
22 right?

23 A That's quite true.

24 Q And if you found that there were areas of
25 Widmanstaetten graphite or having the characteristics of

AGBeb 1 Widmanstaetten graphite in the block of EDG 102, you would
2 want to do some further examination and sampling, wouldn't
3 you?

4 A Probably if I had an isolated case I might not.
5 If let's say I ran two different locations and found it,
6 then I would begin to get suspicious. That would be the
7 kind of a groundrule that one would use.

8 Q And am I correct, Dr. Bush, that you are not
9 aware of how extensive the characteristics of Widmanstaetten
10 graphite might be in the areas that were referred to in
11 Dr. Wachob's testimony. Isn't that right?

12 MR. ELLIS: I object. Again it mischaracterizes
13 Dr. Wachob's testimony.

14 JUDGE BRENNER: I am going to let him ask the
15 question that way. The objection is overruled.

16 You can come back on redirect and put certain
17 other things to the witness. You can also cross-examine--
18 Well, you can do that, and I think we are probably going
19 to-- Well, let me stop there.

20 I will overrule the objection.

21 MR. ELLIS: But--

22 JUDGE BRENNER: It is overruled. I understand
23 your problem. I don't necessarily agree with the finding
24 you're going to write. I might or might not in the end. So
25 for now let's hear what this witness has to say.

AGBeb

1 WITNESS BUSH: Without seeing the structures I
2 could arrive at no conclusion. I spent several years as a
3 metallographer and I quite frankly wouldn't -- in a case
4 like this I wouldn't accept a set of words as representative
5 of the microstructure.

6 BY MR. DYNNER:

7 Q Dr. Bush, on the bottom of page 26 in your last
8 answer on that page you state, and I quote:

9 "The assumption may certainly be made
10 that the material in the cylinder blocks for
11 engines 101 and 102 was superior to the material
12 in the original 103 cylinder block."

13 Don't you feel that in order to be conservative
14 in this subject matter that it would be advantageous to do
15 further sampling or testing in order to see whether that
16 assumption was correct or not?

17 A (Witness Bush) Not necessarily. I would say if
18 there were evidence that tends to move one away from the
19 assumption that indeed this is a typical gray iron, and
20 probably 99 out of 100 or 999 out of 1,000 castings would be
21 typical, then I might say yes.

22 Obviously the only way to respond to this
23 question is by the physical removal of material and the
24 testing because the B blocks will tell you nothing about
25 this.

AGBeb

1 Q And you would feel better or more confident,
2 wouldn't you, Dr. Bush, if let's say there had been samples
3 taken from 20 different areas of the block, provided that
4 those samples did not degrade the operability or performance
5 of the block. Isn't that right?

6 A I would have a larger sample to examine and that
7 would make me more confident. That's almost always the
8 case. Obviously one has to balance reason and the size of
9 the sample. From a statistical point of view, usually in a
10 case such as this, if you get around a dozen samples it
11 should begin to be statistically significant if they all
12 show the same structure.

13 Q And you would want them to be from a variety of
14 different areas, not all from the same localized area.
15 Isn't that true?

16 A That's true.

17 Q Now, Dr. Bush, I would ask you to please turn to
18 page 27 of your testimony, and I now have some questions for
19 you about the ligament cracks.

20 A Yes, sir.

21 Q You refer in your testimony to empirical evidence
22 based on repetitive examinations of cracks in both ship and
23 stationary diesels. Would you identify the marine diesels
24 that you were referring to in that testimony?

25 A Let's see. I'm trying to remember the ligament

AGBeb 1 cracks. There were a number of ships and I will have to
2 remember their names. The GOT I think is one, and I will
3 have to recall where the cracks were in that particular
4 instance.

5 All I can think of is the FLYING CLOUD, and
6 that's not right because that was a Clipper ship.

7 Well, there were two that were Alaskan ferries,
8 but I thought there was one other ship also that had
9 evidence of cracking in it. Those are the ones I'm thinking
10 of. The COLUMBIA. Is that it? There was one other I
11 thought.

12 The ST. CLOUD I guess is the one I was thinking
13 of. That's a stationary one; that's right.

14 Q Dr. Bush, it would be important to you in
15 weighing the value of this empirical evidence to know what
16 loads that those marine diesels operated at, wouldn't it?

17 A Yes, it would. I discussed this with
18 Mr. Henriksen, who has a lot of experience onboard ships.

19 And one of the reasons that the evidence I think
20 would -- there is that when you attempt to make a tide, you
21 usually crank up the diesel so that it sees a performance
22 analogous to what we're concerned with here, namely, an
23 overload condition. And that is one reason I would put some
24 degree of credence on the ship diesels.

25 Q Do you know what the rated load of the engines on

AGBeb 1 the GOT were?

2 A Off the top of my head, no.

3 Q Do you know what loads that the GOT engines
4 operated at during the period that you are referring to for
5 your empirical evidence?

6 A No. I was mainly concerned, since I'm not a
7 diesel man and I wouldn't be able to correlate it, with
8 looking at similar locations and the evidence of cracks
9 there as contrasted to the behavioral characteristics of the
10 diesels. If that came up I had to refer to somebody else
11 because I am not that familiar, in fact I still can't get
12 the parts of the diesel straightened out.

13 Q Well, you're not aware, for example, as to
14 whether the GOT ever operated at more than 80 percent of
15 its rated load, are you?

16 A Probably not.

17 Q And you are not aware of what loads the COLUMBIA
18 operated at, are you?

19 A No.

20 Q Now I would like to ask you about the stationary
21 diesels that you refer to in that sentence. Could you
22 identify those for me?

23 A Well, I'd have to go back through the notes which
24 I have on the thing, which is going to take some doing I
25 think. The ST. CLOUD, as I recall, is one. There was a

AGBeb 1 Bell-- Let's see, there was an Alaskan--

2 JUDGE BRENNER: Dr. Bush, excuse me. I can't
3 tell when you're trying to talk to one of your panel members
4 or--

5 WITNESS BUSH: No, I wasn't.

6 JUDGE BRENNER: -- trying to talk for the record.

7 WITNESS BUSH: Sorry.

8 JUDGE BRENNER: But I can't hear you part of the
9 time.

10 WITNESS BUSH: I could remember the ones -- the
11 copper ones, but I can't remember the names, no.

12 BY MR. DYNNER:

13 Q And you do know what loads those engines operated
14 at, do you?

15 A (Witness Bush) No, and I don't necessarily
16 consider them relevant.

17 Q Well, when you say you don't consider them
18 relevant, it would be relevant, for example, to your
19 conclusion about the ligaments cracks arresting if in fact
20 those engines never operated at above 60 percent of rated
21 load. Wouldn't that be true?

22 A That would-- Not necessarily, because about all
23 that might do, that might not affect the initiation phase
24 but it may have an effect on the propagation phase.

25 Q Well, does it or doesn't it?

AGBeb 1 A It should have, yes.

2 Q So that it would be important for you to know, in
3 reaching any conclusions based upon this evidence, whether
4 the diesels you referred to, the stationary diesels,
5 operated at only 30 percent of load or at 80 percent of load
6 or 100 percent of load. Isn't that right?

7 A I wasn't trying to use the data in that context.
8 I was looking at a family of diesels that admittedly
9 operated under different conditions than emergency diesels
10 to see if there was a repetitive pattern on crack initiation
11 and arrest. That's as far as I went.

12 Q So it's true, isn't it, that you really can't put
13 very much credence in that evidence when you don't know the
14 loads to which those diesels -- the loads at which those
15 diesels were run, or for the number of hours, or other
16 pertinent information. Isn't that right?

17 A I believe that the bottom part of the question
18 that you are addressing states that very thing.

19 A (Witness Berlinger) Mr. Dynner, may I add to
20 Dr. Bush's answer?

21 You had asked if we had any knowledge of the load
22 levels at which some of these engines that Mr. Bush has
23 identified, particularly on shipboard. I have had
24 discussions with a chief engineer who at the time I had
25 discussion with him was on one of the TEXAS -- STAR TEXAS

AGBeb 1 ships, and he had also been the chief engineer on the GOT.

2 He indicated to me that typically in the GOT and
3 in the STAR TEXAS and in other ship applications, at normal
4 cruising speed, the load on these engines is approximately
5 80 to 85 percent of the rated load of the engines.

6 In addition, he indicated that there were many
7 times when the engines would have to be run up at full rated
8 load. These instances would be, as Dr. Bush has indicated,
9 while they were out at sea having to maneuver against the
10 tide or in a particular service application in heavy seas,
11 et cetera.

12 So that there is a fairly good amount of evidence
13 out there as to the operating load, both under normal
14 running conditions and also under unusual or heavy load
15 conditions which would indicate that the load that these
16 engines typically run at would be between 100 percent and
17 down as low as around 80 percent.

18 MR. DYNNER: I move to strike this testimony.
19 This witness has given no testimony on this. This is
20 Dr. Bush's testimony and Dr. Berlinger, if he had testimony
21 on this, presumably would have put it in the prefiled
22 testimony and had an opportunity to add to it.

23 Also it is based on hearsay, rank hearsay.

24 JUDGE BRENNER: Mr. Perlis.

25 MR. PERLIS: As to hearsay, first of all hearsay

AGBeb 1 is admissible in administrative proceedings. That would go
2 only to the weight.

3 Secondly, in Dr. Berlinger's position I believe
4 it would not be uncommon for him to talk to the engineers of
5 such vessels to get this information. It is our view that
6 what Mr. Berlinger has just said is relevant. He did not
7 sponsor the answer, you know, the written testimony. That
8 is Dr. Bush's testimony. But we would oppose the motion to
9 strike.

10 JUDGE BRENNER: Did you want to add anything,
11 Mr. Ellis?

12 MR. ELLIS: I think certainly also before the
13 motion to strike should be ruled on I think it is clear that
14 Staff and Dr. Bush communicate and he obtains information
15 from a number of sources.

16 JUDGE BRENNER: All right. I'm going to make it
17 easy. I will overrule the objection on those grounds in
18 terms of the fact that another witness added because it is
19 reasonable that these witnesses work together in the course
20 of their professional activities. So I will overrule that
21 ground.

22 What about the hearsay ground?

23 MR. ELLIS: I think Mr. Perlis did respond to
24 that. We have had a great deal of hearsay in this
25 proceeding, and some the Board has admitted and some it

AGBe's 1 hasn't.

2 I think it clearly should go to the reliability
3 of the testimony -- to the weight of it, rather, rather than
4 to the admissibility. Otherwise there is simply no way you
5 ever get testimony that's--

6 JUDGE BRENNER: All right.

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1 JUDGE BRENNER: Mr. Perlis, wasn't it the staff's
2 position at some point in the prehearing process, perhaps
3 discovery process, that it wasn't going to pursue details as
4 to the operations of marine diesel TDI engines because it
5 would be not sufficiently applicable to be worth the effort
6 or something to that effect, or perhaps too difficult to get
7 the operating conditions also and perhaps --

8 MR. PERLIS: Mr. Chairman, I wasn't available at
9 that time but I believe Mr. Berlinger did make a statement
10 on that and I would like to refer you, if I could....

11 JUDGE BRENNER: I'll turn my statement into a
12 question to you.

13 WITNESS BERLINGER: Yes, Judge Brenner. In
14 response, the Staff did state a position previously that
15 after attempting three discussions with people from the
16 marine industry that a lot of the information that we would
17 need to make specific judgments was not available. But
18 during that process of inquiry we did find out some
19 information which is not, call it, 100 percent accurate
20 because it was not based on written records on board ship
21 but rather on individuals with responsibility for running
22 these ships. So although the previous Staff position as
23 stated during, I think, a prehearing conference was the fact
24 that we didn't feel that this type of information would be
25 very useful in making analytic determination, it was, from

AGBpp

1 a standpoint qualitatively speaking, of value to be able to
2 make that judgment. That information might not be
3 pertinent.

4 JUDGE BRENNER: All right.

5 MR. ELLIS: Judge Brenner --

6 JUDGE BRENNER: We're going to disregard, in
7 essence, we're granting the motion to strike and it is not
8 because of hearsay grounds. Actually the facts testified
9 to limit it totally to those facts. They're not
10 sufficiently complicated that we wouldn't permit an expert
11 in the course of gathering information to rely on those
12 facts. However, the facts, as I've heard them, are very
13 limited. That is, that the ship operated at 80 to 85
14 percent load typically and at times operated at 100 percent
15 load but we have no idea what those operating hours are in
16 terms of the life of the engine and things like that.

17 Dr. Berlinger, himself, indicates it is kind of a
18 nonquantitative check in his mind, if I can put that in my
19 own words, interpreting it.

20 More important, the Staff did not perceive this
21 information in the detail necessary to find it probitive so
22 the whole area is insufficiently probitive. Moreover, LILCO
23 itself on the motion to strike which was granted of very
24 similar testimony of the County's testimony and as a result
25 we're just not going to use any. At least, we're not going

AGBpp 1 to use Mr. Berlinger's oral explanation. But I
2 wanted to emphasize that the grounds, as I've stated them,
3 are not the same grounds given in the objection, although
4 the result is the same, namely, the facts are insufficiently
5 probitive to use.

6 MR. ELLIS: Judge Brenner, may I just note
7 though --

8 JUDGE BRENNER: I've made the ruling.

9 MR. DYNNER: Just to clarify the record,
10 Dr. Berlinger's answer was the only answer that was
11 stricken, is that correct?

12 JUDGE BRENNER: Correct.

13 You've got a good indication of what we're going
14 to do with the whole subject here..

15 I don't want to preclude the fact that there may
16 be some testimony in this record somewhere that goes through
17 it that has something to do with a ship that may be a
18 particular specific fact that we find useful and
19 Mr. Berlinger's answer was not included in that category.

20 BY MR. DYNNER:

21 Q Mr. Henriksen, if a ligament crack did not arrest
22 at the liner landing what could be the impact on the engine
23 operation if it continued to propagate?

24 A (Witness Henriksen) I can foresee that it will
25 continue to crack so I can't really answer that.

AGBpp

1 Q Well, I'm asking you a hypothetical question
2 based upon your expertise in the diesel engine and in this
3 particular one if the crack continued to propagate through
4 the liner landing ledge what effect would that have
5 potentially on the diesel's operability.

6 A You are now talking from the cylinder liner
7 counterbore to the cylinder stud, right?

8 Q The ligament cracks, yes.

9 A At the moment I can't see any adverse effect
10 to that crack alone.

11 Q It's true, isn't it, that if it propagated for
12 about two and a half inches it would go through to the
13 jacket water; wouldn't it?

14 A Well, without the drawing I'll just have to take
15 your word for it that two and a half inches is correct.

16 Q If not two and a half inches something in that
17 approximate range; isn't that right?

18 A Yes, as far as I recall.

19 Q And if a crack, a ligament crack, propagated
20 to the jacket water what effect might that be?

21 A That some water would seep up through the top and
22 up to the top of the block.

23 Q So you could have a loss of jacket water; is that
24 correct?

25 A Yes.

AGBpp

1 JUDGE BRENNER: I'm sorry. In the previous
2 answer I didn't hear what you said, Mr. Henriksen, as to
3 where the water would seep up.

4 A (Witness Henriksen) It would come up to the
5 top of the block.

6 BY MR. DYNNER:

7 Q Could you also have combustion gases getting into
8 the jacket water as a result of that?

9 A (Witness Henriksen) I cannot see that at all.

10 Q The jacket water is under pressure; isn't it,
11 Mr. Henriksen?

12 A That's correct.

13 Q And that would cause the jacket water to leak at
14 a greater rate than if it were not under pressure; isn't
15 that right?

16 A Sure.

17 Q Have you made any calculations or done any
18 analysis as to the effect on engine operability of a
19 ligament crack that propagated through to the jacket water?

20 A No.

21 Q Dr. Bush, have you had an opportunity to look at
22 Suffolk County Diesel Exhibit 79 which is an eddy current
23 examination report of September 12, 1984?

24 A (Witness Bush) The answer is I've looked at it.
25 I would have to look at it again. I know I have it here.

AGBpp

1 JUDGE BRENNER: It wouldn't be in a book.

2 MR. DYNNER: Mr. Perlis, can you help your
3 witnesses?

4 WITNESS BUSH: I have there, but I don't have
5 numbers or I probably can't identify them unless it was the
6 set that was lost in the mail.

7 (Document handed to the witness.)

8 (Witness reviewing document.)

9 BY MR. DYNNER:

10 Q I would ask you, Dr. Bush, to look at the last
11 page of this eddy current examination report that shows a
12 crack extending onto the liner landing ledge; doesn't it?

13 A (Witness Bush) I must confess that I'm having a
14 great deal of difficulty establishing what geometry we are
15 looking at here to tell the truth because I don't have any
16 frame of reference of it.

17 Q Anyone on the Panel, isn't it correct that this
18 examination report shows a crack extending on the liner
19 landing?

20 A (Witness Berlinger) Mr. Dynner, my
21 interpretation of this drawing, it shows in the top center
22 two stud holes and on the right and I think on the left, the
23 outer radius of the cylinder bore and liner landing; is that
24 correct? That's what it looks like and it indicates also
25 that the location of the crack -- there is an indication on

AGBpp 1 the liner landing itself, which -- I think I've properly
2 interpreted this sketch.

3 Q In the line coming out on the righthand side of
4 the sketch would be the arrow pointing to it saying, "crack
5 extends on land." That's what we've called a ligament
6 crack; isn't it, in this drawing?

7 A Yes. A ligament crack as defined from the
8 cylinder liner counterbore across to the stud hole nearest;
9 that's correct.

10 Q And just so the record is clear, do you recall
11 that LILCO's Panel testified that when they did a liquid
12 penetrant examination of this same area that they did not
13 see that the crack extended onto the landing ledge; do you
14 recall that?

15 A (Witness Bush) This was the written testimony?

16 Q The oral testimony; do you recall it or not?

17 A No.

18 A (Witness Berlinger) I don't recall it either,
19 specifically, Mr. Dynner.

20 Q Does this examination report, Dr. Bush, give
21 you confidence in the assumption that the ligament cracks
22 necessarily arrest at the landing ledge and wouldn't extend
23 beyond it?

24 MR. ELLIS: I object to the question because it
25 has given just the report without lengthy testimony that

AGBpp 1 would with it provides a predicate that is misleading.

2 JUDGE BRENNER: I'll overrule the objection
3 although I don't know how much good it's going to do given
4 that knowledge of these witnesses leading up to your
5 question but we will evaluate it along with the questions
6 that you asked are on transcript page 25,503 and the pages
7 leading up to that of the LILCO witnesses.

8 WITNESS BUSH: I would say that I have
9 insufficient information to answer. I would have to say
10 essentially it in three dimensions. In other words, in the
11 inner service the top down and on the landing before I could
12 even get it. And, quite frankly, this record doesn't tell
13 me very much.

14 BY MR. DYNNER:

15 Q Dr. Bush, if you assume for a minute --

16 A (Witness Bush) All right.

17 Q -- that at least one ligament crack did extend
18 onto the liner landing wouldn't that give you less
19 confidence in your assumption that the ligament cracks
20 arrest at the liner landing ledge?

21 A I don't believe I ever said they stopped. I said
22 they go into a negative K field and the liner landing has
23 very severe loads on it from the pushing down of the liner,
24 things of that nature. Now, that would tend to favor a
25 circumferential crack which, if it existed, would tend to

AGBpp 1 serve as a limiting low side or a point of limitation for a
2 crack that is moving down into that zone, if that didn't
3 exist I wouldn't be at all surprised to see it move out on
4 the landing.

5 A (Witness Berlinger) Mr. Dynner, the depth of the
6 crack that is indicated here on the liner landing, if it
7 were well beyond that particular surface then, yes, it might
8 raise some additional concern or uncertainty.

9 However, my recollection is that the approximate
10 depth below the block top of the liner landing level and the
11 stud hole threads, the first stud hole thread is
12 approximately the same, somewhere between 1.5 and 1.7
13 inches. It would not be unusual to assume that some crack
14 that approximate depth. That, in fact, is what I was
15 referring to during my testimony in the last day and a half.

16 Q So you wouldn't be surprised if there were a
17 number of ligament cracks that extended onto the liner
18 landing ledge itself; is that right?

19 A I would not be -- well, let me see if I can term
20 it a little bit differently. I would be surprised but I
21 would not be overly concerned unless that crack continued to
22 show that it had moved well down below that liner landing
23 ledge.

24 Q Dr. Bush, could you turn for a moment to LILCO's
25 Exhibit B-49?

AGBagb 1 Now you agree, don't you, that this Goodman-Smith
2 diagram shows that for low cycle fatigue at 100 percent of
3 load EDGs 101 and 102 blocks are predicted to initiate
4 ligament cracks and are also predicted to initiate
5 stud-to-stud cracks where ligament cracks are present, isn't
6 that right?

7 I am referring to again Exhibit B-49. I noticed
8 you had the wrong exhibit.

9 A (Witness Bush) That's why I was having... I
10 have B 49 but that doesn't tell me what you said
11 necessarily.

12 Q B-49 is labeled "Goodman-Smith Diagram for
13 Low Cycle Fatigue, 100 Cycles at 100 Percent Load for
14 Shoreham Engines DG 101 and DG 102," is that the exhibit you
15 have before you?

16 A That's the exhibit I have in front of me.

17 Q Okay.

18 Now do you see the star or asterisk labeled
19 "Ligament?"

20 A Well I see three asterisks all used for the same
21 thing, yes.

22 Q Now the star that's labeled "Ligament," doesn't
23 that show that ligament cracks are predicted to initiate
24 under the conditions stated in the label or heading for that
25 exhibit?

AGBagb 1 A If those asterisks represent the physical loads
2 under mean stress and alternating stress, that would be
3 true.

4 Q And do you have any reason to believe that this
5 information shown on this Goodman diagram is incorrect as to
6 the initiation of those cracks?

7 A No, I would have no reason to disbelieve that.

8 Q And if you turn to Exhibit B-50 it's true, isn't
9 it, that when you read this Goodman-Smith diagram it
10 demonstrates that for high cycle fatigue at 100 percent of
11 load for EDGs 101 and 102 ligament cracks are predicted to
12 initiate and stud-to-stud cracks are predicted to initiate
13 where ligament cracks are present, isn't that right?

14 A That's correct. It almost looks as if it has
15 exceeded the ultimate strength, that's why I'm a little
16 confused.

17 Q I'm sorry, could you explain what you meant by
18 that last --

19 A Well if you look at the lines and when you go to
20 zero alternating stress that normally is the point of the
21 ultimate tensile strength we would expect failure, that's
22 why I'm looking at it, it looks as if they are to the right
23 of that so I'm just wondering about the location of the
24 asterisks and so on. Because fundamentally that would say
25 that the first time you loaded the system it would fail.

AGBagb 1 Q Do you have any reason to believe that these
2 predictions are not accurate?

3 MR. ELLIS: I object. There's no testimony that
4 they are predictions, in fact, there is a great deal of
5 testimony --

6 JUDGE BRENNER: Stop. I want to get the witness'
7 views of it. That's what happens when you ask a different
8 set of witnesses questions as to testimony including
9 exhibits and explanatory oral testimony of another witness.
10 And although when there are total mischaracterizations we
11 will certainly sustain objections because otherwise the record
12 is useless, when you are in a gray area of different
13 parties will have different opinions of what the findings
14 will be supported by the facts I am going to permit the
15 examination. Sometimes the examination will turn out to not
16 be very valuable if the only thing Witness B knows is what
17 he's reading on something and what counsel is suggesting --
18 is asking him to assume. But for now the questions have
19 been permissible in our opinion and we will overrule the
20 objection.

21 WITNESS BUSH: I would interpret this diagram as
22 indicating that in all instances the cracks would initiate.
23 My comment on mean stress would be if it were global mean
24 stress that it would also say that they would all have
25 failed long since. That's why I was surprised at the

AGEagb 1 location of some of the asterisks.

2 BY MR. DYNNER:

3 Q Do you have any reason to believe that the
4 information on this exhibit is incorrect or inaccurate?

5 A (Witness Bush) The point I raised makes me
6 wonder because usually the way one reads such a diagram is
7 that at zero cycles you run from the point where you would
8 expect failure at zero cycles, namely, by pure load and then
9 you move over. And if I read this one correctly the mean
10 stress there it looks as if they have exceeded the ultimate
11 strength with the two asterisks, if they're located
12 correctly. So I have problems with the diagram, quite
13 frankly, under those circumstances.

14 I recognize that these are a simulation based on
15 other tests, but if one extrapolates and applies the same
16 loads and assumes that the loads are constant then you have
17 a totally different situation and that's why I'm confused.

18 Q You're aware, aren't you, that these
19 Goodman-Smith diagrams were prepared by FaAA and are based
20 upon the strain gage testing that was performed on EDG 103,
21 isn't that right?

22 MR. ELLIS: I object again. It is an incomplete
23 -- it's a wrong characterization -- or an incomplete
24 characterization of what they're based on. There is a
25 tremendous amount of testimony on these things.

AGBagb 1 JUDGE BRENNER: I want to find out what this
2 witness knows about these diagrams and this question will
3 help me in that regard so the objection is overruled.

4 WITNESS BUSH: The answer is yes, I'm aware of
5 that.

6 BY MR. DYNNER:

7 Q And Dr. Bush, it's true, isn't it, that you've
8 carefully reviewed LILCO's testimony concerning the
9 initiation of ligament cracks and stud-to-stud cracks in the
10 blocks, haven't you?

11 A (Witness Bush) As much as I had available to me,
12 yes. I have examined the June report in some depth and I
13 have examined the written testimony and I have, shall I say,
14 attempted to read the oral testimony over a period of the
15 last few weeks.

16 Q And aside from the comment that you made that you
17 were surprised to see the low stress levels at which these
18 cracks are shown to initiate, you have no other reason for
19 disagreeing with these data, do you?

20 A So far as an initiation is concerned, it is
21 obviously a probabilistic event, it doesn't say that it has
22 to occur at one, but in any event if you are markedly above
23 the lines on there with regard to the combination of
24 stresses then normally that would indicate that you would
25 have crack initiation. After that, then it depends on the

AGBagb 1 ligament cracks already in the block, don't they?

2 A As they read at 100 percent load and for that
3 number of cycles, that's correct, which is a caveat of
4 course.

5 Q And you don't disagree with that information, do
6 you?

7 A As test information I don't disagree with it,
8 that's correct.

9 You realize that that doesn't necessarily say
10 that I interpret that to be what is going to happen in the
11 actual system because the load characteristics will not be
12 at all the same as we are portraying here.

13 Q You mean the load characteristics may be less
14 than 100 percent of load, is that what you're referring to?

15 A That's correct.

16 Q Do you recall that there was testimony that
17 cracks, stud-to-stud cracks possibly can initiate in the
18 presence of ligament cracks even at 90 percent of load,
19 that was testimony by LILCO's panel, do you remember that
20 anyone?

21 MR. ELLIS: Again I object to his
22 characterization of LILCO's testimony.

23 JUDGE BRENNER: What probitive value is it going
24 to have, Mr. Dynner, to ask him if he remembers it? Do you
25 have follow-up questions?

AGBagb 1 MR. DYNNER: If he remembers it I would like to
2 then explore very briefly how that relates to his previous
3 answer.

4 JUDGE BRENNER: Do you have a cite?

5 MR. DYNNER: No, I don't, the record will speak
6 for itself, sir. I was not characterizing the testimony I
7 was asking whether he recalled testimony to that effect.

8 WITNESS BUSH: No.

9 BY MR. DYNNER:

10 Q Dr. Berlinger, do you?

11 A (Witness Berlinger) Could you restate the
12 question, please?

13 Q Yes.

14 . Do you recall any testimony from the LILCO panel
15 to the effect that under these Goodman-Smith diagrams as
16 shown in Exhibits B-49 and B-50 that they would show that
17 stud-to-stud cracks possibly would initiate in the presence
18 of ligament cracks even at 90 percent of load?

19 A I do not recall.

20 Q You're aware, aren't you, gentlemen, that the
21 current FSAR requires that the EDGs be capable of continuous
22 operation at 3500 kilowatts for one year and at 3900
23 kilowatts for two hours in any 24-hour period; are you aware
24 of that?

25 A I'm aware of a statement similar to that in the

AGBagb 1 FSAR as far as the rating of the engine is concerned.

2 Q By "similar," can you tell me whether that's a
3 fair characterization of the FSAR performance requirement
4 for these diesels?

5 A Mr. Dynner, I didn't memorize the FSAR and I'm
6 not trying to be facetious in responding to you. But there
7 has been a lot of discussion previously in this hearing with
8 regard to the one year of continuous service operation and
9 how it is interpreted. And I don't remember the precise
10 wording in the FSAR --

11 Q My question is was that a fair characterization,
12 a fair paraphrase of the FSAR requirement?

13 A I think that words to that effect are in the FSAR
14 but I don't recall precisely what they are to say
15 unequivocally that the way you have characterized it is
16 accurate.

17 Q Is it your testimony that you, Mr. Berlinger,
18 Dr. Berlinger, don't know what the performance rating is for
19 the EDGs in the current FSAR?

20 MR. ELLIS: I object to the question on the FSAR
21 continuous rating. The standard in this litigation is the
22 first refueling outage loop LOCA load profile and that is
23 the standard --

24 JUDGE BRENNER: That's nice, overruled.

25 MR. ELLIS: Well, but may I finish?

AGBagb

1 JUDGE BRENNER: No, the question is permissible.
2 I want to find out what Dr. Berlinger has to say on the
3 subject and not what you have to say in the way of
4 testimony on the subject, Mr. Ellis. But I will
5 certainly --

6 MR. ELLIS: I had in mind arguing.

7 JUDGE BRENNER: -- I will certainly pay careful
8 attention to your findings on this subject, I assure you.
9 But at this point in the process we are at the evidentiary
10 hearing and I want to hear from the witness on it.

11 WITNESS BERLINGER: Could you repeat the
12 question, please?

13 MR. DYNNER: Yes.

14 BY MR. DYNNER:

15 Q Do you know what the performance requirement is
16 for the EDGs in the current FSAR?

17 A (Witness Berlinger) Yes, I do.

18 Q Could you please tell us?

19 A The FSAR as approved at the present time, keeping
20 in mind that there is a proposed modification that has been
21 submitted to the Staff relative to FSAR Section 8.3, but in
22 particular the rating of the engine is 3500 kilowatts and
23 that it would be able to provide 3900 -- up to 3900
24 kilowatts of load for two hours out of every 24 hours of
25 continuous service.

AGBagb 1 The two hour out of 24 portion of the load
2 rating, if I could use that terminology, is intended to
3 indicate that the engine is capable of providing 110 percent
4 overload service without any increase in the normal
5 maintenance and frequency which would be recommended by the
6 manufacturer.

7 The particular rating and the specific
8 information relative to to one year of continuous service is
9 not intended to state that the engine would have to run
10 continuously for one year but the engine could be operated
11 at, say, 3500 kilowatts and that it would be permissible for
12 the engine to be shut down for normal maintenance and to
13 remedy any problems that may develop during that operating
14 period.

15 Q When you referred to 110 percent, 3900 kilowatts
16 is not 110 percent of the continuous rated load of 3500, is
17 it? It's slightly more than 110 percent, isn't it?

18 A Yes, it's slightly more, yes.

19 Q And the continuous rating, in fact, requires the
20 EDG to operate continuously for 8760 hours with maintenance
21 intervals required by the Delaval manual, isn't that right?

22 MR. ELLIS: Objection, asked and answered.

23 JUDGE BRENNER: Overruled. He is probing or
24 following up on a previous answer which was a little more
25 general and in fact not quite the same answer. I'll

AGBagb 1 overrule it.

2 WITNESS BERLINGER: Can I ask you to repeat that,
3 please?

4 MR. DYNNER: Yes.

5 BY MR. DYNNER:

6 Q The 3500 Kw continuous rating requirement is for
7 continuous operation for 8760 hours with maintenance
8 intervals required by Delaval, the manufacturer, isn't that
9 right?

10 WITNESS BERLINGER: Before I can answer, your
11 Honor, I need a little more clarification as to whether
12 Mr. Dynner is referring to what's in the FSAR or what we use
13 in the way of regulations in order to qualify these diesels
14 for nuclear service.

15 JUDGE BRENNER: As I heard the question I think
16 it would be open to you to include any basis to support
17 whatever answer you give. And if there are two possible
18 answers I guess you'd better inform Mr. Dynner and the rest
19 of us also.

20 WITNESS BERLINGER: Thank you.

21 The NRC reviews the diesel generator and its
22 adequacy for nuclear service in accordance with the
23 regulation which is stated very generally in the general
24 design criteria, GDC 17.

25 In addition, we use guidance provided in

AGBagb 1 regulatory guides which references IEEE, I think it is IEE
2 385 or 387. That, in turn -- that IEEE standard in turn
3 refers to DEMA as -- Diesel Engine Manufacturers'
4 Association guidelines.

5 Basically there is no specific requirement in our
6 regulations that says that an engine must be able to provide
7 continuous service for the one year equivalent thousands of
8 hours. There is no specific requirement within the
9 regulation which requires that the engine provide 110
10 percent service, 110 percent of design rating, nameplate
11 rating service.

12 In fact the regulations as they state indicate
13 that the engines should provide reliability and that they
14 should be capable of providing the required service in
15 response to a loss of off-site power or a design basis event
16 involving loss of off-site power.

17 In a nutshell, that's the way we review the
18 design from the standpoint of calling it according to the
19 Federal regulations.

20 BY MR. DYNNER:

21 Q And in the absence of these specific requirements
22 in the regulations, you have to look to the requirements in
23 the FSAR for a specific engine and plant, don't you?

24 A (Witness Berlinger) What we have to do is
25 determine whether or not these diesels will provide the

AGBagb 1 required service and do it reliably.

2 Q And you have to look at the FSAR as a first step
3 in that process, don't you?

4 A The FSAR will provide information relative to how
5 well those diesels stack up against this requirement. The
6 FSAR is not regulation. The FSAR states the position by the
7 utility as to how they feel they meet the regulations.

8 Q I'm asking you what the NRC Staff does in the
9 ordinary case, let's forget about Shoreham for a minute. In
10 the ordinary case, in the absence of specific requirements
11 in the regulations as to the performance requirements for
12 EDGs in nuclear power plants, the Staff has to look at the
13 FSAR and does in fact look at the FSAR in making its
14 determinations as to whether the requirements of GDC 17 are
15 met, doesn't it?

16 A That is correct because the FSAR provides the
17 utility's position defining how they feel their engines meet
18 the regulations.

19 Q And it's true, isn't it, that at the current time
20 Section 8.3.1.1.5 of the FSAR requires each EDG at Shoreham
21 to be rated to operate continuously 8760 hours at full load
22 of 3500 Kw with maintenance intervals required by Delaval,
23 isn't that right?

24 MR. ELLIS: I object to the question unless it
25 also adds the remainder of the provisions in that section

AGBagb 1 which relate to GDC 17.

2 JUDGE BRENNER: The objection is overruled. He
3 can ask the question. You can come back with whatever you
4 want to, Mr. Ellis.

5 WITNESS BERLINGER: Please repeat the question,
6 Mr. Dynner.

7 MR. DYNNER: This is just taking an inordinate
8 amount of time --

9 JUDGE BRENNER: All right. Your comment adds
10 extra seconds to that time.

11 BY MR. DYNNER:

12 Q It's true, isn't it, that Section 8.3.1.1.5 of
13 the FSAR, current FSAR for Shoreham requires each EDG to be
14 rated to operate continuously 8760 hours at full load of
15 3500 kilowatts with maintenance intervals required by
16 Delaval, isn't that right?

17 A (Witness Berlinger) I can't attest to the
18 accuracy of your reference. I will assume that it is
19 perfectly correct and that you have basically read it to
20 me. If that's the case then yes, that's what's stated in
21 the FSAR.

22 JUDGE BRENNER: Mr. Dynner, are you going to move
23 that portion of the FSAR into evidence? You think about the
24 state of the record, given the witness' answer just now.

25 MR. DYNNER: I think under the circumstances I

AGBagb 1 am going to have to. I'm not prepared to do it today, sir,
2 or at this time.

3 JUDGE BRENNER: Okay. If you are going to do it,
4 do it while the witnesses are here.

5 (Pause.)

6 JUDGE BRENNER: Would you like to break for lunch
7 now? It is within a few minutes anyway.

8 MR. DYNNER: All right. I'm going to do my best
9 -- in fact, I will have to pledge to you that I am going to
10 finish up today. I will finish today.

11 That is the best commitment I have ever made to
12 this Board.

13 JUDGE BRENNER: I haven't said a word. You keep
14 talking.

15 I had what I guess was a pipe dream that we might
16 finish with this witness panel totally today, but obviously
17 if you take the remainder of the day that won't happen.

18 All right. Let's break until 1:30.

19 (Whereupon, at 11:55 a.m., the hearing in the
20 above-entitled matter was recessed, to reconvene at 1:30
21 p.m., this same day.)

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AFTERNOON SESSION

(1:45 p.m.)

JUDGE BRENNER: We can go on the record now.

Whereupon,

SPENCER H. BUSH,

ADAM J. HENRIKSEN,

and

CARL H. BERLINGER

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

JUDGE BRENNER: Mr. Dynner.

MR. DYNNER: Thank you, your Honor.

CROSS-EXAMINATION (Continued)

BY MR. DYNNER:

Q Gentlemen, will you please turn for a moment to
page 29 of your testimony?

Dr. Bush, in your answer in the first full
paragraph on page 29 you stated that in your opinion, on the
basis of a limited review, the most probable location for
cracks to initiate would be at the corner of the counterbore
at the start of the threads.

If a crack initiated at that point, you could not
determine whether or not the crack were there by an eddy
current reading inside the stud hole, could you?

A (Witness Bush) Yes, you could.

WRBeb

1 Q All right.

2 Could you determine whether that crack were there
3 accurately with an eddy current probe?

4 A You should be able to, yes.

5 Q Could you determine whether that crack had
6 initiated there-- Let me back up for a minute.

7 In answering those questions, would your answer
8 be the same if the crack had not propagated up to the top of
9 the block?

10 A It would still be the same.

11 Q How accurate do you think an eddy current reading
12 would be? I mean would it be within 5 percent, 20 percent,
13 30 percent? Do you have an opinion on that?

14 A I would anticipate that it would be plus or minus
15 a tenth of an inch at the worst.

16 Q Could you locate the initiation of such a crack
17 by liquid penetrant exam inside the stud hole?

18 A Would you define location for me? And I think I
19 can answer the question.

20 What do you mean by location? Do you mean the
21 specific site?

22 Q The location at the corner of the counterbore at
23 the start of the threads, as you've testified.

24 A Very well.

25 The answer is that assuming that the surfaces are

WRBeb 1 smooth enough or that I could smooth them up sufficiently, I
2 should be able to locate it by penetrant testing. It may
3 not be easy but it's possible.

4 Q In your opinion, Dr. Bush, could a stud-to-stud
5 crack initiate from the corner of the counterbore at the
6 start of the threads?

7 A I think that's possible, given I have a high
8 stress concentration factor and that I probably have to have
9 a deep ligament crack. Or are you presuming that it
10 initiates as a separate item, and that there is no ligament
11 crack? Maybe I should understand which case you are talking
12 about.

13 Q Okay. I'm asking you so maybe you can tell me
14 under what circumstances would it be most likely for a
15 stud-to-stud crack to initiate from the corner of the
16 counterbore at the start of the threads?

17 A I would feel that there would have to be a
18 substantial ligament crack with a redistribution of stresses
19 in there, and presumably enough crack-driving force for that
20 location. And I'm not sure whether there is enough or not,
21 under the circumstances, to cause initiation.

22 Q You testified, didn't you, that there would be
23 enough stress for a ligament crack to initiate?

24 A That's correct, because I'm interested in the
25 thermal gradients, but as we move further away from the

WRBeb 1 sources, thermal gradients become a relatively trivial
2 factor.

3 Q How long would it take for a crack that initiated
4 from the corner of the counterbore at the start of the
5 threads to propagate up to the top of the block, Dr. Bush?

6 A Well, it's obviously a highly subjective
7 judgment. That's a fairly steeply ascending K field so
8 presuming it did initiate at that corner in there, I suppose
9 it is not impossible that it could get to the surface in a
10 matter of days.

11 And then I say days, that doesn't mean in the
12 sense of a specific period but perhaps days of operation of
13 the unit where you might have started the unit, stopped it,
14 started it, stopped it, started it, stopped it, and
15 accumulatedly that would probably be enough to cause it.

16 JUDGE BRENNER: Dr. Bush, are you talking about
17 either side of the stud, or the cylinder, the so-called
18 ligament side, or only the stud side?

19 WITNESS BUSH: My comments now are exclusively on
20 the ligament side.

21 JUDGE BRENNER: Okay.

22 WITNESS BUSH: As I understood the question it
23 was a question of if it initiated at that corner, how long
24 would it take to propagate.

25 JUDGE BRENNER: The question didn't specify which

WRBeb 1 side of the stud, and that's why I asked.

2 WITNESS BUSH: I was inferring the ligament only.

3 BY MR. DYNNER:

4 Q When you said that the ligament crack initiating
5 at that point could propagate up to the block top in a
6 matter of days, were you assuming any particular load, or
7 number of hours at a particular load?

8 A (Witness Bush) Well, what I'm assuming here
9 would be a series of starts and stops which would maximize
10 the types of stresses that I'm concerned with in there, in
11 other words, quick starts at the full load. And I would
12 have to make a guesstimate but I think if I have a really
13 steeply ascending K field, I would think that perhaps once
14 it's initiated, 10 or 20 quick starts might be enough to
15 cause it, you know, where you might run it a few hours each
16 time. That's a supposition, you know.

17 I haven't been able to sit down and look at the
18 stresses of the thing.

19 Q If the engine were not being subjected to a
20 number of quick starts to full load but were simply
21 operating continuously at full load, would you then expect
22 the ligament crack that initiated down at the start of the
23 threads to propagate to the block top at a slower rate?

24 A At a slower rate; that's correct.

25 Q And if you had a stud-to-stud crack that

WRBeb 1 initiated at the corner of the counterbore at the start of
2 the threads, would you anticipate that that type of crack
3 would propagate to the block top at still a slower rate than
4 the ligament crack?

5 A Yes, I would think so. I'm not saying that I
6 necessarily figure that it would at that corner because
7 that's a matter of redistribution once one gets a fairly
8 large ligament crack. But predicated on what you say, I
9 would say yes, I would believe it would be much slower.

10 Q And am I correct that in order to do an eddy
11 current measurement to discovery whether or not there was a
12 crack initiating at the corner of the counterbore at the
13 start of the threads that you would have to remove the
14 cylinder head from that stud hole?

15 A I think that follows that if you have a crack in
16 that area, you can't examine it with the head on. That's
17 correct.

18 Q Dr. Berlinger, do you agree with Dr. Bush that
19 the eddy current examination is accurate to within plus or
20 minus a tenth of an inch, assuming of course that it's done
21 properly by a competent examiner?

22 A (Witness Berlinger) Based on the experience that
23 I have seen I would generally anticipate that the technique
24 would have an accuracy of from plus or minus 20 to 30
25 percent. That is not wholly inconsistent with Dr. Bush. It

WRBeb 1 depends on what you're using the eddy current technique to
2 identify.

3 If you wanted to use it to try and measure a
4 depth, then you're talking about an accuracy of either plus
5 or minus 20 percent, 30 percent, or a tenth of an inch. But
6 if you were using it primarily to identify the existence of
7 a crack or get a relative measurement as to how deep the
8 crack is, it would be sufficient and the accuracy is not
9 that relevant. It would clearly indicate the existence of a
10 crack.

11 Q When you say it would clearly indicate the
12 existence of a crack, are you speaking about only a surface
13 crack?

14 A Yes. The eddy current technique is a surface
15 technique.

16 Q Now, Dr. Berlinger, how accurate along-- With
17 the same sort of guidelines, that is, if you can tell us
18 within a plus or minus percentage, how accurate a technique
19 for measuring the length of cracks is the liquid penetrant
20 examination technique, in your view?

21 JUDGE MORRIS: Excuse me, Mr. Dynner. May I
22 interrupt for a moment?

23 MR. DYNNER: Certainly.

24 JUDGE MORRIS: I don't understand Dr. Berlinger's
25 answer of 20 percent. Of what? I assumed that you both

WRBeb 1 were talking about a surface indication, and that the
2 question was how accurately can you determine the length of
3 that indication, and it might be very short, it might be
4 very long.

5 WITNESS BERLINGER: I interpreted the question as
6 far as the length of the crack actually to be the depth of
7 the crack. It would be very accurate as long as measuring
8 the length along the surface. And I interpreted your
9 question to say how accurately could you measure the depth
10 below the surface that the crack extended.

11 The method is not accurate in any way in
12 determining the profile of the crack if it isn't.... It is
13 not going to be a straight line, or linear, so it in no way
14 can be used to try to characterize or measure the contour of
15 a crack.

16 The plus or minus 20 or 30 percent is generally
17 for talking about the depth of the cracks that have been
18 reported of roughly anywhere from a half inch up to an inch
19 and a half in depth. I base that on some experiences I have
20 had, and that's the type of crack depths that I was talking
21 about, in that range anywhere from really a quarter to an
22 inch and a half deep.

23 So my estimate of, say, plus or minus 20 percent
24 would be approximately .3 of an inch, plus or minus .3 of an
25 inch for an inch and a half deep crack.

WRBeb

1 MR. DYNNER: Let me try to clarify that if I may
2 with some examples.

3 BY MR. DYNNER:

4 Q Mr. Berlinger, if you take a ligament crack and
5 you measure the ligament crack running along the surface of
6 the cylinder counterbore which would be a surface
7 measurement but it would show you the depth of the ligament
8 crack at that point,-- Isn't that right?

9 A (Witness Berlinger) That is correct.

10 My answer previously was just taking a look at
11 the surface and trying to use eddy current technique to
12 measure the depth below that surface that a crack has
13 propagated,--

14 Q Let me try to--

15 A -- to put it in perspective.

16 Q -- clarify it in these examples, if I may,
17 Mr. Berlinger.

18 JUDGE BRENNER: Mr. Dynner, my opinion, for what
19 it's worth, is we have been through a lot of this already,
20 and I think I finally have straight the dimensions being
21 discussed. But if you think there is a problem I will let
22 you stay with it.

23 MR. DYNNER: I'm getting somewhere, and I think
24 this may be significant.

25 JUDGE BRENNER: All right.

WRBpp

1 BY MR. DYNNER:

2 Q Now, in measuring a crack, a ligament crack,
3 along the counterbore of the cylinder with an eddy current
4 examination and in reality it was a one-inch crack, one inch
5 long, what variation, if any, would you expect to find from
6 that one inch in your measurement with an eddy current?

7 A (Witness Berlinger) The question may be even
8 more confusing to me.

9 If I'm going to use an eddy current probe to
10 determine the type of crack from the block top surface down
11 into the block by using the probe in the stud-counterbore
12 area to determine how far down into the block down in the
13 stud counterbore area then the accuracy would be very good
14 because you would be looking at basically indications or
15 measurements that would do a very good job of indicating the
16 extent of the crack down into the whole.

17 It's almost like looking at the extent of the
18 surface of a piece of metal to determine the length along
19 the surface of that crack.

20 Q If you were to try to measure the length of the
21 surface of the crack running along the inside of the
22 cylinder counterbore with ligament penetrant how accurate
23 would you expect that measurement to be.

24 MR. ELLIS: Judge Brenner, I'm going to object to
25 this line of questioning. I don't think there has been any

WRBpp 1 indication that this is Dr. Berlinger's special area of
2 expertise or that he is a level two or three or anything
3 else inspector. Therefore, my objection is that there is no
4 foundation.

5 JUDGE BRENNER: Mr. Dynner?

6 MR. DYNNER: Dr. Berlinger, if you're attacking
7 his expertise, his testimony on page 29 and onto 29A about
8 the measurement of cracks with eddy current and I'm
9 exploring with him the accuracy of that and other
10 nondestructive examination techniques. So nobody has
11 previously including LILCO objected to Dr. Berlinger's
12 expertise to give that testimony. It's on the same general
13 subject matter, measurement of crack depths.

14 MR. ELLIS: May I respond, Judge Brenner?

15 JUDGE BRENNER: Wait.

16 (Pause.)

17 MR. DYNNER: And I would add that he testified
18 extensively in answer to Mr. Ellis's questions on the same
19 questions about the crack maps and the means by which they
20 were measured.

21 JUDGE BRENNER: When I told Mr. Ellis to wait I
22 meant everybody.

23 All right. I'm going to allow the question
24 partly because Dr. Berlinger has had the benefit of hearing
25 this dialogue and as all witnesses should know if the

WRBpp

1 question is beyond his area of expertise or if he knows part
2 of the answer, the answer should indicate that limitation
3 and if in answering the question he doesn't deem it
4 necessary to include any such limitation, we will allow
5 somebody else who disagrees with the answer to come back and
6 ask him how he knows.

7 But, Mr. Dynner, what I did not let Mr. Ellis
8 point out was that although he asked him some questions of
9 the nature you discuss, they were not questions about liquid
10 penetrant testing, per se. Nevertheless, we will allow the
11 question now and see what Dr. Berlinger has to say about it.

12 Do you remember the question? He wants to know
13 -- well, I'll ask it and Mr. Dynner can correct me. He
14 wants to know what the accuracy of a liquid penetrant
15 examination would be as to -- done in the stud hole.

16 MR. DYNNER: In the cylinder counterbore along
17 the cylinder counterbore surface.

18 WITNESS BERLINGER: To determine the length of
19 the crack down the counterbore area?

20 MR. DYNNER: Yes. As it appears on the cylinder
21 counterbore surface.

22 WITNESS BERLINGER: The use of liquid penetrant
23 there would be, again, fairly accurate because you are using
24 that technique basically to locate the edge or the end of a
25 crack along that surface.

WRBpp

1 JUDGE BRENNER: You know, I should have pointed
2 out also if any member of the Panel has information that
3 disagrees particularly information that disagrees, he or she
4 should speak out.

5 WITNESS BUSH: The only comment I would add is
6 that that's quite sensitive to the surface if you have a
7 rough, a very rough machined surface that it gets a lot more
8 difficult other things being equal, if it reasonably
9 finished then penetrant testing generally is a fairly
10 accurate representation. There have been fairly extensive
11 studies done on this correlating MT and PT with destructive
12 measurements that confirm that with reasonable surfaces that
13 you can -- that it is quite accurate. I used a tenth of
14 an inch deliberately. That is kind of a bounding value
15 assuming you have good finish.

16 BY MR. DYNNER:

17 Q It's possible, isn't it, that the stud-to-stud
18 crack in the 101 or 102 blocks might initiate during a loop
19 LOCA; isn't that correct?

20 A (Witness Bush) Given that we may have a
21 pre-existing ligament crack and we operate for an extended
22 period of time, I would say yes, it certainly is possible.

23 Q When you say an extended period of time, are you
24 relating that to the Goodman-Smith diagrams or is that a
25 general statement?

WRBpp

1 A I was assuming not so much a loss of power
2 because a loss of power, we've only had one really long one
3 that I'm aware of. But let's assume one has a LOCA and
4 needs the pumping characteristics for a hypothetical time,
5 which may not bear a relationship to reality. Then the
6 answer is that, yes, it may initiate; the time may be long
7 enough for it to initiate.

8 Q And how long are you referring to when you say --
9 what length of time do you have in mind in your answer?

10 A Well, I'm considering the possibility of a worst
11 type of accident where we might be pumping literally for
12 many days. Presumably you could reconnect but let's make
13 the worst possible assumptions and then it doesn't and then
14 it continues to pump. I'm also assuming that we have a bad
15 case and we may not wish to blowdown the system so that we
16 are pumping against the head which, as far as I'm concerned
17 this is a whole series of very conservative assumptions,
18 maximizing the power needs.

19 Q Have you performed any analysis to determine the
20 rate at which a stud-to-stud crack would propagate?

21 A No.

22 Q Well, it's possible then, isn't it, that a
23 stud-to-stud crack which initiated during a loop LOCA might
24 propagate to engine failure during the loop LOCA; isn't that
25 right?

WRBpp

1 A That presumes that the calculations with regard
2 to compressive fields are not valid. In other words, we've
3 been talking about a crack that would propagate upward.
4 That does not necessarily say that the crack will propagate
5 indefinitely. I think there is sufficient evidence to
6 indicate that there won't be the driving force for that. My
7 major concern is with regard to initiation and propagation
8 tend to be related to a lot of stop-starts and operation
9 under a loop LOCA approximates at least as a first
10 approximation, steady state conditions. Which, so far as
11 I'm concerned, would not necessarily have the same degree of
12 driving force as otherwise.

13 Q What are the calculations of compressive fields
14 to which you referred?

15 A Looking at some of the things in the reports,
16 some of the values that I have seen either orally or in
17 written form with regard to the reports of FaAA.

18 Q Can you please identify with more specificity the
19 calculations of compressive fields you were referring to?

20 A Well, I have seen some values on bold loads on
21 there and I have heard oral testimony on it outside of
22 this. I'm trying to remember if it is in here or not.

23 (Pause.)

24 JUDGE BRENNER: He couldn't answer your question
25 and that's where it stands for now.

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WITNESS BUSH: Yes.

JUDGE BRENNER: We've been waiting a few minutes.

BY MR. DYNNER:

Q What's your basis for the statement that there was is a limited driving force with respect to the propagation of a stud-to-stud crack?

A (Witness Bush) Because when you bolt down on that you develop a compressive field in there and you would have a tensile field, a circumferential tensile field around the bolt but then you go into compression.

Q What bolts are you talking about?

A I thought we were talking about the stud-to-stud so that would be those studs.

Q The cylinder head studs?

A Yes.

JUDGE BRENNER: Off the record.

(Discussion off the record.)

JUDGE BRENNER: Back on the record.

BY MR. DYNNER:

Q Now, as I understand your testimony you have agreed, haven't you, that looking at those Goodman-Smith diagrams that you did not disagree with that stud-to-stud cracks are predicted to initiate in the presence of a block that has ligament cracks; right?

MR. ELLIS: Objection. Asked and answered.

WRBpp

1 JUDGE BRENNER: You know, I was so sure that the
2 objection was going to be on other grounds, that I didn't
3 focus on the last half of the question which should be the
4 subject of your objection.

5 MR. ELLIS: I'll have a backup.

6 JUDGE BRENNER: I'm sorry, I'm going to have to
7 hear the question in order to rule on whether it's asked and
8 answered. But I'm going to make my own objection to the
9 fact that I did not accurately characterize the testimony.

10 BY MR. DYNNER:

11 Q Dr. Bush, why wouldn't the effect of the cylinder
12 head studs, which you say -- why wouldn't the effect of the
13 cylinder head studs be to preclude stud-to-stud cracks from
14 initiating?

15 A (Witness Bush) I don't believe I have ever said
16 anything about them not initiating. We have left the
17 initiation phase and they have been talking about
18 propagation, that's a different animal entirely controlled
19 by a totally different set of characteristics. In other
20 words, I can visualize initiation either at the counterbore
21 area or at the surface. If I squeeze down and spread out
22 and develop transverse loads and I get a pulsating load on
23 there, that's one thing. After I initiate a crack I have to
24 have a driving force to continue to propagate it and then I
25 move over into a totally different type of calculation.

WRBpp

1 I would have to essentially do a cumulative
2 fatigue analysis on it looking at the cycles that exist in
3 terms of da/dm and on that basis look at the K fields that
4 would be generated.

5 In general, my opinion is that we do have
6 compressive fields on there. I might comment in passing
7 that in review of this report we raised specific questions
8 which have not necessarily been answered yet but that is
9 outside of the province of this testimony as I see it.

10 Q Why don't these compressive fields prevent
11 ligament cracks from propagating?

12 A I have already said they don't beyond a
13 certain point.

14 Again, we're in a situation that we have agreed
15 that cracks will initiate which is what you're using the
16 Goodman diagram for. And we, essentially, said we would
17 anticipate that they would initiate primarily in the
18 ligament area and only secondarily and probably after a
19 substantial depth in the stud-to-stud area. Once they have
20 initiated then you have to do an analysis and the only
21 definitive way that I know of -- and this was a subject of
22 considerable discussion yesterday -- would be do to a
23 three-dimensional finite element where essentially all of
24 the inputs have been validated to examine how deep the crack
25 would go. I tend to feel that there's a limit, I think we

WRBpp 1 disagree on where the limit may be. That would apply
2 whether we're talking of ligament cracks or whether we're
3 talking about stud-to-stud cracks. Now, I have not
4 attempted to do such an analysis, I've looked at the
5 values, I've discussed the models with our finite element
6 experts and he and I tend to agree on the format of the
7 thing, and that's about as far as we went. We both felt
8 that, yes, there were compressive stresses because of the
9 loading characteristics that would tend to be self-limiting
10 but we didn't know where that self-limiting point would be.

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WRBagb 1 Q Dr. Bush, what is the compressive force that you
2 have been talking about in numbers?

3 A Well that's a real good question. That's one
4 reason I think we need more values. I think there have been
5 values cited in terms of several Kips in there, in this
6 particular report. And certainly looking at it and looking
7 at the bolting loads which I think, assuming that you get
8 torques on them that you could establish, would indicate
9 that there would be that type of field.

10 But I don't honestly, outside of a definitive
11 three-dimensional analysis, I don't know whether I can say
12 that the values are -- that the average values are -3 Kips
13 or -10 Kips or something of that nature. I don't know any
14 definitive way to establish it.

15 I don't see any positive ones, that's my problem,
16 of course, after I get below a certain depth.

17 Q What other forces or stresses are present which
18 would contribute to or affect the propagation of
19 stud-to-stud cracks?

20 A Well certainly the bolting itself, the fit-up of
21 the bolts will establish a tensile field around the bolts,
22 that would be one factor. If I load the -- if the
23 stud-to-stud bolts push down I will have a field that will
24 vary between the two studs in some fashion and I can't state
25 precisely.

WRBagh

1 I would expect it to vary, to change, to go
2 through a minimum I guess between the two studs is the way I
3 would look at the thing. I don't see any really severe
4 thermal gradients there compared to what the situation is in
5 the ligament area.

6 I'm still going to get a transmission of some of
7 the load from the hoop stresses, though that again tends to
8 be more predominant in the ligament area. But since I have
9 hoop stresses on both sides obviously I am going to get some
10 transmission of stresses, though they should die out rather
11 substantially. And I probably missed about two of them
12 offhand.

13 Q Would the firing pressure contribute to the
14 propagation of the stud-to-stud cracks?

15 A That's quite a distance. I guess I feel that
16 that would be kind of a second order effect. But again
17 until you do a calculation it's pretty hard to tell.

18 I would not think it would be a major
19 contributor.

20 Q How about residual stress in the block, would
21 that be a factor?

22 A Not in this area, I would think so in this area.
23 Usually where residual stress is a problem. Now if somebody
24 had made a weld in the middle of it, that would be something
25 else again, that you didn't know about that, then I think I

WRBagb 1 would be concerned. Usually a flat surface is not
2 particularly conducive to residual stresses. Usually you
3 will see them immediately adjacent to a weld or where you
4 have a sharp change in section. For example, there are
5 other areas of the block where we have such discontinuities
6 and, under these circumstances, because of restraint that
7 would continue below a certain temperature, I would
8 anticipate it. I wouldn't anticipate very high residual
9 stresses on top of the block.

10 Q Have you done an analysis or measurement of the
11 residual stress in the top of the block?

12 A No, to my knowledge I am not aware of any
13 residual stress measurements on any of the blocks in any
14 location. I only know of about three methods of doing it,
15 two of which are destructive and the other one is difficult.

16 I think you should understand that our charter is
17 such that we weren't necessarily expected to do analyses,
18 per se.

19 Q Mr. Henriksen, how long was the replacement block
20 for EDG 103 tested by Delaval, if at all?

21 A (Witness Henriksen) Well I understand it has
22 just completed 10 to the 7th cycle right now.

23 Q My question was how long was the block tested by
24 Delaval before it was delivered to LILCO?

25 A To the best of my knowledge not at all.

WRBagb 1 Q You refer in your testimony on page 34 to the R-5
2 cylinder block.

3 How long was the R-5 cylinder block tested, for
4 how many hours, that is?

5 A As I recall it was -- I may be wrong on this, but
6 as I recall it was in excess of 600 hours at loads which
7 produced roughly 2000 psi max pressures.

8 Q Did the R-5 block develop cracks during its
9 testing?

10 A If they did I have no reports of it.

11 Q You don't know?

12 A No.

13 MR. DYNNER: Judge, I am moving to page three of
14 the cross plan.

15 BY MR. DYNNER:

16 Q Take a look, will you, gentlemen, at your
17 supplemental testimony.

18 Dr. Bush and Mr. Henriksen, I am referring to
19 your first answer on page one. Have you determined whether
20 or not the geometry of the blocks of EDGs 101 and 102 are
21 the same as the actual geometry that you saw on EDG original
22 103 block?

23 A (Witness Bush) The answer to that, at least
24 insofar as looking at the disassembled engine, in my case
25 was no. We looked at the 103 because our problem was

WRBagb 1 interpretation of the blueprints. The blueprints, to my
2 knowledge, were all the same. And after physical
3 examination of the 103 we made the assumption that the three
4 blocks had the same geometry in the cam gallery area.

5 Q As I understand your answer you did not
6 physically inspect 101 and 102 to confirm that it has the
7 same geometry in the cam gallery area as 103, is that right?

8 A That's correct.

9 Q Shouldn't the changes in the as-built block of
10 103 been made from revised drawings and subject to the
11 quality assurance requirements of Appendix B?

12 MR. PERLIS: Your Honor, I object. I think it
13 goes beyond the scope of their direct.

14 MR. ELLIS: I wasn't sure that I heard the
15 question correctly.

16 JUDGE BRENNER: I am confused on the question
17 also. I don't know which 103 block you're talking about.

18 MR. DYNNER: Original 103. I am discussing, as I
19 said, specifically their answer number one on page one of
20 the supplemental testimony.

21 MR. ELLIS: May I have the question read, your
22 Honor?

23 JUDGE BRENNER: Wait a minute.

24 (The Board conferring.)

25 JUDGE BRENNER: I am going to overrule the

WRBagb 1 objection on the inference that the question is a follow-up
2 to the previous answers given by the witness on the
3 subject. Now we'll get it read back for you, Mr. Ellis.

4 MR. DYNNER: I'll repeat it.

5 BY MR. DYNNER:

6 Q Shouldn't any changes in the actual block of
7 original EDG 103 block in the cam gallery area have been
8 made from revised drawings and subjected to the quality
9 assurance requirements of 10 CFR Part 50 Appendix B?

10 MR. ELLIS: I object there now that I understand
11 it. I don't recall any testimony about changes to the
12 original 103.

13 JUDGE BRENNER: I guess I don't either now that
14 I've heard the question again. I, too, focused on that same
15 part.

16 BY MR. DYNNER:

17 Q Do I understand your testimony please, gentlemen,
18 that the actual bearing saddles in the cam gallery of the
19 original EDG 103 block were different than as shown in the
20 drawings?

21 A (Witness Bush) Let me try to clarify. I have
22 looked at a lot of blueprints. These were some of the more
23 incomprehensible. We, after looking at it and spending a
24 great deal of time on it, decided in the absence of any
25 other information that in essence the cam gallery area and

WRBwrb 1 the bearing supports were cantilevered as shown on page
2 two. We physically visited Shoreham and examined the block
3 and found that indeed it was not cantilevered and so we
4 modified our testimony accordingly.

5 So what this is based on was a physical
6 examination, an actual going up and looking at the cam
7 gallery region and understanding what the situation was in
8 contrast to the perceived geometry obtained from the
9 drawings, which was all we had access to initially.

10 Q Dr. Bush, did you physically personally examine
11 the sample of the cam gallery crack from cam gallery No. 7
12 which was subjected to fractography by FaAA?

13 A If you mean did I hold it in my hands and look at
14 it, in that context I looked at the pictures and so forth.
15 And I have seen parts-- No, I don't think I've seen that
16 one. I was trying to remember whether that was physically
17 available when we were at FaAA.

18 I've seen part, but not all.

19 Q Which part did you see?

20 A I haven't any idea. You know, you take two parts
21 and you plunge it in liquid nitrogen and break it, and you
22 examine the part. But I can't tell which part.

23 Q You examined one half of the crack that was split
24 open?

25 A And I have seen pictures of the other, yes.

WRBwrb 1 Q The part that you examined, did you look at it
2 under a microscope?

3 A No.

4 Q Did you subject it to any tests or examinations
5 other than a naked eye visual examination?

6 A I rarely do that in any evaluations, because I
7 find that the photomicrographs are more significant than the
8 original specimen by far.

9 A (Witness Berlinger) Mr. Dynner, just to add for
10 completeness: At the time we viewed the specimens, the only
11 thing available was about a 5X magnifying glass. And that's
12 all we looked at. If, in fact, we chose to look at it under
13 magnification, it was just with a magnifying glass and not a
14 microscope.

15 Q When you looked at the crack that was subject to
16 fractography -- I'm just going to call that the No. 7 crack
17 for shorthand, so we'll all know what that means -- did you
18 see a dark oxide layer on the surface of that crack?

19 A (Witness Bush) Certainly on the pictures I saw
20 the -- I did, yes.

21 Q Well, my question is-- I'm talking now about the
22 physical examination you made of the specimen itself, not
23 about the photographs.

24 A As I told you, I put very little faith in looking
25 at samples like that. At this stage I can't really say that

WRBwrb 1 I did.

2 Q Do I understand that this is a specimen you just
3 glanced at, you did not conduct a careful physical
4 examination?

5 A That's correct.

6 Q So for your testimony you're relying upon the
7 photographs and not your physical inspection?

8 A That's what I usually do; that's correct.

9 Q Did the photographs show the thickness of this
10 oxide layer?

11 A They show a thickness measurement, yes, on the
12 thing.

13 Q Well, you don't have any basis, do you, Dr. Bush--
14 Strike that.

15 You would not be able to detect the presence or
16 absence of graphite on the surface of that No. 7 crack just
17 by looking at a photograph, would you?

18 A I would not be able to detect it by looking at it
19 with a 5X microscope either.

20 Q That wasn't my question.

21 A Very well.

22 Q Will you answer the question?

23 A That depends on the characteristics of the
24 photomicrographs whether I could or not.

25 Q Well, were you able to, just by looking at the

WRBwr b 1 photographs, tell whether or not graphite was present on the
2 surface of the crack?

3 A No, I don't think I could.

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1 JUDGE BRENNER: Dr. Bush, when you say you looked
2 at photographs of the fractography, would that be a
3 photograph similar to Suffolk County Exhibit S-4? Do you
4 have that exhibit? It is bound with the supplemental
5 testimony of the County.

6 WITNESS BUSH: I don't think I have S-4.

7 JUDGE BRENNER: It looks like it to me right in
8 front of you.

9 WITNESS BUSH: Does it have a specific number, or
10 is there another number?

11 (Document handed to the witness panel.)

12 I have never seen this one.

13 JUDGE BRENNER: Is S-4 in fact photographs of the
14 fractography?

15 Do you have S-4?

16 WITNESS BUSH: I have never seen this report.

17 JUDGE BRENNER: Just look at S-4.

18 WITNESS BUSH: I don't know what S-4 is. There
19 is no identification on it that helps me.

20 JUDGE BRENNER: Listen to my question. My
21 question is would this be a photograph of the fractography
22 of anything? I just have no idea what you mean when you say
23 in your testimony "photograph of fractography." And I
24 thought, perhaps irrationally, that this would be one way
25 for me to get a feel for what kind of photographs you looked

WRBeb 1 at.

2 I didn't ask you if this was the same photograph.

3 WITNESS BUSH: This looks like a section showing
4 graphite, and I can't tell whether these are void areas or
5 are cracked surface area or not, and the upper one is a
6 backing area. This might be a backing area which would say
7 that this is the oxide and then we are looking at the
8 graphite underneath it.

9 But this particular picture I can't identify.

10 JUDGE BRENNER: Dr. Bush, my question is would
11 this be a photograph of the fractography of anything? I
12 don't know what a photograph of the fractography is, and I
13 am trying to find out. So it is either "Yes, this is the
14 kind of thing you might see in a picture of fractography,"
15 or "No, this is nothing like the kind of picture you're
16 talking about."

17 WITNESS BUSH: The upper left-hand corner could
18 be a mounting material. The dark area could be an oxide.
19 And the area to the right could be -- it appears to be the
20 graphite structure on there.

21 JUDGE MORRIS: Dr. Bush, the question is more
22 simple than I think you think it is. Judge Brenner would
23 like to know what is meant by the word "fractography."

24 WITNESS BUSH: Oh, I'm sorry.

25 In this instance it would be where you have a

WRBeb 1 fracture surface and that you examine it either by looking
2 down on it or looking at the edge of it on there. If you're
3 concerned with an oxide layer then what you would do is
4 mount it so you're looking at the edge so that you can
5 measure the oxide layer with respect to the base metal as a
6 thickness measurement.

7 If you're interested in other structures you
8 break the thing and look down on it and look at the facets
9 and try to determine what there is there.

10 I'm sorry I misunderstood the question, so I was
11 off on another wavelength.

12 JUDGE BRENNER: And this would not be such a
13 photograph then?

14 WITNESS BUSH: It could be if it is mounted the
15 way I think, but I can't tell from looking at the thing what
16 it is.

17 This exhibit I have never seen.

18 JUDGE BRENNER: In passing-- I didn't mean to
19 get into this but in passing you said "I've never seen
20 this," and you held up the whole volume of supplemental
21 testimony of Dr. Robert N. Anderson, et cetera, dated
22 October 18th, 1984. You have never seen that testimony?

23 WITNESS BUSH: No, not this one.

24 I don't know whether this was-- There was one
25 possibility and I can't tell on it. One package was sent to

WRBeb 1 me that never arrived.

2 JUDGE BRENNER: All right. I'm just interested
3 on whether you've seen it or not.

4 WITNESS BUSH: No, I have not seen this package
5 at all. I've seen pictures but I haven't seen this exhibit.

6 BY MR. DYNNER:

7 Q Dr. Bush, you refer on page 1 in the last answer
8 on that page to photographs of the fractography of cam
9 gallery Number 7.

10 A (Witness Bush) Yes.

11 Q If you look for a moment at Exhibit S-4 in the
12 volume that you had in front of you a minute ago, can you
13 tell me whether that is one of the photographs that you were
14 talking about in your testimony?

15 A This is 1500 X. I thought I had seen something
16 that looked different from this, quite frankly, so I can't
17 say whether these specific pictures were part of the ones
18 that I looked at or not. That is why I'm confused at this
19 stage. This says 9/4/84.

20 Q Dr. Bush, approximately when did you examine the
21 photographs of fractography that you refer to in your
22 written supplemental testimony?

23 A This should have been-- It was late in
24 September. It was the last time I was here, which would
25 have been during the crankshaft hearings, which I guess

WRBeb 1 would have been the week of the 18th or the 19th of
2 September.

3 Q Were all of the photographs of the fractography
4 that you're referring to in black and white?

5 A I can't remember. I was mainly concerned with
6 the appearance of the oxide and so forth, or the thickness
7 of the oxide more than anything else.

8 You mean there were some of them that would have
9 been in color?

10 Q Yes.

11 A The atlas over there might have some that I
12 looked at, but I don't recall it now.

13 (Document handed to Dr. Bush.)

14 JUDGE BRENNER: Just keep asking questions.

15 BY MR. DYNNER:

16 Q Dr. Bush,--

17 JUDGE BRENNER: Dr. Bush, Mr. Dynner wants to ask
18 you another question.

19 WITNESS BUSH: Yes, sir, I'm listening.

20 BY MR. DYNNER:

21 Q Can you identify what the metallographic
22 specimens of cracks in two cross-sections through the cam
23 gallery are that you refer to on page 1 of your testimony in
24 Answer A?

25 A (Witness Bush) Well, they should be in this

WRBeb 1 stack right here.

2 Q Dr. Bush, can you recall what the metallographic
3 specimens were that you refer to?

4 A When you say "what," what do you mean? I recall
5 the edge mount, looking at the oxide picture.

6 Q I am not referring any longer to the photographs.
7 If you look at your testimony and your answer at
8 the bottom of the page, you say that you examined
9 photographs of the fractography of cam gallery Number 7, and
10 metallographic specimens of cracks in two cross-sections
11 through the cam gallery.

12 A Those were the ones on the Friday meeting.

13 Q These were specimens of a different crack -- is
14 that correct? -- not the Number 7 crack? The metallographic
15 specimens?

16 A No, I would assume that's the same crack.

17 Q You say you assume. Do you know?

18 A I'm quite sure that that's the case, yes. All
19 right, I'll say I know in that case. It was written in that
20 format.

21 Q Was there one specimen which had -- or two
22 specimens? How many specimens?

23 A Well, this says "in two cross-sections through
24 the cam gallery." That would be two specimens, but not
25 necessarily -- but they could be from the same cam gallery.

WRBeb 1 Q Well, what is your recollection? Or don't you
2 have any?

3 A I don't have a map. I usually am interested in
4 what the picture looks like, and I would have to go back and
5 look for that, which I don't have with me, unfortunately.

6 Q Now in the next sentence you refer to
7 metallographic evidence. What metallographic evidence
8 specifically are you referring to in that sentence?

9 A The fact that when you look at the samples and
10 you see a very heavy oxide, and I can't account for any
11 mechanism for formation of the heavy oxide under these
12 circumstances other than quite high temperature because
13 anything at lower temperatures is not going to develop any
14 particular thickness.

15 Q Is the metallographic evidence that you're
16 referring to obtained from the photographs that you looked
17 at?

18 A The photographs and the specimen, yes.

19 Q Are these the specimens that you said you just
20 glanced at and didn't really do a thorough examination of?

21 A Well, in that case you look more at the
22 photographs because I certainly would not be able to tell
23 much about fatigue growth or something of that nature. But
24 there was no obvious evidence of it in there, and
25 essentially the oxide film.

WRBeb

1 In other words, if there had been fatigue I would
2 expect that area to essentially be bare of any oxide layer.
3 In other words it would be a breakoff on the thing,
4 presuming the sample is mounted correctly.

5 Q How did you determine that the layer was an
6 oxide?

7 A I guess by inference more than anything else. In
8 fact you may recall that somewhat earlier I suggested it
9 would be an excellent idea to determine the crystallographic
10 structure, which should resolve the issue once and for all.

11 Q And in fact if you determined that the type of
12 oxide was not wustite then that would indicate to you that
13 the oxide was formed at lower temperatures. Isn't that
14 right?

15 A I'd have a great deal of difficulty establishing
16 how it ever got so thick.

17 Q Is your answer to my question yes?

18 A If it is not wustite I would not be able to
19 account for what the situation was.

20 Q Because if it wasn't wustite it would have been
21 formed at a very high temperature. Isn't that right?

22 A That's correct.

23 Q Now, Dr. Bush, are you aware that or do you
24 believe that prior to the introduction of the weld material
25 into the cam gallery cracks on the original blocks that the

WRBeb 1 cracks were ground?

2 A Obviously they were partly ground, yes. I am
3 also convinced they weren't completely removed.

4 Q And that grinding would have removed a portion if
5 not all of the oxide layer, if there was an oxide layer
6 present at the time of the grinding. Isn't that right?

7 A Only in the area that's ground.

8 Q Yes.

9 The photographs that you looked at would not show
10 you whether or not there was a thick oxide layer under the
11 weld material, would it? That is, between the weld material
12 and the cast iron to which the weld was adhering?

13 A I think you're talking now about near the surface
14 where the weld metal lies. I would not expect any there;
15 that's correct.

16 Q The photographs you saw didn't show that, did
17 they?

18 A There was the one that was broken away into two
19 halves, one on there of part of the weld metal and the other
20 part with adhering what I will call base metal for the time
21 being, yes.

22 Q And that didn't show any thick oxide layer
23 between the weld material and the base metal, did it?

24 A Not as I recall. I wouldn't expect it to, in
25 fact.

WRBeB

1 Q Why not?

2 A Well, why would there be-- Okay, I'm sorry. I
3 shouldn't ask it that way.

4 For very obvious reasons. The whole idea of
5 making a repair is to bond the base metal to the weld
6 material, and if it had been done correctly, which I don't
7 think it was, they would have ground the entire crack out
8 and prepared -- run an appropriate weld preparation.

9 And the way you do that is you weigh the beads
10 down, and if you are doing it correctly, you try to reduce
11 the residual stresses by the way you make the welds. Now by
12 laying the beads down against the metal you get a fusion to
13 the graphite material, and you simply build up. And there
14 is no fundamental mechanism, because you have a very
15 localized heat source, to get any particular oxide.

16 Q Why don't you think that all of the thick oxide
17 layer in the crack was ground off before the crack was
18 welded?

19 A If that had been the case, I think it would have
20 been a much deeper weld prep. They would have had to go the
21 full depth on it. In other words, once they've sealed over
22 and if I crack again I see no mechanism whatsoever for
23 getting anything in that that would be very significant.

24 In other words it is my opinion that you had a
25 fairly deep hot crack or hot tear that was oxidized. There

WRBeb 1 was a grinding operation to remove part of it, but not all
2 of it, which is counter to good practice. The welding was
3 done. And if I believe the testimony I've read, not too
4 surprisingly around the weld there was found martensite
5 which I would expect because of the hardenability of this
6 material is very high with this carbon level and the fact
7 that I strongly suspect there was no preheat.

8 I would expect the nickel-iron alloy to bond to
9 there and build up, but I would also expect under those
10 circumstances that I had simply covered a portion of a crack
11 that had not been ground out.

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WRBpp

1 Q Dr. Bush, it's true, isn't it, that you really
2 don't have any basis for knowing how much grinding took
3 place before the welding was done?

4 A That should be very obvious because what you
5 grind out is filled with weld metal and that establishes the
6 maximum depth. That's pretty obvious.

7 Q How deep did that weld material go into the
8 cracks?

9 A I only saw one of them so I would say, perhaps,
10 certainly less than a half an inch. It seemed to be more
11 like a quarter of an inch in trying to visualize what was
12 there.

13 Q And how deep was that particular crack?

14 A That must have been a crack that was -- it was
15 approximately an inch.

16 Q So it was ground in the -- the first quarter inch
17 or so was ground out prior to welding; right?

18 A Yes.

19 Q And that grinding at least in that portion of the
20 crack removed the thick, dark oxide; didn't it?

21 A It should remove all of it; that's correct.

22 Q And it didn't?

23 A I didn't see any evidence and I wouldn't expect
24 to because what you effectively have is a crack like this
25 and you remove away from it so you have taken a lot more

WRBpp

1 metal out on there. And so the only way I would expect to
2 see it oxide would be if it were a very poor welding
3 process.

4 Q In fact, this crack number 7 that we've been
5 talking about had a thick oxide layer running from the very
6 top to the very bottom of the crack; isn't that right?

7 A Yes. And by the top you're talking underneath
8 the weld down to the tip of the crack?

9 Q Yes.

10 A Yes.

11 Q And you saw the thick, dark oxide under the weld
12 material in a photograph?

13 A Well, I looked at the pictures and I looked at
14 the metallographical samples of the thing and that's about
15 as much as I've seen so far.

16 Q Would you answer the question. Did you see the
17 dark oxide under the weld material?

18 A That I cannot remember.

19 JUDGE BRENNER: You changed the question the
20 second time; do you know that?

21 MR. DYNNER: No.

22 JUDGE BRENNER: You left out the "in the
23 photograph" part the second time.

24 BY MR. DYNNER:

25 Q Did you see it in the photograph?

WRBpp

1 A (Witness Bush) I have been looking at an awful
2 lot of pictures and this one I can't -- I don't have it in
3 front of me to look at to tell if that's the situation.

4 A (Witness Berlinger) May I comment?

5 JUDGE BRENNER: Make sure Mr. Dynner is finished
6 with this slide. Mr. Dynner?

7 MR. DYNNER: I have not completed the line of
8 question yet.

9 JUDGE BRENNER: Just hold it then, Dr. Berlinger.
10 Wait a minute. He wants to pursue the questions
11 of Dr. Bush to find out what Dr. Bush knows; that's why I
12 asked you to hold it. So part and parcel of that is not to
13 have a conversation on the subject just now.

14 BY MR. DYNNER:

15 Q Dr. Bush, I'm going to try to clarify this
16 because I'm a little confused.

17 The section of the crack that you saw, crack
18 number 7, you had one area that ran from the top of the
19 crack down to the top of the weld; is that right -- to the
20 bottom of the weld?

21 A (Witness Bush) It would be much simpler for me
22 to clarify the record if I had some pictures to look at.

23 Q Yes. Now, Dr. Bush, was there in any of the
24 examination that you made, was there a thick oxide layer
25 running from the top of the crack extending below and

WRBpp

1 underneath the weld material and then continuing on to the
2 bottom of the crack where there was no weld material?

3 A (Witness Bush) I don't understand your question.

4 Q You testified that the weld material was in the
5 top approximate quarter inch of the crack, right? Was there
6 a thick oxide running from the top of the crack through that
7 quarter inch depth underneath the weld material?

8 A If I understand your question that's where the
9 weld material is and the answer would be no.

10 I must not be understanding your question.

11 Q Dr. Bush, let me try it this way:

12 There were two surfaces of crack number 7;
13 correct?

14 A Yes.

15 Q One surface of that crack had no weld material
16 adhering to it; correct?

17 A As I recall that's the case; yes.

18 Q All right.

19 Was there a thick oxide layer extending along the
20 entire surface from the top to the bottom of that side of
21 the crack?

22 A I do not recall any thick oxide layer. You're
23 talking about on the weld itself?

24 A No. I'm talking about the side of the crack to
25 which no weld material adhered.

WRBpp

1 A I do not recall a thick oxide layer in the area
2 that would be the mating area where it pulled away from the
3 weld; is that what you're talking about? If that's what
4 you're talking about the answer is I do not recall any thick
5 oxide layer in that area and I would not expect it in there.

6 Q If there were a thick oxide layer on that side of
7 the surface of the crack, would that raise questions about
8 your conclusions as to the formation of these oxide in those
9 cracks?

10 A If there were a thick oxide layer there should
11 have been no bonding whatsoever with the weld metal
12 presuming that the thick oxide layer is still there and
13 I have weld metal on the other side of it because there
14 would be no bonding through. Because the first thing that
15 would happen if I had an oxide was that I would, when I put
16 the molten metal down I would remove it. I would puddle it
17 off. And it would disappear.

18 MR. DYNNER: Judge, if you wanted to ask some
19 questions, I've completed this line.

20 JUDGE BRENNER: Why don't we give Dr. Berlinger
21 an opportunity to add what he wanted to add.

22 WITNESS BERLINGER: Thank you, your Honor.

23 The often referred to photographs that you have
24 questioned Dr. Bush on, there are two types of photographs
25 that were viewed and that are included in the County's

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1 testimony. The photographs that we saw at the meeting with
2 the people from LILCO at the Shoreham site on September 21
3 were either photomicrographs or fractographs. Both of these
4 are photographs and they are not IX photographs. They are
5 photographs at varying magnifications. Photographs taken
6 through a microscope. And by studying those photographs we
7 were able to observe a thick oxide layer that went from
8 the tip of the crack and the deepest part of the crack that
9 extended up to a point in the vicinity of the bottom of the
10 weld bead.

11 My recollection was that there was a much thinner
12 layer which appeared to be a thin oxide layer that might
13 have developed during the welding process or after the weld
14 interface with the base metal had cracked or pulled away.
15 There may have been some oxidation that could have taken
16 place.

17 But to the best of our ability from the
18 photomicrographs and from the fractographs it appeared as if
19 there were two different layers, a thick one and a thin
20 one. The thick one was deeper and the thinner one was more
21 toward the cam gallery surface of the sample. These were in
22 addition to also looking at the actual metallographic
23 samples as they were mounted for examination and for
24 photography with 5X magnification and clearly with 5X
25 magnification you could not see the details that were in the

WRBpp 1 other photomicrographs or in the fractographs, for that
2 matter.

3 BY MR. DYNNEP:

4 Q Dr. Bush, did you accompany Dr. Berlinger at this
5 meeting?

6 A (Witness Bush) Yes.

7 Q Dr. Berlinger, were these photomicrographs in
8 black and white or in color?

9 A (Witness Berlinger) My recollection is that
10 there were some color and I think there were some prints
11 that were in black and white. I'm not absolutely certain as
12 to whether all of the photomicrographs were in color but I
13 think I recall seeing some color photographs.

14 JUDGE BRENNER: Are you still on the subject?

15 MR. DYNNER: Yes, I have one more question.

16 BY MR. DYNNER:

17 Q Are all the photomicrographs that you have
18 located in the photographic album that you have there with
19 you that you have been looking at?

20 A (Witness Bush) I'm fairly certain they're not.

21 Q The question is for Dr. Berlinger, if you don't
22 mind at this point?

23 A I'm sorry.

24 A (Witness Berlinger) Without going through this
25 entire book and even if I did I'm not sure if I could attest

WRBpp

1 absolutely -- with absolute certainty that all the
2 photographs we looked at are in this book.

3 Q Are all the ones that you're relying on for your
4 testimony in that book?

5 JUDGE BRENNER: Why don't you ask him an easier
6 one that I think would serve your purpose: Are there any
7 photographs in there that would at least in part be relied
8 upon by you to support the testimony, the testimony given in
9 the second answer on page 1 of your supplemental testimony?

10 If you don't know, we'll come back to it. I
11 don't want to sit here while you go through every page of
12 the book. I changed the question to see if we could avoid
13 having you go through every page in the book.

14 WITNESS BERLINGER: I think the best way I can
15 answer the question is to state that photographs if not all
16 the photographs that I have viewed but photographs are
17 contained in this booklet which are either identical or
18 similar or out of the same sample of photographs which would
19 provide the information which was the basis for the
20 conclusions.

21 BY MR. DYNNER:

22 Q Can you identify for me, then, the photograph
23 which shows that the oxide layer from the bottom of the weld
24 bead upward is much thinner than the layer from the tip of
25 the crack to the bottom of the weld bead?

WRBpp

1 MR. ELLIS: Judge Brenner, would it be
2 appropriate to let them take a break so they could look
3 through there?

4 JUDGE BRENNER: We could do that.

5 Do you have an objection to that, Mr. Dynner. If
6 you do, we will wait.

7 MR. DYNNER: I don't have an objection and I will
8 expand the question so that we could see the photographs
9 that the witnesses believe they are using to support the
10 testimony or that Dr. Bush is using all the photographs that
11 they rely upon.

12 JUDGE BRENNER: All right. Let me ask one
13 question and then we'll take the break and you can use the
14 break to go through it and see if you can show all Counsel
15 before we come back on the record at least some, if not all,
16 the photographs that you would use to support the point
17 about which Mr. Dynner asked you in his last question.

18 I want to ask one question on wüstite, Dr. Bush.
19 Is it hard to test for wüstite?

20 WITNESS BUSH: The expert is sitting back in the
21 room there. I don't think it's the easiest thing in the
22 world. You'd have to use some form of an x-ray technique
23 and scan across to determine this crystal structure.

24 JUDGE BRENNER: Hard is probably a better
25 phrase. Do you know? If you don't --

WRBpp

1 Let me make it more specific. Would it be
2 feasible to test for wustite on cam gallery cracks as they
3 presently exist in the old 103 block?

4 WITNESS BUSH: It's been a long time since I did
5 such things. I think it will be possible. We usually
6 manage to get a sample and put it in a small capsule and
7 then examine it. You don't have to examine it directly on
8 the surface but whether one can get enough sample or not I
9 can't state.

10 MR. ELLIS: Judge Brenner, there's an reference
11 to the expert in the room and since the composition of the
12 room may change by the time I come back to that, may I know
13 who that reference is to?

14 JUDGE BRENNER: Who did you mean, Dr. Bush?

15 WITNESS BUSH: I meant Dr. Wachob.

16 JUDGE BRENNER: All right. Let's take a break
17 until 3:35.

18 (Recess.)

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AGBpp 1 JUDGE BRENNER: We're back on the record. You
2 can continue, Mr. Dynner.

3 BY MR. DYNNER:

4 Q Gentlemen, during the break you've been examining
5 a book of photographs; is that right?

6 A (Witness Berlinger) That is correct, Mr. Dynner.

7 Q And can you confirm to me now that that book
8 contains all of the photographs that are relied upon for
9 your testimony?

10 A (Witness Bush) So far as I can tell this
11 represents the full record.

12 Q And can you identify for me in the book of
13 photographs the photographs -- or photograph which
14 demonstrates that the layer of oxide is much thinner above
15 the bottom of the weld bead than from the tip of the crack
16 to the bottom of the weld bead?

17 A (Witness Berlinger) Let me first indicate by the
18 nature of the fractograph, the photographs, and the
19 photomicrographs. At different magnifications you see a
20 smaller and smaller region of what you're trying to study so
21 as you go from, say, 50X to 500X you're looking more close.
22 So in order to examine along the crack you have to look at a
23 series of photographs or if you want to study a particular
24 area you look at a series of photographs at higher and
25 higher magnification. It's the same photograph blown up to

AGBpp

1 be reproduced at a higher magnification.

2 There are photographs within this booklet, which
3 indicate the innerphase area between the weld bead and the
4 base metal which also show a crack existing between the weld
5 bead and the base metal. And in that area there is no heavy
6 layer -- whether it be oxide or whatever -- but no heavy
7 layer accumulated in that area.

8 On the other hand if you look at other
9 photographs in this series which are taken deeper down into
10 the cam gallery wall below the weld bead or away from the
11 weld bead is clear, even at this same magnification and in
12 some cases even lesser magnification that there is a heavy
13 layer, it's sort of a grayish colored, darker layer than the
14 -- but gray compared to the actual crack that you see in the
15 photographs.

16 I would gladly give you examples except that the
17 photographs are not identified with a specific number unless
18 they're -- well, it might be on the back.

19 (Pause.)

20 I've got DW-15, dated 9/4/84. If you want to
21 look at your book of photographs here's what it looks like.

22 (Witness Berlinger displaying photograph.)

23 It's in the back of the second full-page of
24 photomicrographs, okay? And that's one example.

25 Another example would be --

AGBpp 1 Q Excuse me, Dr. Berlinger, another example of
2 what?

3 A Of the deeper heavy-layered portion of the crack
4 in the cam gallery area, I think. A better example would be
5 one more page towards the rear of the book -- DW-2.

6 Q Can you hold that up and show me that one?

7 A Looks like a sick worm.

8 (Witness Berlinger displaying documents.)

9 Q Is it 500 power; is that right?

10 A I can't tell you -- yes, it's at 500 power.

11 Q Now, is that photograph DW-2, is that looking at
12 the surface from a cut-away view --

13 A You mean a cross-section?

14 Q Cross section or is that looking flat straight
15 on?

16 A I believe it is a cross section. It is a side
17 mount.

18 A (Witness Bush) Excuse me. Looking down at the
19 crack, looking at the oxide.

20 A (Witness Berlinger) A side or section view
21 looking at the edge of the crack.

22 Now, in the other case that we refer to --

23 Q Just a minute. How can you tell by looking at
24 these photographs which portion of the crack surface they
25 come from? How do you know whether it is the top of the

AGBpp

1 crack or the bottom of the crack or the middle of the crack?

2 A You would not be able to see a layer along the
3 crack unless you took the section and mounted and viewed it
4 from the edge.

5 Q My question was how do you know from which
6 portion of the crack these photographs were taken? The
7 photograph doesn't say, does it?

8 A No. But I'll give you a for-instance. If you
9 look at the photograph which I told you to look at which is
10 DW-2, it is an enlargement of the photograph to its left,
11 which is DW-1 and basically what you're looking at in these
12 two photographs is an enlargement of a section of DW-1 which
13 is slightly below the center and slightly to the left of the
14 center of the photograph. Now, I'll point to the area.
15 It's right here.

16 (Witness indicating.)

17 Q Yes.

18 A So this is a magnification of additional 5X. So
19 it goes from 100X to 500X magnification and that's what
20 you're looking at and this is how I know where it is. It is
21 very far down almost as far down into the cam gallery wall
22 as the crack went.

23 Q Is that, Dr. Berlinger, DW-1 and DW-2
24 cross-sections of the surface of the crack?

25 A Yes. I believe so.

AGBpp

1

JUDGE BRENNER: Let's go off the record for a

2

minute.

3

(Discussion off the record.)

4

JUDGE BRENNER: Let's go back on the record.

5

WITNESS BERLINGER: To continue to try to give

6

you a more complete answer --

7

BY MR. DYNNER:

8

Q Dr. Berlinger, would you just give me a minute

9

please?

10

(Pause.)

11

Q Dr. Berlinger, I want to just follow up on this

12

for a minute because I'm a little confused.

13

MR. ELLIS: Can he finish his answer first? He

14

wanted to finish his answer.

15

JUDGE BRENNER: No, I'm going to let Mr. Dynner

16

follow up.

17

BY MR. DYNNER:

18

Q If you will look for a minute at DW-1 and DW-2

19

and you may as well keep them out for a minute so you can

20

maybe hold them up for the Board.

21

MR. ELLIS: Judge Brenner, wouldn't it be a good

22

idea if we marked these now?

23

JUDGE BRENNER: I'm not sure we're going to have

24

to and I would rather get the witnesses views of what it

25

says as fully on the record a feasible, whether or not we

AGBpp

1 would mark it later, I don't know. If any party wants to
2 mark it later we will consider that request but even if we
3 are going to mark it later I still want a very full
4 description because this isn't a simple photograph within,
5 at least, my everyday experience that I can simply look at
6 for myself in any event so I need fully what the expert
7 thinks it says and words on the transcript, in any event.

8 BY MR. DYNNER:

9 Q Dr. Berlinger, as I understand it, the crack was
10 split open and you then have a surface of the crack and if
11 you laid that specimen down in front of you flat on the
12 table so that you're looking down on the surface of the
13 crack, is that what you're seeing in DW-1 and DW-2?

14 A (Witness Berlinger) All right. If you were to
15 take that specimen now and turn it on its side and then look
16 at the crack from that angle is that what you're looking at
17 in DW-1 and DW-2?

18 A No.

19 Q All right. Because this is before the crack has
20 been opened up and the two pieces separated. This is a
21 cross-section of the crack in the composite piece before it
22 has been taken apart. But it is a cross-section.

23 A (Witness Bush) The best way to tell that is you
24 have separate oxides on both sides which would indicate that
25 that would be the case.

AGBpp

1 JUDGE MORRIS: Mr. Dynner, excuse me. Could I
2 try to visualize this for myself from a different point of
3 view?

4 MR. DYNNER: Yes.

5 JUDGE MORRIS: Gentlemen, if you look at Suffolk
6 County Exhibit B-77 -- to be complete I should say Diesel
7 77.

8 MR. PERLIS: Excuse me. I have a copy if the
9 witnesses don't have it.

10 WITNESS BERLINGER: Please. It might speed
11 things up.

12 JUDGE MORRIS: Am I correct that this diagram
13 illustrates a crack in the cam gallery area which is
14 representative of the crack that you have been talking about
15 in the photograph?

16 WITNESS BUSH: A schematic of it, yes.

17 JUDGE MORRIS: With respect to this drawing, can
18 you tell me the plane that corresponds to the surface of
19 that photograph?

20 WITNESS BUSH: The plane of the paper would be.
21 In other words, if you are looking down the crack would be
22 going into the paper, so to speak, and moving in this
23 direction. (Indicating) That's not very good because it
24 doesn't help from that point of view.

25 In essence, the crack that propagated from the

AGBpp 1 righthand side, namely the curved wall towards the rear
2 surface and it would have a finite width which would mean it
3 would come out of the plane of the paper -- or go into the
4 plane of the paper. So it would be two-dimensional in
5 essence so it would -- I guess one could describe it like
6 one's hand, so to speak, as an example of what the crack
7 would look like in a three-dimensional sense.

8 WITNESS BERLINGER: But the section shown in the
9 photograph is the same plane as shown on this piece of paper
10 and this drawing. What you are looking at in the photograph
11 is a portion of the crack well down below the weld bead into
12 the cam gallery wall. And, basically, if you took a piece
13 out of this wall and cut through it vertically, put a
14 vertical cut through it, then you would be looking at the
15 edge of that surface that you had just cut, just as you are
16 in this schematic, and that's what you would prepare and use
17 as your sample to take these photographs.

18 JUDGE MORRIS: Thank you. That helps me. I hope
19 it helps you, Mr. Dynner.

20 WITNESS BUSH: I might comment that the
21 traditional metallographic process which appears to be
22 followed here is that there is always an overlap and
23 therefore you can always key from 100X picture to the next
24 100X picture because there will always be a portion of the
25 one overlapping on the other so that you can match them and

AGEpp

1 continue through in that particular plane.

2 BY MR. DYNNER:

3 Q I'm correct, aren't I, Dr. Berlinger, that none
4 of these photographs or photomicrographs of the number 7
5 crack as I call it, are in color. They are all black and
6 white?

7 A (Witness Berlinger) That's correct. On the 21st
8 of September at that meeting, I recall seeing color
9 photographs but, in fact, those photographs may not have
10 been in either the fractograph or in the photomicrograph but
11 may indeed have been some of the color photographs that have
12 been shown as to how they prepared the samples and mounted
13 them so I may have been somewhat confused.

14 Q Dr. Bush, are you aware of the fact that on
15 many of the surface areas of the number 7 crack sulfa and
16 calcium were found to exist?

17 A (Witness Bush) Yes. Let's put it this way. I
18 have read the testimony that I've so testified and I have an
19 exhibit which -- well, I shouldn't say it's an exhibit
20 because I'm not sure it has been introduced -- that
21 discusses some of the measurements of same.

22 Q Can you tell me this. Do you believe that it is
23 likely that the sulfa and calcium deposits came from
24 lubricating oil?

25 A I can't rule that out as a possibility. I would

AGBpp 1 tend to think I would suspect calcium as a possibility
2 depending on the welding process. If they had used a coated
3 weld that would account for the calcium. However, I've
4 never been able to obtain any information on the details of
5 the welding process and so I can't say whether it was a
6 coated rod or not. That would be what I would expect.

7 Q But without being able to give that information
8 it is just as likely that the calcium, particularly in
9 connection with its presence with sulphur would have come
10 from lubricating oil, isn't that right?

11 A I can't rule it out. It would be one of the
12 possibilities that one would have to consider.

13 WITNESS BERLINGER: Judge Brenner, I was
14 wondering whether I could complete my previous answer rather
15 than get it separated and answered by --

16 JUDGE BRENNER: Yes. I'm sorry. Although you
17 were going through more photographs at the time, is that the
18 answer that you mean?

19 WITNESS BERLINGER: Yes.

20 JUDGE BRENNER: I thought that you had answered
21 the question sufficiently for the record although I think
22 Mr. Dynner after the break came back with his "all
23 photographs" question instead of just give us some
24 photographs. Go ahead and finish it.

25 WITNESS BERLINGER: I'll be very brief. The

AGBpp

1 other part of your question that I was trying to answer is
2 to indicate what area didn't have an oxide layer or a thick
3 layer and the photograph that I refer to also, which is in
4 this book, which are really the two photographs in Exhibit
5 S-4 and see from those photographs at 50 and 100X which are
6 taken of the same area of the crack between the weld bead
7 and the base metal that there is no heavy layer, this heavy
8 oxide layer that has been identified elsewhere. That's all
9 I wanted to point out, your Honor.

10 BY MR. DYNNER:

11 Q Dr. Berlinger, I should clarify again what I was
12 particularly looking for in my initial question about the
13 photographs was the area of the crack surface which doesn't
14 have any weld attached to it which is pulled completely free
15 and which, according to your testimony, had a thinner oxide
16 layer near the top than down near the tip.

17 A (Witness Berlinger) Mr. Dynner, if you look at
18 the two photomicrographs in S-4 it's very difficult to see
19 it from these photographs but you can just barely make out a
20 thin, gray area or a lighter gray area which is very thin
21 along the crack between the weld bead and the base metal.
22 Actually, the best way to look at it if you look at the 100X
23 magnification -- even in that one it's difficult. First of
24 all, you can't see a heavy, thick layer and if you can see
25 anything at all it is the very thin gray area along the
dark, black area of the crack.

AGBeb

1 Q I'm talking not about the side of the crack that
2 was split apart that has the weld area attached which is
3 th one that we're looking at in Suffolk County Diesel
4 Exhibit S-4. I'm talking about the other side of the crack
5 which was split apart and which had no weld area attached to
6 it at all. And my question is:

7 Can you identify any photographs as to that side
8 of the crack? It is the other side of the crack than this
9 one. Right?

10 A This shows both sides-- Maybe not. Just a
11 minute.

12 MR. ELLIS: Judge Brenner, may we know which
13 photograph is in issue right now in this question?

14 JUDGE BRENNER: The only photograph asked about
15 in the question is S-4. And what other photographs the
16 witnesses are looking at I don't, but we'll find out if it
17 is important.

18 (Pause.)

19 WITNESS BERLINGER: Mr. Dynner, I'm not
20 absolutely certain that I can answer your question. I'm not
21 sure I understand exactly what you're referring to, and
22 therefore I can't tell whether there are any photographs in
23 this that would go directly to your question.

24 BY MR. DYNNER:

25 Q Dr. Berlinger, are you saying you don't

AGBeb 1 understand my question?

2 A (Witness Berlinger) That's correct. Could you
3 try to clarify it?

4 Q You are aware of the testimony that when the
5 Number 7 crack, as I have been calling it, was split in
6 half, if you will,--

7 A For the fractograph examination.

8 Q Yes.

9 (Continuing) -- that one half came away with
10 weld material adhered to it, and one half came away with no
11 weld material at all adhered to it. Isn't that right?

12 A Yes, when it is pulled apart that is what
13 happens.

14 Q Now I'm talking about the portion that was pulled
15 apart that had no weld material adhering to it at all. And
16 my question was:

17 Is there any photographs in this book that
18 established that as to that side of the crack that was
19 pulled apart with no weld material adhering to it, that
20 there was on that side of the crack surface a thinner oxide
21 layer at the top portion than there was at the bottom
22 portion of the crack surface?

23 A I think I understand your question. The problem
24 is whether I can answer it in the context because the
25 pictures that are in County Exhibit indeed show the weld and

AGBeb

1 they show the base metal at the interface there. Now
2 obviously there is something approaching a mirror image on
3 the other side of the weld. And the real questio.. you are
4 asking is that when there is a -- when the sample was
5 fractured, if it broke on the side that we have in the
6 exhibit, then we have the evidence whether we look at the
7 fractograph or not.

8 If it broke on the other side, I'm not sure from
9 the evidence here as to whether we have pictures or not on
10 that one. That's the problem.

11 In other words, in two dimensions if you
12 visualize a weld nugget and if it cracked and it cracked on
13 the side that appear in the pictures labeled "Cam Saddle
14 Number 7, Face 1, I-613," which are on the first page, then
15 I think what you would be seeing on one face would be the
16 weld nugget attached to a side that I'll say would be the
17 left-hand side, and the other side would correspond, if you
18 would look at the cracked region that is in this I-613 to
19 the right, that would be the base metal, including the
20 heat-affected zone.

21 Now I cannot tell, since I wasn't there when it
22 happened, whether it cracked on that side and the crack went
23 down through and separated, or whether it cracked on the
24 other side of the weld and came back to the same crack. I
25 don't think the results would matter any. I think it would

AGBeb 1 be fundamentally the same under any circumstances.

2 So what we're looking at here is a section that
3 shows the area you are interested in, namely, to the right
4 of the weld. But if you're asking about the fractured
5 surface in here, the ones back in the back would not tell me
6 whether I am looking specifically at the left-hand side or
7 the right-hand side, so to speak.

8 Q Take a look if you would at the picture on the
9 back that is referred to as DP-4. Next to it is DP-2.

10 MR. ELLIS: May we see it as well, please?

11 (Mr. Dynner displaying document.)

12 WITNESS BUSH: Those I think are from two
13 different locations. As I interpret it, one is from cam
14 saddle Number 2 and one is from cam saddle Number 7.

15 BY MR. DYNNER:

16 Q DP-4 is in fact from cam saddle Number 7, isn't
17 it?

18 A (Witness Bush) Yes.

19 Q Could you tell from that photograph, looking at
20 that, was that the surface with the weld material attached
21 or not?

22 A I think to do that I would have to have a higher
23 magnification. You can tell where the fracture surface is
24 from the brightness. I think I would need another picture
25 of the fractograph turned another 90 degrees, and then I

AGBeb 1 would probably be able to tell.

2 I'm not sure if that exists in the record or not.

3 Q And there isn't any such picture?

4 A I don't know if there is.

5 Q Dr. Berlinger, can you answer the question? If
6 you can't I am going to move on.

7 A (Witness Berlinger) I really can't.

8 Q You have looked through this book of pictures
9 over the break and you have had a chance to look at it now.
10 Can you answer the question of whether in fact there are any
11 photographs that show the 90-degree view that you referred
12 to of DP-4?

13 A No, I cannot identify a specific photograph.

14 Q I am going to move on--

15 A (Witness Bush) I could infer something but I
16 think it is not desirable to do.

17 MR. ELLIS: Judge Brenner, I didn't act quickly
18 enough. I don't know what is meant by a 90-degree
19 photograph. We can either clarify it now or I will have to
20 come back to it on recross.

21 JUDGE BRENNER: Why don't you come back to it on
22 recross?

23 BY MR. DYNNER:

24 Q Dr. Berlinger, are you aware of anyone who
25 visually inspected the cam gallery saddle areas of the

AGBeb 1 replacement block for the EDG 103?

2 A (Witness Berlinger) Are you asking about people
3 on my staff?

4 Q Anyone.

5 A Yes, I understand that LILCO has inspected cam
6 saddle areas on the replacement 103.

7 Q Visually only. My question was are you aware of
8 anyone who visually inspected as opposed to non-destructive
9 examination by mag particle or liquid penetrant?

10 A (Witness Bush) If I may respond, if you wish,
11 there is in the testimony a visual examination that was made
12 I think shortly after the shake-out by a gentleman whose
13 name I probably can't pronounce, either Eisleib or Isleib,
14 that did an examination in various areas at nominal
15 magnifications in there and reported -- quote -- "no visible
16 cracks" in that particular area.

17 I am aware of that particular testimony. I would
18 also indicate that if they are tight cracks, visual
19 examination isn't a very productive method of detection of
20 same, but that's another matter.

21 Q Are you referring to the inspection report of
22 Dr. Isleib which is attached as Exhibit S-8 to the County's
23 supplemental testimony, Dr. Bush?

24 A If that's the one-- Yes, I've seen it in a
25 separate one, and I don't relate to that number.

AGBeb 1 Q Take a look.

2 (Witness Bush reviewing document.)

3 A I interpret this when he says "the block" as
4 being the 103 replacement block.

5 A (Witness Berlinger) Mr. Dynner, --

6 Q I'm following up for a minute, please,
7 Dr. Berlinger, and then I'll come back to you.

8 A Okay.

9 Q At page 7 of the County's Exhibit S-8, are you
10 familiar with the conclusion that:

11 "Careful inspection revealed no cold
12 or hot cracks or tears nor any cold shuts visible
13 to my naked eye, nor under the 5 power glass I
14 used."

15 A (Witness Bush) Yes, I am.

16 Q "Special attention was paid to internal
17 fillets such as in the cam shaft bearing saddle
18 areas."

19 A That's correct, I'm aware of that testimony.

20 Q Now, Dr. Berlinger, aside from that inspection
21 and its conclusion, do you know whether anyone else visually
22 inspected the cam gallery saddle areas on the replacement
23 103 block?

24

25

AGBwrb 1 A (Witness Berlinger) No, I don't know of anybody.
2 But I thought your original question was slightly
3 different. That's what I was going to try to answer. I may
4 be wrong. Maybe I misheard you. But I thought you were
5 asking me if anybody, to my knowledge, had just done a
6 visual inspection of the cam gallery area, saddle area, and
7 you did not refer specifically to either Shoreham or to any
8 of the Shoreham engines.

9 Q That wasn't my question. So now you know what my
10 question was. I think I've made it clear now.

11 A Okay.

12 Q You testified earlier today, didn't you,
13 Dr. Berlinger, that visual inspection alone has not detected
14 cam gallery cracks on the new 103 block?

15 A That's correct. The cracks could not be detected
16 with just visual, you have to use, I think, liquid penetrant
17 type inspection in order to identify them.

18 Q Did you personally visually inspect those cracks?

19 A No, I did not.

20 Q Who did? In other words, what's the basis for
21 your testimony?

22 A The basis for my testimony is a daily highlight
23 report which reported the -- what our resident inspector at
24 Shoreham had sent in when those inspections were done.
25 There was information that was provided from the resident

AGBwrp 1 inspector as a result of the inspections performed at
2 Shoreham.

3 Q Did this resident inspector tell you that he was
4 unable to see any cracks when he looked at them?

5 A I don't know for a fact that the resident
6 inspector was an actual participant in those inspections,
7 the visual inspections. It may have been a different time
8 that he looked at them visually and could not see the cracks
9 even after they had been found.

10 Q Well, who told you, if anyone, that they could not
11 see these cracks with the naked eye?

12 A The people from Long Island Lighting and the
13 resident inspector.

14 Q What people from Long Island Lighting told you
15 this?

16 A The individual who called me to notify me of the
17 existence I think was Craig Seaman. Yes, I think it was
18 Craig Seaman.

19 Q Did Mr. Seaman tell you that he was unable to see
20 these cracks with the naked eye?

21 A No. What he told me is that they had been found
22 even though they had previously done only a visual
23 inspection and had not found them, but they had been found
24 when they did some additional inspections prior to the
25 installation of strain gages on those particular cam

AGBwrp 1 galleries. The strain gages had been requested. We, the
2 NRC, had requested that those strain gages be installed.

3 Q So as I understand you, what you're saying is you
4 couldn't see them with the naked eye while the paint was
5 still on the engine; right?

6 A That's correct. I believe that is a true
7 statement, yes. You could not readily see them with the
8 paint on.

9 Q Now, after the paint was removed in preparation
10 for the attachment of the strain gages, did anyone tell you
11 that once the paint had been removed that they still could
12 not see the crack with the naked eye?

13 A No. I don't think I ever asked that question.

14 JUDGE BRENNER: Dr. Berlinger, do you know that
15 there was paint on this cam gallery area of the new 103
16 block?

17 WITNESS BERLINGER: Judge Brenner, I know that
18 there was paint on the cam gallery area. I also was told
19 that when a casting was manufactured at TDI, before it was
20 painted there was a visual inspection done there and,
21 indeed, no cracks were identified during that inspection.

22 As I said just a minute ago, the cracks -- or the
23 cam gallery was re-inspected in preparation for the
24 installation of strain gages for the testing of the engine.

25 That's the best answer I can give you.

AGBwrp 1 JUDGE BRENNER: How do you know there was paint on
2 it?

3 WITNESS BERLINGER: I was told that there was
4 paint on it when it was delivered.

5 BY MR. DYNNER:

6 Q Dr. Bush, I want to ask you some questions now
7 about the circumferential cracks.

8 Have you personally conducted a physical
9 examination of any of the samples sectioned from the old 103
10 block which contained circumferential cracks?

11 A (Witness Bush) No.

12 Q Have you analyzed reliable strain gage or other
13 data which determines the precise stresses in the area of
14 the circumferential cracks?

15 (Pause.)

16 Dr. Bush?

17 A I'm not aware of any such data.

18 Q And I take it your answer would also be, then,
19 that you haven't analyzed such data as to the areas into
20 which the cracks might propagate; is that correct?

21 A You had better rephrase that. You lost me on that
22 one.

23 Q All right.

24 Have you analyzed reliable strain gage or other
25 data which determines the precise stresses in the area into

AGBwrb 1 which the circumferential cracks might propagate?

2 A I am unaware that any such data has been
3 developed. That would require strain gaging of the areas
4 that I don't believe have strain gages.

5 Q What analysis, if any, has been done of actual
6 thermal stresses at the point of the circumferential crack
7 initiation and down into the counterbore?

8 A I'm not aware of a definitive thermal analysis in
9 that area.

10 Q What analysis has been done of the hoop stresses
11 in those areas?

12 A The hoop stresses I've seen values on reported by
13 FaAA that, by analogy, would apply to this area defined in
14 terms of the compression of the head and of the liner, and
15 of the expansion that would occur on heat-up. That's the
16 most I've seen, though.

17 Q Could you tell me what you meant by "applied by
18 analogy?"

19 A I didn't know I said "applied by analogy."

20 Q I think you did.

21 Identify for me what are these exact analyses you
22 are referring to.

23 A One I heard was an oral presentation, and it may
24 have been-- If it has been written up I haven't seen it.

25 That's the only thing I've seen so far. Unless

AGBwrp 1 it's in the supplemental testimony.

2 (Witness Bush consulting documents.)

3 That's not going to help any: it has to be a very
4 late date.

5 I guess I would have to say I don't have a
6 quantitative analysis of that, certainly at the time that
7 this was written. And if it has been prepared, I haven't
8 seen the report. And I refer to the need for -- not for a
9 need, but I'm not aware of a three-dimensional analysis of
10 this situation.

11 Q You say you received an oral report on hoop
12 stresses. What were the hoop stresses quantified that were
13 reported to you during that oral report?

14 A This was a rapid-fire presentation in conjunction
15 with something else, and I was mainly interested in the
16 initiation of the cracks at the time and, quite frankly,
17 didn't make notes or anything else. So I can't reply.

18 Q In your testimony on page 8, if you'll take a look
19 for a minute at the bottom paragraph, you say

20 "Neither LILCO nor the TDI Generator Owners'
21 Group has provided a 3-D analysis for review. I have
22 not recommended that such an analysis be required as
23 a basis for resolution of this issue because I believe
24 that reasonably reliable inferences can be made using
25 engineering judgment and the known behavior of

AGBwrp 1 analogous systems."

2 What analogous systems were you referring to
3 there?

4 A I wasn't thinking of diesel generators under these
5 circumstances, I was thinking of the behavior of the loading
6 of flanges, things of that nature, where you can have a
7 pulsating load and you have a shelf, and you move into a
8 negative stress field and the cracks will stop. Evidence of
9 this -- examples would be hatches where you bolt up and get
10 loads, they see a variable stress, there's either a stress
11 riser there or an actual defect, it propagates the distance
12 and then stops. That's the type of thing I was thinking of.

13 Q You said "hatches." What kind of components were
14 these flanges and shelves in that you were analogizing the
15 diesel engine to?

16 A Well, this particular one was one of the Canadian
17 reactors, as a for-instance. That one is an actual case
18 history that was examined both analytically and by
19 destructive analysis. That's an instance.

20 We have analyzed similar cases on flange
21 situations where you have a very high tensile load in a
22 location which would be analogous to the landing area, and
23 have done, in this instance, analyses by four different
24 organizations -- Westinghouse, General Electric, Babcock and
25 Wilcox and Combustion Engineering -- looking at the behavior

AGBwrp 1 under these circumstances. And so that's the type of
2 analogy that I'm using.

3 In other words, the geometry is somewhat similar,
4 the materials are different, the types of stress fields that
5 you would normally see would be, as a first approximation,
6 similar. And generally what happens there is that the crack
7 moves a finite distance and stops and sits.

8 Q You said the stresses would be somewhat similar.
9 Do those situations you're talking about have hoop stress?

10 A No, they have a bolting stress that would, I
11 guess, as a first approximation, be there, but you certainly
12 wouldn't have the pulsating effect that you would talk
13 about.

14 Q Now, you go on to refer to your engineering
15 judgment. Have you conducted any analysis or experiments of
16 the tensile stresses in the corner formed by the cylinder
17 liner landing and the cylinder liner counterbore?

18 A If you mean have I done a detailed analysis, no.
19 Engineering judgment is just that. It wouldn't be a
20 confirmation by analysis.

21

22

23

24

25

AGBeb

1 What I did really look at would be the fact that
2 we have -- because of the bolt-up, we would anticipate
3 compressive loads as we move away. From past experience, as
4 we move away from a sharp corner like that, one would
5 anticipate or there is plenty of evidence that the loads
6 drop off rapidly and that's fundamentally the type of
7 assumption that I made.

8 It is simply that, an engineering judgment,
9 nothing more.

10 Q You said there is plenty of evidence. What is
11 the "plenty of evidence" you were referring to?

12 A Going back to the analogies, I think that I've
13 seen numerous systems where a crack will initiate, move a
14 slight distance, and stop.

15 If you mean a one-to-one relationship, the answer
16 is obviously no, they don't have a one-to-one relationship.
17 But when one has one where you get a pronounced bending
18 moment by a loading thing that dies off, or you push in and
19 push down on the thing and if you put bolts through and
20 compress the block, obviously you have a compression field
21 below. And so it is a question of where the field changes
22 in that one.

23 I discussed this geometry and other geometries in
24 the context of how one would resolve it quantitatively, and
25 the only way we could decide to do it would have been to do

AGBeb 1 an extensive three-dimensional analysis.

2 Q When you were talking about these analogies,
3 those were the -- and the "plenty of evidence" that comes
4 from those would be the analogies without the pulsating
5 stresses which are present in this situation. Isn't that
6 right?

7 A Yes. I can't think of any particular ones--
8 Well, no, I guess I could think of some that would have a
9 pulsating stress, too.

10 There are reciprocating pumps where you put the
11 head on and you get a pronounced bending moment in the
12 flange area. You load the pump and you would get a
13 pulsating load, so you would get a medium-frequency load
14 that would be somewhat analogous to this situation that
15 we're talking about here.

16 Q You said a medium-frequency load. What would
17 that be?

18 A Well, it wouldn't be that many cycles per second
19 perhaps as we might have here. That's the only difference.

20 Q What would be the difference in the cycles per
21 second, approximately?

22 A Oh, golly, that varies with the types of pumps.

23 Let me rephrase it and say it would be not a
24 high-amplitude load in which case it would be somewhat
25 comparable to the pulsating stress we have here. And the

AGBed 1 number of cycles per second would perhaps vary by a factor
2 of two or three, something of that nature, no more than
3 that.

4 JUDGE BRENNER: Dr. Bush, could you explain, in
5 words that I'll understand, to make it hard for you, exactly
6 what the hoop stress is that you're talking about in the
7 context of the circumferential crack discussion?

8 WITNESS BUSH: Yes, sir.

9 In this instance we have the liner that sits on
10 this landing and it's been pushed down. It means that there
11 is a load on the landing simply by the pushing down, but the
12 liner as such isn't in contact vertically with the block.

13 As you heat it up, the liner sees a higher
14 temperature initially and expands. It finally makes contact
15 with the block and essentially pushes against the block
16 around the total cylinder, and that develops what we call a
17 hoop stress. In other words it is attempting to push
18 outward on there, and so what you have is what amounts to an
19 overturning moment on the vertical portion of the landing as
20 a first approximation.

21 It also is pushing below that, of course, which
22 is one of the reasons why we develop a compressive field
23 into the block. We're pushing the block and of course we
24 also have a vertical compressive field because of the
25 bolting.

AGBeb

1 BY MR. DYNNER:

2 Q Dr. Bush, you don't have any assurance, do you,
3 that EDG blocks 101 and 102 don't already have
4 circumferential cracks extending 360 degrees around the
5 landing, do you?

6 A (Witness Bush) No, I don't have any assurance.
7 I would not be at all surprised if they have circumferential
8 cracks. I would be a little surprised if they had gone 360
9 degrees.

10 Usually because of little differences in surface,
11 you get a slightly higher loading in one location vis-a-vis
12 another. But even a 360-degree crack wouldn't surprise me
13 terribly. I have seen it happen in pipes a number of
14 times. I know it can happen.

15 Q And you don't have any evidence of the depth of
16 circumferential cracks in the EDG 101 and 102 blocks, do
17 you?

18 A That's correct, I don't. In fact I am not aware
19 of definitive measurements on those blocks. That doesn't
20 say they haven't been done. I'm simply not aware of them.
21 But there is nothing that has been brought to my attention
22 that it has been done.

23 Q You gentlemen are aware, aren't you, that there
24 were no TSI depth probe measurements of the EDG 102 block?
25 Are you aware of that?

AGBeb 1 A (Witness Berlinger) Mr. Dynner, is that in any
2 location?

3 Q In the cam gallery area. I'm sorry.

4 A (Witness Bush) Oh, you switched. We are not on
5 the landing area.

6 Q I'm sorry, I apologize. In my own mind I had
7 shifted and I neglected to tell you about it. I'm sorry.
8 I'll rephrase the question.

9 You are aware, aren't you, that there are no TSI
10 depth probe measurements of the cam gallery cracks in EDG
11 102's block? You are aware of that, aren't you?

12 A I'm having difficulty with an oral conversation,
13 but I think probably everything that was being discussed was
14 103. 101 and 102 came up in the discussion, but I think
15 only in the context of inference. And so I guess I would
16 have to say I am not aware-- I'd rephrase the question and
17 say I am not aware of any measurements in that area.

18 MR. DYNNER: I am now going to distribute and ask
19 that there be marked for identification Suffolk County
20 Diesel Exhibit 80, I believe.

21 (Documents distributed.)

22 I am going to identify the document,
23 Judge Brenner. It is an extract from the FSAR for the
24 Shoreham Nuclear Power Station, consisting of seven pages.
25 On the first page the relevant material begins with Section

AGBeb 1 8.3.1.1.5, entitled "Onsite Standby Power Supply." It is at
2 the bottom noted as page 8.3-5, Revision 26, April 1982, and
3 it continues over to page 8.3-8a/b, showing Revision 32,
4 1983.

5 The following page is the FSAR Table 8.3.1-1.
6 There are four pages of this table, and in the bottom
7 right-hand corner it is identified as Revision 31, August
8 1983.

9 JUDGE BRENNER: All right. It is marked for
10 identification.

11 (Whereupon, Section 8.3.1.1.5
12 and Table 8.3.1-1 of the
13 Shoreham FSAR were marked as
14 Suffolk County Exhibit 80 for
15 identification.)

16 BY MR. DYNNER:

17 Q Dr. Berlinger, can you identify this document as
18 the current Section 8.3.1.1.5 of the Shoreham FSAR and the
19 current Table 8.3.1-1?

20 MR. ELLIS: Excuse me. May I have that question?
21 I wasn't sure that I heard the end of it. May I have it
22 read back, or at least the back end of it?

23 MR. DYNNER: The last part was and the current
24 Table 8.3.1-1.

25 JUDGE BRENNER: I think if you add "as approved

AGBeb 1 by the Staff" you will get a simpler answer.

2 MR. DYNNER: Thank you, sir.

3 BY MR. DYNNER:

4 Q As approved by the Staff?

5 A (Witness Berlinger) I believe that is correct,
6 but I wouldn't swear on my life or your life to it because I
7 have nothing to compare to right here. But I think that is
8 it.

9 Q You are not aware, are you, Dr. Berlinger, of any
10 later revisions of these two documents which changed the
11 substance of them?

12 A I am not aware of any revisions.

13 Q Take a look, would you, Dr. Berlinger, at the
14 beginning of Section 8.3.1.1.5?

15 Does that now refresh your recollection
16 concerning the rating of the EDGs at Shoreham as set forth
17 in the FSAR?

18 A Yes, I assume this is what you were specifically
19 referring to earlier today as a continuous 8,760-hour figure
20 that you had questioned me on earlier.

21 MR. DYNNER: Judge, I would like to move the FSAR
22 portions as identified by Dr. Berlinger into evidence.

23 JUDGE BRENNER: All right.

24 MR. ELLIS: Judge Brenner, I would like to have
25 an opportunity to verify that this is the latest, and we

AGBeb 1 haven't had that opportunity yet.

2 JUDGE BRENNER: Okay. I've got more substantive
3 problems than that. That opportunity is around.

4 First of all, Mr. Ellis, if anybody knows of a
5 later revision that has been accepted by the Staff, -- we
6 are not talking about the most recent October 1984 filing,
7 but anything before that but subsequent to this, Staff
8 should certainly let us know right away, and LILCO should
9 let us know, "right away" being as soon as feasible. All
10 right?

11 Mr. Dynner, there is a gap in my mind and maybe I
12 just don't remember what you covered earlier on this. One
13 reason I suggested that you introduce this into evidence or
14 at least as an exhibit for identification is you were
15 purporting to paraphrase some requirements relative to the
16 continuous load from this amendment. And I was hoping you
17 would point particularly to what you had in mind.

18 MR. DYNNER: I'm sorry, Judge, I thought I had in
19 my last question but--

20 JUDGE BRENNER: Let me be more specific.

21 You asked Dr. Berlinger some questions which
22 purported to paraphrase the FSAR as requiring that the
23 continuous load was defined as 8760 hours run continuously
24 except for that routine maintenance specified by I believe
25 you said the TDI Owners' Manual.

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And if you can point me to where you paraphrased that language it would help me.

And Dr. Berlinger had some problems answering your questions without having the amendment in front of him, and that is where the record stood.

MR. DYNNER: All right. I will ask a few clarifying questions.

BY MR. DYNNER:

Q Isn't it true, Dr. Berlinger, that this FSAR section which is identified provides that the performance rating of each diesel generator set is, among other things, a continuous rating which is 8,760 hours at 3,500 kilowatts?

AGBagb

1 That's in Section 8.3.1.1.5.

2 A (Witness Berlinger) Mr. Dynner, as is stated
3 here on this page, 8.3-5, of the excerpt from the FSAR the
4 continuous rating is 3500 kilowatts. The inclusion in
5 parentheses next to the word "continuous" of the numbers
6 8760 hours does not mean that it is necessary in order for
7 these diesels to be qualified for nuclear service that they
8 demonstrate or be able to run continuously at 3500 kilowatts
9 for 8760 hours.

10 In fact, I can be more specific and maybe clarify
11 some of my testimony from earlier today by pointing out to
12 you that the regulations which we require these diesels to
13 meet are specified in the General Design Criteria 17 in
14 Appendix A to 10 CFR Part 50 --

15 MR. DYNNER: Judge, I am going to interrupt the
16 witness --

17 JUDGE BRENNER: Yes, all right.

18 MR. DYNNER: -- because he is not answering the
19 question and he is going off on a totally different --

20 JUDGE BRENNER: All right.

21 MR. DYNNER: -- matter than the question.

22 JUDGE BRENNER: I'll interrupt, but let me tell
23 you that you didn't focus on my point yet either.

24 MR. DYNNER: I was going to try to get there by a
25 series of questions and the witness I think has gone off on

AGBagb 1 somewhat of a tangient. My question I think was a very
2 precise one that could be answered yes or no.

3 WITNESS BERLINGER: Could you repeat the
4 question?

5 JUDGE BRENNER: Why don't you move on to the next
6 point because I want you to show me where the definition of
7 the requirements for the continuous rating is in this
8 amendment that you purported to paraphrase from, Mr. Dynner.

9 BY MR. DYNNER:

10 Q Isn't it true that the 8760 hours that appears in
11 parentheses after the word "continuous" is an indication
12 that the rating for this engine for these EDGs is that they
13 run continuously for 8760 hours, that's the rating, at 3500
14 Kw?

15 MR. ELLIS: Asked and answered. objection.

16 JUDGE BRENNER: It is overruled. We are trying
17 to clarify from some not so clear testimony earlier.

18 BY MR. DYNNER:

19 Q Yes or no?

20 A (Witness Berlinger) The rating of the engine as
21 far as the continuous rating is concerned is 3500
22 kilowatts. The 8760 hours is part of the definition as
23 found in IEEE 387 dated 1977. That was presented earlier in
24 LILCO Exhibit C-4. And the continuous rating is defined in
25 Exhibit C-4, and I can quote it:

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"The electric hour output capability that the diesel generator can maintain in a service environment for 8760 hours of operation per common year with only scheduled outages for maintenance."

That is the definition of continuous rating.

Q Thank you.

MR. DYNNER: I was going to get there, Judge, through the two-step process and Mr. Berlinger has kindly short-stepped it for me.

JUDGE BRENNER: I misunderstood the source of your questions earlier and I guess I added to the confusion because, as I said, I thought you were paraphrasing directly from this and apparently you weren't.

MR. DYNNER: I'm sorry for the confusion, sir.

MR. ELLIS: Judge, I would like to on the record move to strike the testimony as being irrelevant. The witness himself testified that that is not a licensing basis nor is it a licensing requirement.

JUDGE BRENNER: It is not irrelevant. You can argue what it is or isn't later. I have read the FSAR and I have heard the witness' testimony about the source of what he read from.

MR. ELLIS: Maybe I wasn't clear but what I think is relevant and irrelevant is what is the licensing basis.

AGBagb 1 JUDGE BRENNER: I know. We'll decide if it is
2 necessary to decide what all this means.

3 MR. DYNNER: Judge, I am assuming that this
4 document will be admitted into evidence subject to any
5 objections that might be based upon further revisions that I
6 am not aware of, and if there are further revisions then I
7 would hope to have the opportunity to put them in, and if
8 they are substantive we can perhaps find a place to explore
9 the significance of any subsequent revisions. Neither the
10 witness nor I are aware of any subsequent substantive
11 revisions.

12 JUDGE BRENNER: We will certainly inform you
13 before we allow a modification of this to come into the
14 record, if that's what you're worried about.

15 Any objections to admitting this into evidence?

16 MR. PERLIS: Staff has no objection.

17 MR. ELLIS: LILCO has none.

18 JUDGE BRENNER: All right.

19 Suffolk County Exhibit 80 as previously
20 identified is admitted into evidence.

21 (Whereupon, the document previously
22 marked for identification as Suffolk
23 County Diesel Exhibit 80 was received
24 into evidence.)

25 MR. ELLIS: When I said I had no objection though

AGBagb 1 I don't waive my previous objection as to the relevancy of
2 the information. It is still LILCO's position that this
3 isn't -- the particular reference to 8760 hours is not a
4 licensing basis and it certainly --

5 JUDGE BRENNER: I heard you before.

6 MR. ELLIS: Yes.

7 I just want to state further that in addition
8 that the interim licensing basis is different than as stated
9 in the SER.

10 MR. DYNNER: If we're going to have an
11 argument --

12 JUDGE BRENNER: No, we're not.

13 MR. DYNNER: Good.

14 JUDGE BRENNER: You two can after.

15 MR. DYNNER: I have no further questions at this
16 point and I would request that if the Board can it would
17 excuse the witnesses, I have another matter which has come
18 up which I would like to deal with with the Board concerning
19 other testimony and witnesses, since it is 10 minutes to
20 5:00 --

21 JUDGE BRENNER: Concerning other testimony of
22 these witnesses?

23 MR. DYNNER: No, sir, of other witnesses.

24 JUDGE BRENNER: Other testimony of other
25 witnesses.

AGBagb 1 All right. That is acceptable to us.

2 We are going to finish with these witnesses
3 tomorrow, because we have heard a lot of testimony and it is
4 not going to take longer than tomorrow to finish. We have
5 questions, though --

6 (The Board conferring.)

7 Our estimate of our own questions is about an
8 hour.

9 MR. ELLIS: Do you want estimates from the
10 rest --

11 JUDGE BRENNER: No, I'm telling you what time
12 frame you have. We are going to finish at 12:00 tomorrow
13 and in that time frame will be all of the remaining
14 questions of these witnesses.

15 Before we excuse the witnesses, I want to tell
16 you that I learn something every day in these hearings that
17 surprises me and my surprise of the day today is that there
18 are expert witnesses on for one party that have not read
19 arguably important material testimony of another party.

20 And I am asking the Staff to make sure the
21 witnesses read all that testimony that they haven't read
22 tonight because some of our questions are either expressly
23 or implicitly going to be based on that testimony, as were
24 questions today.

25 And we keyed on the supplemental testimony of the

AGBagb 1 County but there is supplemental testimony of LILCO, there
2 is proposed rebuttal testimony of the County and counsel had
3 better put it all together and make the witnesses have all
4 of the testimony and copies in front of them tomorrow also.

5 MR. PERLIS: Yes, sir.

6 JUDGE BRENNER: All right.

7 And the witnesses are excused at this point.

8 (Witness panel temporarily excused.)

9 JUDGE BRENNER: I should indicate that we have
10 pretty much decided the time frame for these witnesses
11 tomorrow and that after we complete the cross-examination
12 of the County's witnesses on these cylinder blocks we are
13 going to want to put on the stand -- I may be using the
14 wrong term -- but the metallographic or the metallurgy type
15 experts to focus on metallurgy matters that are most sharply
16 in dispute and most of them are in the rebuttal testimony of
17 the County.

18 So that I don't mislead you, we're not putting
19 all of the witnesses back up together for all of the
20 parties, we want a very limited number, and just the
21 metallurgy type questions. So where there is any other
22 testimony in the rebuttal of the County, for example, which
23 we do end up admitting, those questions should be asked
24 while the County's panel is up, which is diesel operational
25 questions and so on. Because we are not going to put all

AGBagb 1 of the panels together.

2 And I guess what we have in mind as a working
3 basis -- and again we will hear from the parties, a, as to
4 whether there is an objection to the procedure, and, b,
5 whether we have not identified all of the witnesses who
6 should be part of it or whether we have incorrectly included
7 one who should not be -- but ones we have in mind would be
8 Dr. Wachob, Dr. Rau, Dr. Anderson and Dr. Bush. And we'll
9 do that after the County's testimony next week, immediately
10 after.

11 All right. I mention that in terms of your time
12 frame considerations because we're going to want to come
13 back, for example, and probe what the oxide layer may or may
14 not have looked like is going to be that opportunity with
15 all of the witnesses together so you can budget your time
16 tomorrow with that in mind.

17 MR. ELLIS: That's helpful, Judge, thank you.

18 WITNESS BUSH: Could I ask, since it has a rather
19 substantial impact --

20 JUDGE BRENNER: Well we heard about your schedule
21 last week, Dr. Bush, and we've got severe schedule
22 problems --

23 WITNESS BUSH: I recognize that. All I am really
24 asking is when you would anticipate, that's the only
25 question I had in mind.

AGBagb 1 JUDGE BRENNER: I can't answer it. If I could, I
2 would.

3 WITNESS BUSH: You know if it is the weekend of
4 Thanksgiving I have no problem.

5 JUDGE BRENNER: No, it will be next week, I can
6 tell you that.

7 It will be next week and it is highly unlikely I
8 think to be Tuesday. But now you've got me ahead -- remind
9 me of another subject.

10 I also expect LILCO to finish its
11 cross-examination of the County's panel on Tuesday. I will
12 be disappointed if it is not done that way and I'll leave it
13 at that. And whether I enforce my disappointment with an
14 actual time limit, I certainly cannot judge now because
15 certainly circumstances can occur during the
16 cross-examination that we would adjust to. But as a
17 preliminary thought, keep that in mind.

18 Mr. Dynner, were you going to give us good news
19 or bad news at the end of a long day?

20 MR. DYNNER: I'm going to give you some bad
21 news --

22 JUDGE BRENNER: I don't want to hear it.

23 MR. DYNNER: -- but it can be easily rectified I
24 hope.

25 MR. ELLIS: Judge Brenner, before we get to that,

AGBagb 1 did I understand you to say that only one more day is
2 allotted for cross-examination of the panel of the County by
3 LILCO?

4 JUDGE BRENNER: I didn't quite say it that firmly
5 but yes.

6 MR. ELLIS: As I understand it, we took a recess
7 in the cross-examination of the County panel after it had
8 only proceeded about two and a half hours to do this.

9 JUDGE BRENNER: I'm aware of what occurred and I
10 have an opinion on how useful the amount of material was
11 that we got given the time spent on it. And I didn't set it
12 as a time limit, I used the word "allotted" and I repeat I
13 was not that strict.

14 You know, I'm getting to be a cliché of myself:
15 put your best questions first with the possibility in mind
16 that we may not give you beyond that first day because we
17 are going to make a judgment based on how useful we think
18 what you thought your best questions were. But it is too
19 early for me to say we will cut you off with that time, I
20 don't have enough information to reach that judgment.

21 MR. DYNNER: All right, Judge. Yesterday we were
22 informed by Professor Anderson -- I'm sorry, we were
23 informed by an attorney in California -- not the same
24 attorney --

25 JUDGE BRENNER: I don't want to hear it.

AGBagb 1

MR. DYNNER: I know.

2

We were informed by an attorney --

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JUDGE BRENNER: This is going to be another day

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for your memoirs.

5

MR. DYNNER: I don't think so, I hope not.

6

JUDGE BRENNER: Okay. I'm only kidding, go

7

ahead.

8

MR. DYNNER: We were informed --

9

JUDGE BRENNER: The witnesses -- I'm sorry,

10

Mr. Dynner.

11

The witnesses were excused, I hope I made that --

12

I didn't make that clear.

13

WITNESS BERLINGER: We can sit here and listen?

14

JUDGE BRENNER: Sure, no extra charge.

15

MR. DYNNER: This is like the Coliseum of Rome

16

right now.

17

We were informed by an attorney in California --

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JUDGE BRENNER: I hope we never give you that

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impression.

20

MR. DYNNER: -- that that attorney claims

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Dr. Anderson as a witness in a case which the attorney

22

expected to begin on November 13th. We have spent a good

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deal of time trying to persuade that attorney by all sorts

24

of means to change her mind --

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JUDGE BRENNER: This is another case?

AGBagb 1

MR. DYNNER: This is another case.

2

And the bottom line is that this attorney has indicated that she intends to subpoena Dr. Anderson to appear in that case in California next week.

3

JUDGE BRENNER: I'll issue a subpoena right now for you.

4

5

MR. DYNNER: We have prepared a subpoena for this Board for Dr. Anderson for 9:00 a.m. the 13th of November and from that day to day thereafter until examination is completed.

6

7

(Document handed to the Court.)

8

JUDGE BRENNER: All right. Incidentally everybody gives me an extra initial -- not everybody but from time to time, but that's okay.

9

10

Of course, the subpoena doesn't say on behalf of which party and we are certainly not going to require it be retyped but on the record we're not calling him as a Board witness, we're signing this subpoena on behalf of Suffolk County for him to continue to appear as a witness on behalf of Suffolk County.

11

12

MR. DYNNER: That is understood, Judge, and we also don't intend to treat him as a hostile witness.

13

14

JUDGE BRENNER: And you also, of course, don't intend this to be in lieu of any obligations you might have among the County and Dr. Anderson as an expert witness.

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AGBagb 1

MR. DYNNER: That is correct, sir.

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JUDGE BRENNER: Here you go.

3

(Document returned to counsel.)

4

MR. DYNNER: We'll send it Federal Express,

5

Judge.

6

JUDGE BRENNER: Send it ZAP mail.

7

(Laughter.)

8

MR. DYNNER: Federal Express is more reliable.

9

JUDGE BRENNER: That's a branch of Federal

10

Express.

11

MR. DYNNER: I apologize for this, Judge, it was obviously totally unforeseen by anyone. I am sorry that it has come up and I appreciate the Board's action.

14

JUDGE BRENNER: It was totally unforeseen by you, I accept that. Beyond that I have no facts as to who else it might have been foreseen by.

17

I stated what our position would be in terms of Dr. Anderson's availability after the last adjustment we made and I certainly hope we don't have to remind each other of what the Board stated at that time.

21

Is there anything else?

22

MR. PERLIS: Excuse me, Judge Brenner.

23

JUDGE BRENNER: I meant from Mr. Dynner.

24

MR. DYNNER: No, sir, I have nothing else.

25

MR. PERLIS: It's related to this. I know the

AGBagb 1 subpoena calls for Mr. Anderson to be here at 9:00
2 a.m. Tuesday.

3 JUDGE BRENNER: 10:30.

4 MR. DYNNER: We want him here at 9:00, Judge.

5 MR. PERLIS: I just want to know when the rest of
6 us are supposed to show up. It is still 10:30?

7 JUDGE BRENNER: 10:30.

8 All right. Can we adjourn for the day?

9 (No response.)

10 JUDGE BRENNER: Okay. We will adjourn until 9:00
11 tomorrow morning.

12 (Whereupon, at 4:55 p.m., the hearing in the
13 above-entitled matter was recessed, to reconvene at 9:00
14 a.m., the following day.)

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CERTIFICATE OF OFFICIAL REPORTER

This is to certify that the attached proceedings before the
UNITED STATES NUCLEAR REGULATORY COMMISSION in the matter of:

NAME OF PROCEEDING:

LONG ISLAND LIGHTING COMPANY
(Shoreham Nuclear Power Station)

DOCKET NO.: 50-322-1 (OL)

PLACE: Hauppauge, New York

DATE: November 8, 1984

were held as herein appears, and that this is the original
transcript thereof for the file of the United States Nuclear
Regulatory Commission.

(Sigt) William R. Bloom Anne G. Bloom
(TYPED) William R. Bloom & Anne G. Bloom

Official Reporter

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