

October 3, 1984

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C O N T E N T S

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2	WITNESSES	DIRECT CROSS BOARD REDIRECT RECROSS	
3	STANLEY G. CHRISTENSEN)		
4	G. DENNIS ELEY)	24091 24198	
5	DALE G. BRIDENBAUGH)		
6	(Continued)		
7	EXHIBITS		For Id In Evd
8	LILCO Diesel C-42		24143
9	Depo, ABS witnesses, 7/18/84, Pp 129,130		
10	MORNING RECESS		24089
11	LUNCHEON RECESS		24154
12	AFTERN(X)N RECESS		24247
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1 WRBeb

1 proceeding, was going to proceed on the premises stated in
2 the testimony with the loads as utilized under the old
3 loads, and that LILCO wanted to go ahead with the hearing
4 and actually at that point continue with the hearing, and
5 that is what we're doing.

6 So the filing of the amendment has no effect on
7 the proceeding as far as I can tell, speaking as an
8 individual Judge right now. And my interpretation right now
9 is the only possible way I can make the different statements
10 from LILCO's Counsel on the subject consistent. So that is
11 where the matter stands.

12 In other words, fine, file your amendment, but it
13 has no effect on this proceeding just by the mere act of
14 filing an amendment.

15 Any other matters?

16 MR. DYNNER: Yes, Judge, I have a few matters if
17 LILCO is finished.

18 JUDGE BRENNER: Are you finished, Mr. Stroupe?

19 JUDGE BRENNER: Judge Ellis, may I address that
20 point for just a moment?

21 JUDGE BRENNER: I tell you I have heard so many
22 statements from LILCO's Counsel on that subject that I don't
23 think it is going to be beneficial to hear any more oral
24 statements on the subject at this point, unless you really
25 have something new.

1 WRBeb 1 Those individuals are in California. It is imperative from
2 the County's point of view that Dr. Anderson, the County's
3 metallurgist, be present during those depositions. We have
4 noticed those depositions to take place in Palo Alto,
5 California, at FaAA's offices on October 11th, which is
6 Thursday of next week.

7 That was the earliest time that we could arrange
8 to have Dr. Anderson available since he had telescoped his
9 schedule into the week of October 8th, which it was assumed
10 was going to be a free week, and we have managed to break
11 him free for about three-quarters of that day.

12 I have, in the interests of efficiency,
13 determined to take the depositions of the three FaAA
14 personnel as a panel so that we can get on with it. We will
15 then have to see what other documentation comes in, and
16 information concerning especially the newly discovered crack
17 indications on the new 103 block.

18 We believe that an analysis of the documentation,
19 the transcript of the deposition, as well as coordination
20 with what I now believe will be at least two other
21 consultants with respect to the supplemental testimony, are
22 such that we would project and request that we be permitted
23 to file our supplemental testimony on Wednesday or Thursday
24 of the following week, which would be I think the 17th or
25 the 18th, and then proceed as the Board had contemplated in

2 WRBpp

1 That is perhaps a more full explanation than you
2 wanted, but I did want to give you the details even though
3 it was clear that the Board's ruling was what it was.

4 JUDGE BRENNER: Well, what disturbs me is I can
5 understand you're wanting a gap of about a week between the
6 time you take the depositions and the time you file the
7 testimony such that the other parties receive it. I also
8 understand that other things are going on in the nature of
9 discovery besides the depositions. I do not understand why
10 everyone in this proceeding has to wait so long because
11 Dr. Anderson can't get to a deposition on a free week of the
12 hearing before October .11. We have some very serious
13 schedule considerations of our own here, some of which
14 you're going to hear about later this week, either later
15 today or tomorrow. That is the Board's schedule.

16 You had better tell me in even a little more
17 detail of why Dr. Anderson cannot be at the deposition prior
18 to October .11 on the free week.

19 MR. DYNNER: What I think I suggested to you,
20 Judge Brenner, that --

21 JUDGE BRENNER: You told me he had other things
22 to do.

23 MR. DYNNER: Yes. It is not a free week. He has
24 a very heavy teaching schedule which he has rearranged so
25 that he could be here this week. He is chairman of his

1 WRBpp 1 documents. I don't know whose inspection report you're
2 talking about. I assume you mean one of LILCO's or LILCO's
3 consultants?

4 MR. FARLEY: Yes, sir.

5 JUDGE BRENNER: Not necessarily, no. But some
6 sort of notification or summary of what the situation is if
7 we are not otherwise going to hear about it in testimony.

8 MR. FARLEY: All right.

9 JUDGE BRENNER: So that the parties can have that
10 also and that that will help them decide what to do.

11 Let me back up in the schedule. We made our
12 decision that we would give the County two weeks if they
13 asked for it. As I said at the outset, that's the bottom
14 line. I do want to explore what flexibility there might be
15 within in it. We're probably not going to finish the
16 County's testimony on pistons this week. Maybe I'll be
17 surprised, but my guess now is that we probably would not.

18 Is there a way in which we could complete the
19 County's testimony on pistons some time on the week of
20 October 15th -- it does not have to be the beginning of that
21 week -- such that we would still not begin the block
22 testimony until October 22?

23 MR. DYNNER: Here's my problem. Dr. Anderson is
24 on the piston panel.

25 JUDGE BRENNER: All right. That's the long and

1 WRBpp

1 JUDGE BRENNER: I heard you the first time,
2 Mr. Farley.

3 MR. DYNNER: I was confusing that with his
4 testimony about significance of the --

5 JUDGE BRENNER: All right; stop. The only reason
6 I asked that question was to make sure that, in fact, the
7 depositions were set for the 11th as opposed to the
8 posture being that the County was requesting the 11th and it
9 had not yet been set.

10 MR. DYNNER: I misunderstood, I'm sorry.

11 JUDGE BRENNER: Because I did not want to revisit
12 this subject tomorrow and find out that one of the essential
13 premises had changed.

14 MR. FARLEY: It has not been set until the Board
15 rules.

16 JUDGE BRENNER: I don't have to rule on a
17 particular date if it is acceptable to both parties. That
18 was all I wanted to know. In terms of availability I under
19 you would like them to take the deposition earlier.

20 MR. FARLEY: I beg your pardon? It would depend
21 on when we begin the block testimony.

22 JUDGE BRENNER: All right. In terms of the date
23 for receipt of the block testimony by the County, the 17th
24 would be better than the 18th. But we would be willing to
25 allow you to file it on the 18th if you end up needing the

1 WRBpp 1 day.

2 Does any other party have an objection to that
3 schedule?

4 (No response.)

5 JUDGE BRENNER: And we would provide the same
6 schedule for the Staff, if the Staff chooses to file
7 testimony.

8 MR. GODDARD: The Staff will be filing
9 supplemental testimony, Judge Brenner, and we will file it
10 on whatever date the Board sets.

11 JUDGE BRENNER: All right. Well, file it as soon
12 as you can. That would be our desire with respect to the
13 County, also. In any event, it must be filed so that it is
14 received by the Board and all submitting parties no later
15 than October 18. And if LILCO is going to file anything
16 else on the subject, the 18th may be a little late. And the
17 reason -- one thing I have in mind in setting the 18th is
18 that the first party testifying will be LILCO, and not the
19 County or the Staff.

20 MR. FARLEY: I understand understand that
21 arrangement that if, in the unlikely event, LILCO does file
22 something else, it should reach the County and the Staff
23 sufficiently in advance of the 17th or the 18th, so that
24 they can respond to it.

25 JUDGE BRENNER: Well, yes, that would be ideal,

1 WRBpp 1 but actually what I had in mind is so that they can have
2 time to prepare to cross-examine their testimony by as early
3 as October 22.

4 MR. FARLEY: I agree, your Honor.

5 JUDGE BRENNER: It's hard to say what the last
6 date would be without knowing (a) whether there is going to
7 be anything, and (b) how extensive it is. You will have to
8 use your judgment but we may hear argument about the
9 timing if it is filed too late. I would think that if you
10 got it in the party's hands at least by October 12, then you
11 would be on safe ground. And anything beyond that will
12 depend on viewing the factors.

13 MR. FARLEY: The 12th is it.

14 JUDGE BRENNER: Okay.

15 Now, the kind of notification of what was
16 discovered, we would expect to have sooner than that.

17 When you can be more specific about the piston
18 testimony, Mr. Dynner, let's also discuss the possibility of
19 finishing up the piston testimony sometime on the week of
20 October 15th. Because I think it could be done in, perhaps,
21 two days on that week if we get started on it this week.

22 MR. DYNNER: Yes, sir. And my comment about the
23 impact -- or potential impact -- of when I can report back
24 to you as to the excised portion related to the fact that
25 I'm going to be out to Shoreham. But when I get back I will

1 WRBagb 1 to them?

2 A I am saying that if they have calculations and
3 data supplied they will look at it. But I also have
4 sufficient experience to know that within the parameters
5 that we are working for for these engines that I doubt if
6 you will get Lloyd's to approve a crankshaft which is
7 designed for a normal rating of 3500 -- and doubtful of that
8 -- to operate at 3900. There is no way you could do it.

9 Q You cannot speak for Lloyd's rules, can you, sir?

10 A No, but I can speak as a very competent engineer.

11 Q Are you aware of any instances, sir, in which
12 Lloyd's has approved crankshafts that otherwise would not
13 meet the strict technical requirements of their rules?

14 A I am not privy to everything that goes on in
15 Lloyd's Register. But I have worked there and I have some
16 idea of what goes on. And I want to give a yes or no
17 answer, but in this case here I am prohibited from doing so
18 because it will not give the facts reasonably well. But
19 Lloyd's will allow any engine builder to produce to them
20 whatever he wants to produce.

21 But what I am going to say is this: engine building is
22 a commercial operation and, as such, most engine builders
23 will design their crankshafts not only within the Lloyd's
24 rules but everybody else's rules because this is a
25 commercial operation and the viability of the commercial

1 operation depends on having a crankshaft which will cover
2 everybody's rules. Some people say that is not so, but it
3 is so.

4 Q Professor Christensen, isn't that only true if
5 the engine manufacturer indeed wishes to sell its engine to
6 ship builders all over the world?

7 A An engine builder must be able —

8 Q Sir, could you give me a yes or a no and then
9 give me an explanation if you desire?

10 A Can you give me the question again, please?

11 Q Isn't it true, Professor Christensen, that the
12 only reason an engine builder would have for satisfying all
13 of the classification societies rules would be if they were
14 going to sell their engine for marine use all over the
15 world?

16 A Not only for marine use all over the world but
17 for marine and stationary use. The answer is yes. I'm
18 sorry, I did it the wrong way around. The answer is yes.

19 But an engine builder today -- there is no such
20 thing as a marine engine builder. All engine builders build
21 engines for operation as marine or as stationary units and
22 there is no difference between the marine stationary unit
23 except in the fact that most marine units are made
24 reversible and therefore the cam shaft is different.

25 If the marine unit is put onto a controllable pitch

1 WRBagb 1 orders and the stresses that are coming up with them and I
2 would add them together. But if I wanted to be more
3 precise, I could go to other methods.

4 Q Arriving at the phase relationships from a
5 tabular methodology, such as a table, giving the
6 T-sub-n's won't give you the stresses, will it?

7 A Sir --

8 Q Could you give me a yes or no?

9 A I can give you -- I cannot give you a yes or no
10 answer on that.

11 Q Have you in fact, Professor Christensen, ever
12 performed a detailed calculation where you sum the orders?

13 A I have some considerable time ago.

14 But what I would like to say is this: that there
15 is a "but" in it. The "but" is this: I often have to refer
16 to textbooks because sometimes I might be working in an area
17 where I am dealing with a torsional vibration, another time
18 I might be working in an area where I am dealing with a
19 shipboard vibration.

20 And on my bookshelf at home I have about two feet
21 of books in vibration. I cannot carry a lot of this
22 complicated stuff in my head so obviously I refer to books,
23 and this is what I would have to do in this case here to
24 come up with an answer for you which was valid and I am not
25 prepared to do that by guessing.

2 WRBagb 1 you have some Latin names for people who get first place in
2 examinations -- I don't know what the Latin names are -- but
3 I can tell you I was a medalist of the Institute of
4 Marine Engineers, I was an Allen's Prize winner and I
5 received another award for the highest marks in that
6 examination. And that examination covered the whole of the
7 British Empire in those days, the year was 1948. But I have
8 kept myself up to date.

9 Q Professor Christensen, isn't it true in that time
10 period, the 1940's, that the methodology for computing or
11 for summing orders and doing torsional -- force torsional
12 vibratory calculations was the SRSS method?

13 A No --

14 MR. BRIGATI: Judge, I object to this line of
15 questioning. I don't see how it is relevant to the
16 testimony that Professor Christensen has presented here. He
17 has not done any torsional vibration calculations.

18 MR. STROUPE: I can address that if you want.

19 JUDGE BRENNER: I think it is relevant.

20 MR. STROUPE: I believe he has indicated that he
21 has checked torsional calculations and I think I have a
22 right to inquire as to what his knowledge is.

23 JUDGE BRENNER: That's right.

24 Beyond that he is also talking about compliance
25 or lack thereof under his interpretation of some of the

1 WRBpp

1 safety borne out of long experience whereby the CIMAC rules
2 were built up.

3 BY MR. STROUPE:

4 Q Mr. Eley, having gotten your answer to that
5 question, am I to assume, or can I safely assume, that you
6 do not know whether the CIMAC rules contain an inherent
7 factor of safety?

8 A (Witness Eley) The CIMAC rules do have an
9 inherent factor of safety, otherwise they wouldn't have the
10 rule.

11 Q Gentlemen, let me refer to sheet 5 of 9 of
12 Suffolk County Exhibit 39. Doesn't this sheet 5 of 9 show,
13 among other things, that the CIMAC predicted endurance limit
14 for the Shoreham replacement crankshafts, as calculated by
15 TDI, is 32,846 psi or 32.8 Ksi?

16 A Yes.

17 Q Can I ask you, please, to look at LILCO Exhibit
18 C-17, page 3-9?

19 Do you have that available?

20 JUDGE BRENNER: It's the May 22, FaAA report, if
21 that helps you, gentlemen.

22 WITNESS ELEY: Page -- ?

23 MR. STROUPE: Page 3-9.

24 JUDGE BRENNER: Is yours the May 22 report?

25 WITNESS ELEY: Yes, sir.

2 WRBpp

1 BY MR. STROUPE:

2 Q Mr. Eley, doesn't the fact that the calculations
3 you have just made, the percentages you have just come up
4 with, give you some evidence of the conservatism or the
5 additional evidence of the conservatism or the inherent
6 factor of safety within the CIMAC rules themselves?

7 A (Witness Eley) The CIMAC rules themselves don't,
8 as far as I can recollect, refer to any measured value
9 which has been used here.

10 Q Again, Mr. Eley, that was not my question.

11 A It does show that there is some measure of
12 conservatism, yes.

13 Q Isn't it true, gentlemen, and overall, that the
14 1.0422 calculated by TDI as a factor of safety under the
15 CIMAC rules contains a large margin of safety when viewed in
16 this context?

17 A (Witness Christensen) It shows that there is a
18 factor of safety, but I think we could start discussing if
19 we wanted to make this a protracted long, drawn-out answer,
20 the relative merits of the word large.

21 Q Mr. Eley, would you have any comment on that?

22 A (Witness Eley) I would like to explain at some
23 time, why I still have reservations on the factor of safety.

24 JUDGE BRENNER: You can do it now. The reason
25 you can do it now is -- and I was going to jump in before

1 WRBagb 1 calculating the safety factor. You just now were asking me
2 about Von Mises' theory and we can calculate many, many
3 safety factors on many, many theories.

4 A (Witness Eley) I think the alternating bending
5 stress is given at the top of Sheet 5 of 9 and the
6 alternating torsional stress is just underneath it.

7 Q Do you agree, Professor Christensen?

8 A (Witness Christensen) I thought I had answered
9 your question.

10 Q Do you agree with what Mr. Eley just stated?

11 A Yes, I do.

12 JUDGE BRENNER: Wait a minute. I'm sorry, I
13 didn't hear you, Mr. Brigati.

14 MR. BRIGATI: I was curious as to whether a
15 question was pending. I was not aware that there was one.

16 JUDGE BRENNER: All right. We have taken care of
17 that now.

18 MR. BRIGATI: That's right.

19 BY MR. STROUPE:

20 Q In reviewing these calculations did you also
21 check the accuracy of these torsional vibratory
22 calculations?

23 A (Witness Christensen) Which torsional vibration
24 calculations are you referring to?

25 Q The ones that Mr. Eley just referred to at the

1 WRBagb 1 have done exactly what it says there in the deposition.

2 Q Did you go -- Did your calculation go from the
3 actual boundary of the crankshaft material in the webs at
4 one fillet -- the metal in one fillet to the metal in its
5 opposite fillet?

6 A I did exactly that.

7 Q And can you tell me why you arrived at a
8 different figure than ABS or Professor Sarsten?

9 A I arrived at a different figure I think because I
10 looked at it very, very thoroughly.

11 Q You are not inferring that Professor Sarsten did
12 not look at it thoroughly, are you?

13 A I am not inferring anything. I am just saying
14 what I did.

15 JUDGE BRENNER: Yes, but Professor Christensen,
16 you really didn't answer the question in terms of something
17 that would be helpful to me in this regard.

18 Can you tell me and everybody else here what you
19 actually did in terms of that dimension of the web that was
20 different than what Professor Sarsten and ABS did?

21 (The panel conferring.)

22 WITNESS CHRISTENSEN: Yes. What I did, Judge
23 Brenner, was this: I have worked in this area before and I
24 got a reconfirmation of this from the deposition given by
25 the people from ABS. I then constructed drawings of a

1 WRBagb 1 triangular pieces at the base of the drawing. There are two
2 triangular sections with some curvature on the ends. That
3 is the actual line of the metal removed.

4 They are given by the dimensions 3.965 and by the
5 figure .76, which does not look too clear in the diagram
6 here. The figure .76 is over on the left-hand side -- just
7 a little bit to the left and a little bit to the right and
8 lower down from the .875 figure. That view shows the actual
9 material boundary following the curvature of the fillet.

10 The rectangular section measuring 4.9244 by 21
11 inches is the rectangular section of the web taken on that
12 plane, if I remember rightly, at an angle of something a
13 little in excess of 24 degree's.

14 ~~The upper part there where you see the figure 3,~~
15 that is another rectangular area which is part of the web
16 section. And where I have drawn the line on the plane is
17 the section through the circular fillet which I have
18 included.

19 The reason I have included this was because I
20 thought there might be some objection from the other side if
21 I had not included it.

22 Then I have taken the various moments of the area
23 in various parts of this diagram and come up with a moment
24 of inertia, which is what is defined here by Woytowich. And
25 then I divided by the value Y to get a moment of resistance.

1 WRBeb

1 But if we are in the middle of a particular
2 sequence here and it looks like staying with the witnesses
3 might finish it up if it is not already finished by then, we
4 will consider other factors.

5 All right. Mr. Stroupe, I don't know how much
6 more you have left. Can you enlighten me?

7 MR. STROUPE: Judge Brenner, I think things began
8 to go a little faster than I had expected, and I think I--
9 I would hope that in a couple of hours I can finish up.

10 JUDGE BRENNER: All right. Why don't you proceed
11 at this time then?

12 MR. STROUPE: Were you finished with your
13 questioning on the ABS web, Judge Brenner?

14 JUDGE BRENNER: Yes. We may come back to it, but
15 I did not want to get in your way any more. And in fact I
16 was sorry I did as much as I did.

17 Go ahead.

18 CROSS-EXAMINATION (Continued)

19 BY MR. STROUPE:

20 Q Professor Christensen, I would like to ask you a
21 few questions, sir, about your calculations and
22 Professor Sarsten's calculations, following up what you have
23 already been asked.

24 It is true, isn't it, that Professor Sarsten
25 measured from metal to metal as indicated by ABS?

1 WRB:b

1 Q What about at 3500 Kw?

2 A At 3500 Kw, I think the highest figure that I
3 could find, or we could find was 1720, yes.

4 Q And thus wouldn't it be true,

5 Professor Christensen, that even under your calculations
6 under ABS as to crankshaft web sizing, based on the highest
7 calculated or measured cylinder pressure, 1720 at 3500 Kw in
8 the Shoreham EDGs, the replacement crankshafts would meet
9 the ABS requirements?

10 A For 3500, yes, but for 3900, no.

11 Q You are aware, are you not,

12 Professor Christensen, that ABS did not calculate an
13 overload situation under its rules for the Shoreham EDGs?14 A I am well aware of that. But this is the whole
15 problem that I have in facing up to this fact that this
16 crankshaft has been approved. I don't think it has been
17 approved for 3900 Kw operation, which is what it is supposed
18 to operate at.19 If I can just enlarge a bit more on this problem
20 area here, it is that the old crankshaft broke right across
21 the web section that we are considering now, and the new
22 crankshaft web section is virtually about the same.23 Q Isn't it true, Professor Christensen, that
24 Professor Sarsten determined, based on his calculations
25 under ABS, that even in the overload situation of 3900 Kw,

2 WRBpp 1 calculations, which are very close to the range that begin
2 by Stone and Webster.

3 Q That was not my question. Let me see if I can
4 restate it.

5 For purposes of your testimony, Mr. Eley and
6 Professor Christensen, didn't you, in fact, rely on or utilize
7 the calculations of FaAA in coming to your opinions as to
8 the ABS torsional stresses, under their rules?

9 A Yes, we did.

10 JUDGE BRENNER: Mr. Stroupe, could I back up to
11 your previous question and answer? I'm not sure if there
12 was an answer to the question and maybe that's because I
13 didn't understand it, Mr. Eley.

14 Mr. Stroupe had asked you if you had performed
15 any calculations under the ABS, and in the course of your
16 answer you talked about considering submitting something to
17 the ABS. Does that mean that you did perform calculations
18 or that you didn't?

19 WITNESS ELEY: I have performed some of the
20 calculations but not all of them, Judge Brenner. I don't
21 have the software. I don't have TORVAP I, TORVAP S, I've
22 not used these before. I've not got COMHOL. I've got none
23 of these software programs. But I did do the three modes
24 of vibration. I did the natural frequencies, I did a check
25 on those. And they were compliant with those submitted by

1 WRBpp 1 TDI. I used their mass-elastic system to do that.

2 JUDGE BRENNER: Okay.

3 BY MR. STROUPE:

4 Q Mr. Eley, the figure on page 123 of your
5 testimony of 5,640 psi --

6 A (Witness Eley) Yes.

7 Q -- that you utilized as calculated by FaAA, do
8 you see that?

9 A Yes.

10 Q Isn't that, in fact, a figure that was present in
11 an earlier -- a report by Failure Analysis Associates prior
12 to the April and May 22 reports of FaAA on the replacement
13 crankshafts?

14 A I do believe it was, yes. I think it was the
15 October 31, '83 report. It's the one that the Franklin
16 Research Center referred to. That's the one that I used.

17 Q And do you know whether or not this was based on
18 measured cylinder pressure?

19 A No, I think that one was based on the theoretical
20 indicator diagram used.

21 Q Do you know what the figure that equates to this
22 in the May 22, 1984, FaAA report on the replacement
23 crankshafts is? It's figure 7,006 -- I'll jog your memory.

24 A Figure 7,006; that seems to ring a bell, yes.

25 Q And isn't it true that FaAA utilized a method of

1 WRBpp

1 MR. STROUPE: Well, I'm using what the County
2 handed me yesterday. It's not numbered.

3 JUDGE BRENNER: Well, my copy was numbered by the
4 County. In any event, it is page 14.

5 MR. STROUPE: I believe it is the 14th page in
6 the sequence from the front.

7 BY MR. STROUPE:

8 Q Do you have that in front of you?

9 A (Witness Eley) I have a page which reads,
10 "Critical speed for fifth and a half order is:" on the top.
11 Is that the one you're referring to?

12 Q Yes.

13 A Yes, I've got it.

14 Q Approximately half to two-thirds of the way down
15 the page, do you see where the figure of 4,701.4 psi is
16 arrived at?

17 A Yes, I do. It's the resultant stress of the sum
18 of the square root of 2537 squared plus 3598 squared.

19 JUDGE BRENNER: What you said before was it's the
20 RMS sum?

21 BY MR. STROUPE:

22 Q And isn't that indeed the methodology by which
23 ABS summed the orders for purposes of calculating the
24 torsional stresses on the Shoreham replacement crankshafts?

25 A (Witness Eley) That is two orders, yes. That's

2 WRBpp 1 the fourth and the fifth and a half order, I believe.

2 Q And do you know what ABS calculated for the
3 allowable torsional stresses on the Shoreham replacement
4 contraacts under the 1984 ABS rules?

5 A The '84 rules?

6 Q Yes.

7 I think if you will turn over two pages --

8 A Yes, I've got it.

9 By the 1984 rules, which were not in effect when
10 these calculations were made, 5,035 psi and it has "okay"
11 after them. On the line above that, for the '83 rules, it
12 had 4608.5 and said, "the calculated stress exceeded the
13 allowable." That was just for two orders.

14 Q And isn't it true, Mr. Eley, that under ABS's
15 summation of the orders under the 1984 rules, the Shoreham
16 replacement crankshafts met ABS's requirements for torsional
17 stresses?

18 A Under the '84 rules, the two stresses that they
19 summed, which is the fourth and the fifth and a half order,
20 tend to 4701, which is less than 5035, yes.

21 Q Well, it's true, isn't it, that ABS has indeed
22 approved the torsional critical speed arrangement for the
23 TDI diesels at Shoreham?

24 A I would just like to add here that this is just a
25 rough calculation. I don't know that the American Bureau of

1 WRBagb 1

2 JUDGE BRENNER: Mr. Stroupe, while you are on
3 that page of County Exhibit 47 that is numbered page 14, do
4 the County's witnesses have the original of this document?

5 MR. BRIGATI: No, Judge.

6 JUDGE BRENNER: All right.

7 Mr. Eley, did you know from seeing any better
8 version, even if it was not an original, what the marginal
9 note says on the right-hand margin of page 14 -- which you
10 can piece together a little bit from page 15 but not
11 perfectly?

12 And the note I am speaking of has an arrow
13 pointing to the 4701.4 psi figure that you just discussed
14 and then another arrow pointing to the figure at the bottom
15 of the page of 4005 psi.

16 WITNESS ELEY: Yes, Judge Brenner, I do. It says
17 that the stress exceeds the rate allowable for grade.

18 I am surmising. It's not very clear but that's
19 what it is.

20 JUDGE BRENNER: Well you are doing the same thing
21 I can do. My question was whether you knew.

22 Let me put it this way:

23 Given your surmising -- and Professor Christensen
24 can join it if he wants to -- what does that mean, do you
25 know, in terms of the calculations presented on this page by
the ABS?

1 WRBagb 1 of the marginal note. Mr. Eley, orally you said the ABS was
2 comparing 4701 psi to an allowable of, I think you said,
3 4608. I'm wondering why you said 4608 instead of 4705 based
4 on the marginal note and the arrows on this page. That is
5 the numbered page 14 of County Exhibit 47.

6 WITNESS ELEY: That is the allowable for a Grade
7 4 material which has a UTS of 83,000 psi.

8 JUDGE BRENNER: And you have to go to page 16

9 WITNESS ELEY: That's correct, Judge Brenner.

10 JUDGE BRENNER: -- to get the picture that you
11 gave us?

12 WITNESS ELEY: Yes.

13 JUDGE BRENNER: All right. Thank you.

14 I'm sorry, Mr. Stroupe, go ahead.

15 BY MR. STROUPE:

16 Q Mr. Eley, do you know whether ABS approved the
17 torsional critical speed arrangement of the Shoreham EDG's
18 pursuant to the 1983 rules or the 1984 rules?

19 (Pause.)

20 WITNESS ELEY: I am looking for the ABS letter,
21 Judge Brenner.

22 JUDGE BRENNER: Did you hear your counsel? He
23 gave you the exhibit number, 44, which is the correct one.

24 WITNESS ELEY: Yes. This letter is dated the 3rd
25 of May 1984.

1 WRBagb 1 statement as he is entitled to do on cross-examination.

2 So the question now is --

3 MR. STROUPE: Maybe I can rephrase it and just
4 ask him:

5 JUDGE BRENNER: Why don't you do that?

6 BY MR. STROUPE:

7 Q Is your recollection of what you just
8 stated, Mr. Eley, based on what you looked at in the
9 calculations?

10 A (Witness Eley) Yes.

11 Q Isn't it true that your testimony on page 123,
12 which concludes that the total torsional vibration stress
13 imposed upon the replacement crankshafts exceeds the maximum
14 permissible under ABS rules for the design of materials in
15 question by a factor of more than 10 percent, utilized a
16 method of summing the orders which took into account 24
17 orders rather than the two orders summed by ABS?

18 A Yes, it did.

19 Q Let me refer you again to the Suffolk County
20 Exhibit 47 to the last handwritten page next to the Goodman
21 diagram.

22 A Safety Factors?

23 Q Yes, it is entitled, "Safety Factors" --

24 A Yes, I've got it.

25 Q -- and it has "desired minimum equal 1.34."

1 WRBpp

1 BY MR. STROUPE:

2 Q I refer you to pages 130 and 131 of your
3 testimony, specifically with reference to the strain gauge
4 measurements, wherein you say that the reports explicitly
5 state that the strain gauge measurements could be as much as
6 5 percent higher. That's on page 131 in the first answer.
7 Isn't it also true that the strain gauge results could be as
8 much as 5 percent lower?

9 A (Witness Eley) Yes.

10 Q How can block cracking, such as the EDG's at
11 Shoreham has experienced, affect torsional stresses?

12 A (Witness Christensen) When you say block
13 cracking, are you referring to the cylinder block cracking?

14 Q I'm referring to the indications that have been
15 observed and reported in the Shoreham cylinder blocks.

16 A If there is something in our testimony about
17 that, could you point that out to me, please?

18 Q Professor Christensen, will you look on page 132
19 at the question which begins, "Did TDI inform the ABS about
20 the other abnormalities that have arisen during actual
21 operating experience of the EDG's, such as the cracking in
22 the blocks?"

23 A Yes, I can see that there, yes.

24 Q And can you tell me how that would affect
25 torsional stresses?

1 WRBpp 1 ABS deposition. I have not been able to find it now.

2 JUDGE BRENNER: All right. So you were not going
3 to follow up?

4 MR. STROUPE: If you'll give me a moment, I'll
5 see if I can locate it.

6 JUDGE BRENNER: All right. Then I'll make my
7 point. I don't understand what good it's going to do you
8 even assuming the largest -- even assuming the best possible
9 answer, from your point of view with these witnesses,
10 because I don't know how you can possibly consider proposing
11 a finding that ABS thinks shot-peening might be a 20 percent
12 -- might give you a fatigue limit increase of 20 percent,
13 given the testimony of witnesses present here for LILCO.

14 MR. STROUPE: I think it goes to the credibility
15 of these witnesses, rather than to finding request on that,
16 Judge Brenner.

17 JUDGE BRENNER: All right.

18 Proceed.

19 BY MR. STROUPE:

20 Q Gentlemen, isn't it true that neither one of you
21 performed any independent calculations or analyses which
22 would show that the factor of safety calculated by
23 FaAA, 1.48 based on actual measured data, is inaccurate?

24 A (Witness Eley) We didn't do a calculation on
25 that, no.

1 WRBwrb 1 When you add that 10 percent do you get close to
2 4300 Kw?

3 A I would just like to run that one out quickly, if
4 I may.

5 Q Well, let us accept that— Well, maybe you
6 would--

7 A It is 4290.

8 Q Okay. And that is figure I think you calculated
9 before. And that is what you are saying that the generators
10 should be capable of delivering for a quarter of an hour; is
11 that correct?

12 A That's correct, Judge, yes.

13 Q Sticking with this generator for the time being,
14 you indicated that you felt that the crankshaft in the
15 generator should be designed in such a way that it would
16 withstand the effects -- and I use your words here: the
17 effects of subsidence; is that correct?

18 A I used that word in a general context, yes.

19 Q Okay.

20 Do you feel that that is an important
21 consideration in the EDGs at Shoreham?

22 A I don't know enough about the foundations to make
23 any judgment. But I was making this statement based on
24 normal stationary engine practices ashore.

25 Q But you're not certain whether that's an important

1 WRBwrb 1 and the codes of the society.

2 Was that a misinterpretation?

3 A (Witness Christensen) I think that was a
4 misinterpretation, Judge; because I know from my contacts
5 which I have maintained over the years with the research
6 department of Lloyds that they did a lot of full-scale
7 fatigue testing of crankshafts. They have a computer
8 program now based on that testing, and they have done an
9 enormous amount of research work using all the modern tools
10 of the trade.

11 Q I see.

12 A (Witness Eley) Judge Ferguson, I feel that the
13 latest techniques are very good tools indeed. That's what
14 they are, tools.

15 Q I see.

16 And if, in fact, we do have tools -- analysis
17 tools that will give us insight into the safety of a
18 machine, we should use all of those tools; is that your
19 feeling?

20 A By all means. But bear in mind that the testing
21 of the components must also be done in order that-- All
22 tools have limitations.

23 Q I see.

24 Did you want to add something?

25 A (Witness Christensen) Yes. I would say use all

1 AGBpp

1 Could I just make one little additional piece
2 here? If we look at the literature which has been published
3 by the technical institutions in the matter of crankshafts,
4 we will see Lloyd's people's names coming up very, very
5 often. There was just recently a paper read at the
6 Institution of Mechanical Engineers in London by Brian
7 Hildrew, who is the managing director of Lloyd's, on the
8 calculation of crankshaft stresses. This paper was based on
9 the research work which he had done -- or his society has
10 done -- and he received, I think, the Clayton Memorial
11 Award for that paper. It was a very, very important
12 contribution to knowledge of crankshaft design and
13 crankshaft stresses.

14 Q Thank you, very much, Professor Christensen.

15 Perhaps this is a good time to take a break.
16 Judge Brenner says we should be back in 15 minutes. Let's
17 make it 12 minutes by the clock.

18 (Recess.)

19 BY JUDGE MORRIS:

20 Q Professor Christensen, I will direct the first
21 question to you. It seems like a long time ago, but we did
22 talk about Piezo electric quartz crystals for measuring
23 pressure, I believe earlier in the week. And there was some
24 discussion on the relative accuracy between the Keine gauge
25 and the Piezo electric crystals. But we didn't, or at least

1 AGBagb 1 of the top of the arch as against the area of the arch
2 divided by the width which would give me a mean height like
3 we use in electrical calculations.

4 I hope I haven't clouded the issue more.

5 Q No, I understand what you are saying.

6 BY JUDGE MORRIS:

7 Q We are still having trouble, Professor
8 Christensen, with your use of "mean" and its being derived
9 from the square root of the sum of the squares.

10 Would you characterize that as a geometric mean?

11 A (Witness Christensen) No, I will characterize
12 that as saying that if the maximum value of that
13 sinusoidal is X then the mean value -- I can't remember the
14 actual figures -- would be .7 something of that maximum
15 value.

16 Q Well the way you describe it to me it sounds like
17 a single oscillation, but I thought the sum of the squares
18 was combining amplitudes of two oscillations.

19 Am I incorrect?

20 A Yes. If you take two oscillations you've got a
21 positive and a negative and they cancel themselves out; you
22 have to take a half oscillation to get some value.

23 Q Let me put it differently:

24 I am willing to take only the positive half of
25 the wave, but I am assuming an oscillation which is forced