

ORIGINAL

UNITED STATES
NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:

DOCKET NO: 50-322-01
(OL)

LONG ISLAND LIGHTING COMPANY
(Shoreham Nuclear Unit)

LOCATION: HAUPPAUGE, NEW YORK

PAGES: 24061 - 24247

DATE: WEDNESDAY, OCTOBER 3, 1984

TR-01

All 2 copies to ASLBPE/N-439

d1

ACE-FEDERAL REPORTERS, INC.

Official Reporters
444 North Capitol Street
Washington, D.C. 20001
(202) 347-3700

8410120052 841003
PDR ADUCK 05000322
T PDR

NATIONWIDE COVERAGE

AGBagb 1

UNITED STATES OF AMERICA

2

NUCLEAR REGULATORY COMMISSION

3

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

4

----- X

5

In the matter of: :

6

LONG ISLAND LIGHTING COMPANY : Docket No. 50-322-01

7

(Shoreham Nuclear Unit) : (OL)

8

----- X

9

State Office Building,

10

Veterans Memorial Highway,

11

Hauppauge, New York

12

13

Wednesday, 3 October 1984

14

The hearing in the above-entitled matter was

15

convened, pursuant to adjournment, at 9:00 a.m.

16

BEFORE:

17

JUDGE LAWRENCE BRENNER, Chairman,

18

Atomic Safety and Licensing Board.

19

20

JUDGE PETER A. MORRIS, Member,

21

Atomic Safety and Licensing Board.

22

23

JUDGE GEORGE A. FERGUSON, Member,

24

Atomic Safety and Licensing Board.

25

AGBagb

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

APPEARANCES:

On behalf of the Applicant:

ODES STROUPE, Esq.,

TIM ELLIS, Esq.,

MILTON FARLEY, Esq.,

Hunton and Williams,

700 East Main Street,

Richmond, VA. 23219

On behalf of the Nuclear Regulatory Commission Staff:

RICHARD J. GODDARD, Esq.,

DONALD HASSELL, Esq.,

Office of the Executive Legal Director

On behalf of the Intervenor, Suffolk County:

ALAN ROY DYNNER, Esq.,

JOSEPH J. BRIGATI, Esq.,

DOUGLAS J. SCHEIDT, Esq.,

Kirkpatrick, Lockhart, Hill, Christopher

and Phillips,

1900 M Street, N.W.,

Washington, D.C. 20036

AGBagb

C O N T E N T S

1			
2	WITNESSES	DIRECT CROSS BOARD REDIRECT RECROSS	
3	STANLEY G. CHRISTENSEN)		
4	G. DENNIS ELEY)	24091 24198	
5	DALE G. BRIDENBAUGH)		

6 (Continued)

7

8	EXHIBITS	For Id In Evd
9	LILCO Diesel C-42	24143

10 Depo, ABS witnesses, 7/18/84, Pp 129,130

11

12

13

14

15

16

17

18

19

20

21

22	MORNING RECESS	24089
----	----------------	-------

23	LUNCHEON RECESS	24154
----	-----------------	-------

24	AFTERNOON RECESS	24106
----	------------------	-------

25

WRBeb

P R O C E E D I N G S

1

2

JUDGE BRENNER: On the record.

3

4

Good morning. I see we have appearances for the Staff, LILCO, and Suffolk County.

5

Are there any preliminary matters?

6

7

MR. STROUPE: Judge Brenner, I believe there are a couple of preliminary matters.

8

One, we wanted to state to the Board that we have already informed the parties of this, that in view of the statements that were made last week, I believe, to this group, and in view of what was said yesterday about the questions relating to 3300 Kw, we wanted to inform the Board at the earliest possible time, and I believe that is today, that between October 12th and October 15, LILCO will be filing a formal amendment to the FSAR, and that formal amendment will adopt, as a qualified load, a figure of approximately 3300 Kw for approximately a two-hour period.

18

19

20

21

22

23

As I say, we hope to have that filed some time between October 12th and October the 15th, and in accordance with what has been said, we wanted to bring that to the attention of the parties as soon as possible, and to the attention of the Board. And indeed, we will have that document filed as soon as possible.

24

25

JUDGE BRENNER: Yes. However, we also were previously informed by Counsel for LILCO that LILCO, in this

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 MR. ELLIS: Judge Ellis, may I address that point
20 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.

WRBeb

1 MR. ELLIS: Well, I am prepared to pursue the
2 issue with the Board if it wishes.

3 I think it is essentially what has been said
4 before, to the effect that we are proceeding on the basis of
5 the testimony. However, as the Board has indicated, if the
6 record permits findings for some other load other than those
7 loads, then we would seek those as well. But we--

8 JUDGE BRENNER: That's not exactly what I said,
9 and I will just leave it at that.

10 What I said was if there had been or some day may
11 be proper notice and due-process considerations to all
12 parties and the Board accommodated, that it may then be
13 possible to utilize part of the record, but that would be an
14 incidental factor and not a purpose in adducing any record
15 on the subject. And that was the most I said on it.

16 I certainly did not say that as things stood now
17 that LILCO could utilize that record to support findings at
18 loads different than the premises in the testimony because
19 LILCO insisted in going ahead with the proceeding, both from
20 the beginning and then again when I put the question quite
21 directly to LILCO's Counsel. I don't know the exact day but
22 I think it was September 20th, give or take a day.

23 And we are not in the habit of sitting through
24 weeks of hearings only to learn that a party has decided
25 that it wants to go back over the same subjects in those

WRBeb 1 hearings under different premises when that party knew
2 before the hearing started that the premises might change.

3 And that is where it stands.

4 MR. ELLIS: Judge Brenner, we simply note for the
5 record that we would respectfully disagree. But let me
6 point out one other thing, if I may, that I think is
7 important.

8 Of course with respect to the cylinder heads,
9 that matter is resolved.

10 With respect to the pistons and the crankshafts,
11 I think the testimony did proceed on the loads as contained
12 in the direct testimony there, and there were a number of
13 loads stated.

14 With respect to the blocks, I think it is
15 important for me to point out at this time that the loads
16 stated there are the LOCA loads, and those loads are also
17 set forth in the FSAR, and they are not the same as 35 and
18 39. So it is--

19 JUDGE BRENNER: Tell me more precisely what
20 you're trying to tell me about the blocks.

21 MR. ELLIS: All right.

22 The block testimony evaluates the blocks on the
23 basis of loads that are experienced in the loop LOCA. The
24 loop LOCA event has a profile for the kinds of loads that
25 are experienced during the roughly 180 or whatever number of

WRBeb 1 hours, how many number of hours there are in the loop LOCA,
2 and those loads are not 35 and 110 percent. Those loads are
3 different.

4 The reason that-- And this is a typical
5 situation in the evolution of a plant where the design loads
6 change as the plant readies for operation, so the loop LOCA
7 loads that are in the block testimony are the ones that the
8 block testimony proceeds on.

9 The cylinder head testimony is in essence
10 irrelevant because that matter is settled. And then we have
11 the piston and the crankshafts, and we believe that there
12 there was certainly notice that LILCO --

13 JUDGE BRENNER: Let me stop you, because I was
14 just trying to get a factual point.

15 Are you telling me that LILCO believes that the
16 loads that we should consider when considering the block
17 testimony will be different than the loads we considered in
18 the crankshaft and piston testimony?

19 MR. ELLIS: Yes, I think that's right,
20 Judge Brenner.

21 JUDGE BRENNER: And that was in the original
22 block testimony filed?

23 MR. ELLIS: That's correct. I think it says the
24 loop LOCA in the block testimony, and not 35 and 39.

25 JUDGE BRENNER: Well, does it give a number for

WRBeb 1 it?

2 MR. ELLIS: It doesn't in the testimony. It does
3 in the FSAR.

4 JUDGE BRENNER: Forget it. The FSAR is not going
5 to be considered in this proceeding. I've told you time and
6 time again why, as of now. And it is that simple.

7 Look, I don't have to spell it out for you.
8 Other parties have a right to come in and challenge the
9 premises under which you want to change those loads, if you
10 are now changing it. And I already told you that I thought
11 LILCO was less than forthright in proceeding with the
12 hearing on schedule if they wanted to change the premises
13 upon which the loads were based because those premises are
14 essential or may be essential to the proof on every subject
15 before us.

16 And I think I was charitable when I said less
17 than forthcoming.

18 MR. ELLIS: Well, Judge Brenner, personally--
19 Judge Brenner,--

20 JUDGE BRENNER: Stop it right here, Mr. Ellis,
21 because--

22 MR. ELLIS: Let me change one thing. They are in
23 the direct testimony. I was mistaken in that connection.
24 The loads are in the direct testimony on the block.

25 JUDGE BRENNER: In the original testimony?

WRBeb 1

MR. ELLIS: Yes, sir.

2

JUDGE BRENNER: Or just the later testimony?

3

MR. ELLIS: The original testimony.

4

JUDGE BRENNER: All right. I don't recall that.

5

What are the loads in there?

6

MR. ELLIS: The loads I believe begin at 3881 for

7

.2 hours, 3409 for .8 hours, and 167 hours at 2617.

8

JUDGE BRENNER: All right. I will look at it in

9

the context when I look at the testimony.

10

There are different loads that evolve as the

11

period of time goes on during a loss of offsite power, a

12

loss-of-coolant accident. And if they are the same loads as

13

the original premises stated, then there is no problem. I

14

will leave it right there.

15

MR. ELLIS: Yes, sir. That's what I intended to

16

convey.

17

JUDGE BRENNER: Mr. Dynner.

18

MR. DYNNER: Judge Brenner, two matters that I

19

would like to deal with, the first very shortly.

20

I informed parties this morning, in view of some

21

statements that had been made earlier by this Board seeking

22

to eliminate extraneous testimony in view of the information

23

that was adduced during cross-examination testimony of the

24

LILCO witness panel and the Staff witness panel, the County

25

is in the process of deleting significant portions of its

WRBeb 1 direct testimony on pistons.

2 It is our belief that this will contribute to a
3 more efficient proceeding, will eliminate matters which have
4 been dealt with by the other parties during the
5 cross-examination to the satisfaction of the County. And as
6 soon as this process is completed, and we expect it to be
7 completed very shortly, the copies of the revised, shall I
8 say, direct testimony which will contain these deletions
9 will be handed out to the parties.

10 JUDGE BRENNER: I expect to start the piston
11 testimony this week.

12 MR. DYNNER: Yes, sir. And we expect that this
13 will, instead of causing any inconvenience or problems, will
14 reduce the amount of cross-examination significantly and
15 will contribute to a more efficient hearing. We expect to
16 complete the process today.

17 JUDGE BRENNER: All right. I was going to ask
18 you for your definition of "very shortly." That was my
19 problem.

20 MR. DYNNER: Yes, sir.

21 JUDGE BRENNER: Besides just deleting testimony,
22 I would like to get some sort of statement or stipulation as
23 to what portions are no longer in controversy so we do not
24 have to infer that from removal of the testimony.

25 MR. DYNNER: Yes. I am not sure I should say

WRBeb

1 portions not under controversy. There are portions-- The
2 principal portions that are being deleted -- and I say
3 "principal" because the process is underway and not at all
4 completed yet -- will deal with the critique of the detailed
5 -- the detailed critique of the FaAA fracture mechanics
6 analysis and, to a large extent, the critique of the FaAA
7 finite -- I should say the FaAA analyses regarding the
8 initiation of cracks in the boss area.

9 There may be other areas as well, but we have not
10 yet completed, as I said before, the final review to
11 determine what all the deletions will be.

12 The County's contention as to the inadequacy of
13 the pistons will remain intact. It is the critique of the
14 analyses principally that I'm discussing. There may be
15 other areas as well that are reduced through deletions.

16 JUDGE BRENNER: Well, does that mean that the
17 County no longer disagrees with those particular analyses,
18 even though the contention still remains in controversy?

19 MR. DYNNER: It means that the County now is--
20 Again, I think you are pushing me a little bit, a little too
21 hard on it because the process is on-going. And I would
22 appreciate if we could just let the document either speak
23 for itself if it is finished this afternoon, because I
24 really feel pressed and I don't want to say anything here
25 that is going to mislead anybody, or that is going to be

WRBeb 1 incorrect.

2 JUDGE BRENNER: All right.

3 I was going to add that you didn't have to answer
4 just now, and in effect you said that also.

5 But I don't think just the deletions will be able
6 to speak for themselves. I need to have a better
7 understanding of why they are being removed, and how that
8 might affect what subjects we have to make findings on. I
9 understand the contention on pistons is still in controversy,
10 but there may be portions upon which findings no longer have
11 to be made, even though there was evidence, both written and
12 oral, by the Staff and LILCO on the subject. And that is
13 what I want to find out by way of narrowing the issue.

14 So when you are ready, that is, at the time you
15 have the deletions which I hope is right after the lunch
16 break, or as soon thereafter as possible because we will
17 have to consider it, and I would like to be able to consider
18 it this afternoon, in the hopes that we could get to the
19 piston testimony certainly by tomorrow morning, possibly
20 today, although if you have a problem doing that, given the
21 deletions and there is only an hour left today, we can
22 certainly be flexible on that.

23 MR. DYNNER: Okay.

24 Let me report to you on the other area which may
25 have an impact on what you just said.

WRBeb

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

This is our report concerning the supplementary testimony that was filed by LILCO on the blocks and the discovery that proceeded therefrom. The Board ruled at transcript page 23,277 on September 24th, 1984, that -- quote:

"If the County tells us that (a), it will be filing supplemental testimony and (b), that it will be extensive enough such that it could not file it by a received date of October 12th, then we will accord the County the two-week break in the hearing."

There was other language in that part of the transcript in which the Board made it clear that they expected the County to proceed with all haste and good faith to try to get this matter concluded as early as possible and, hopefully, to be able to start the hearing, if not again on October 15th, then some time during that week.

LILCO has proceeded expeditiously to provide the County with numerous documents which we requested in discovery on this matter. Those documents, as late as yesterday, being delivered to the County. Some of them have been looked at; some of them of course are still being analyzed.

Yesterday we also had an opportunity to make a preliminary examination of some of the samples of the areas

WRBeb

1 of the block 103 which had been cut up and analyzed, and we
2 also had an opportunity to look at some of the photographs.
3 And that was, as you will recall, the period when
4 Dr. Anderson was able to leave the panel, and thereafter.

5 On the basis of the information that we so far
6 have gotten from discovery, it appears to the County that we
7 will be filing supplementary testimony and that it is likely
8 that that testimony will be extensive. How extensive I
9 cannot say.

10 Yesterday, as the Board will recall, LILCO
11 announced that it has now discovered that there were crack
12 indications on the new replacement 103 block in the cam
13 gallery area. We have requested photographs and
14 documentation concerning those cracks, and we will be of
15 course analyzing those in the context of the additional
16 discovery.

17 LILCO's Counsel informed me yesterday that at the
18 present time they do not expect that the crack indications
19 on the new replacement, the 103 block, will lead to
20 additional supplementary testimony on LILCO's behalf,
21 although it may in the future.

22 We have noticed deposition of three FaAA
23 employees who we have been informed by LILCO's Counsel were
24 the operative individuals in the analyses and inspections
25 carried on regarding LILCO's supplementary testimony.

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

WRBeb

1 its ruling, given our need for extensive supplementary
2 testimony, to proceed with the block hearings on the week of
3 October 22nd.

- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25

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 w.

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

WRBpp

1 department. I have been over this with him very carefully
2 and extensively. I, myself, --

3 JUDGE BRENNER: Judge Ferguson has the same
4 problem, let me put it that way to you. I'm serious.

5 MR. DYNNER: Well, I am too. And I think that
6 I'm a little surprised. I think we are proceeding in good
7 faith. We are proceeding as expeditiously as possible.

8 I wanted to add that we have arranged with LILCO,
9 and they have kindly consented, to allow Dr. Anderson and I
10 to go out to the plant this morning after we complete the
11 preliminary matters now, in order to look at the cam gallery
12 areas on the old and the new 103 block. We are proceeding
13 as quickly as possible. We do need -- I would just like to
14 finish. We do need the period before the depositions in
15 order to review extensive documentation so that the
16 depositions are efficient. I am not available this weekend
17 because of a religious holiday. And I don't think at all,
18 in view of the way this matter arose -- it was a matter
19 which arose, as the Board noted -- not with the fault of
20 Suffolk County. And I frankly feel a little bit, at this
21 point, under the gun unnecessarily for something that I
22 think we are all trying to do as quickly and as
23 expeditiously and as efficiently as is possible. And I
24 think any lawyer in this room with any experience would be
25 glad to be put under oath and testify that to complete the

WRBpp

1 discovery that we're involved in, to do the deposition that
2 we're involved in, and to prepare and submit written
3 testimony on these matters within the two-week period that's
4 allotted, is not excessive at all.

5 JUDGE BRENNER: All right. Let me agree with
6 some of what you just said because as you said, it was what
7 we said on the -- I guess it was the 24th -- none of these
8 last minute changes are due to the fault of the County. We
9 laid the responsibility for that at LILCO's doorstep. And
10 that was why we said we would give you the two weeks if you
11 said you needed it. And that is going to be the bottom
12 line.

13 However, what I was exploring a moment ago is
14 some of the details as to why it would take two weeks. And
15 it seems to me that, depending on one person, namely
16 Dr. Anderson, who cannot get to a deposition before October
17 11, is not very reasonable on the part of the County.

18 MR. DYNNER: Well, Judge Brenner, I had, I think,
19 two other points and I don't want to put the monkey
20 completely on Dr. Anderson's back.

21 I did say, and it is true, that we have a lot of
22 documents to look at. We haven't gotten the documents yet
23 on the new cracks on EDG 103 replacement block. I will not
24 be available to do any work on, at least, from Friday
25 through Sunday.

WRBpp

1 JUDGE BRENNER: I heard you.

2 MR. DYNNER: And I cannot travel on those days
3 either. And I think under those circumstances that the
4 three days that we're talking about, Monday, Tuesday, and
5 Wednesday, are not excessive to complete the document review
6 and to prepare for the depositions.

7 JUDGE BRENNER: Have the depositions been set for
8 the 11th? Will the FaAA deponent be available then?

9 MR. FARLEY: Yes, Judge Brenner. They're
10 available now. I offered to produce them in Washington and
11 I offered to produce them in New York. I offered to produce
12 them anywhere to expedite this matter. The documents began
13 production last Monday, last Wednesday, last Friday, and
14 last Saturday. Now, I don't think -- I understand where the
15 fault is being put. But I think it has to be put in
16 context.

17 The first change on the cam gallery area is not
18 significant. The change on the stud testimony is not
19 significant. The change on the circumferential testimony --
20 they can say they never saw it in the preliminary FaAA
21 report, but they've known about circumferential cracks ever
22 since they've had anything to do with these blocks.

23 I would be delighted, ordinarily, to accomodate
24 Mr. Dynner, but the considerations of the Board and the
25 considerations of my client just do not enable me to do

WRBpp

1 that. I don't think I am going to file --

2 JUDGE BRENNER: I only asked you one question,
3 although you have managed to squeeze in a lot more. That
4 was whether the depositions had been noticed. But if
5 there's something else you want to tell me --

6 MR. FARLEY: Mr. Dynner indicated to you that we
7 may file supplemental testimony on the new 103. I think
8 that is very, very unlikely. I don't want to say
9 absolutely, positively it won't be done, but I don't want to
10 give the impression that it is something that is
11 contemplated.

12 JUDGE BRENNER: Somebody is going to have to
13 apprise us formally of whatever new facts stem from that,
14 whether it be in evidence through a witness or by some
15 formal notification in terms of obligations we have
16 discussed before. Because the bare oral statement here is
17 not sufficient to totally fulfill that obligation. It was
18 sufficient to give timely initial notice, but not beyond
19 that.

20 MR. FARLEY: Does the Board want copies of the
21 inspection reports that I'm going to give Mr. Dynner and
22 Mr. Goddard?

23 JUDGE BRENNER: Well, we had a discussion on that
24 yesterday. We want copies of all the routine
25 correspondence. We do not want background discovery

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 with 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

WRBpp 1 the short of it.

2 Is he on the piston panel extensively or just in
3 passing? Remind me.

4 MR. DYNNER: Yes, I was about to get to that.

5 I'm going to have to look and see, once we cut
6 out these portions, just how extensively he is still
7 involved. But I don't know that right now, sir.

8 I might add, in answer to your question about the
9 deposition scheduling, that I notified LILCO's Counsel -- I
10 believe it was on the weekend, last weekend -- of noticing
11 the depositions, asking them to check with FaAA. They came
12 back to me and said they did check, that the 11th was a day
13 in which the FaAA personnel would be available in Palo
14 Alto. I suggested that we, for convenience, use FaAA's
15 offices, if they have one available for purpose of taking
16 the deposition. I was told the office would be available.
17 And I suggested 10 a.m. was a starting time, and nobody said
18 anything to indicate that that would not be all right. I
19 was told yesterday --

20 JUDGE BRENNER: Now you are giving me a lot of
21 detail I'm not interested in. What you're saying is
22 inconsistent with what Mr. Farley said.

23 MR. DYNNER: I just want to make it clear that --

24 JUDGE BRENNER: He said they were available then.

25 MR. DYNNER: Then I misunderstood what he said.

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 understand
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

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

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

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 excized portion related to the fact that
25 I'm going to be out to Shoreham. But when I get back I will

WRBpp

1 immediately attend to the piston matters.

2 JUDGE BRENNER: All right.

3 We can pick now, I believe, with the crankshaft
4 testimony.

5 MR. FARLEY: Excuse me, Judge. Do we understand
6 that you are going now to resume the blocks on October the
7 22?

8 JUDGE BRENNER: Not necessarily. No earlier than
9 October 22. We have been through this several times now.
10 We are going to finish the piston testimony first. I don't
11 know when that's going to be. We will need some more facts.

12 MR. FARLEY: Thank you, sir.

13 JUDGE BRENNER: Mr. Stroupe, I did say I'm going
14 to ask you for a time estimate at the outset.

15 MR. STROUPE: Yes, Judge Brenner. And I went
16 back last night with my colleagues and consulted and spent
17 about three hours trying to pare down what we had, and as
18 candid and frank as I can be with the Board this morning, I
19 believe that I can --

20 JUDGE BRENNER: But before everybody leaves --
21 one reason I'm asking you that now is that it will give us
22 some insight into when we may be to the piston testimony.

23 MR. STROUPE: I had anticipated, if I had gotten
24 started when I had hoped I would get started, that I would
25 finish by mid-afternoon. I will still make every effort to

WRBpp

1 try to do that. I think the Board will see that we have
2 some very relevant questions this morning on these various
3 classification societies.

4 JUDGE BRENNER: All right, It sounds like we
5 will probably not be getting to pistons today, given that.
6 But I hope we get to it first thing tomorrow. But we still
7 need a report back at some point today.

8 MR. BRIGATI: Before we resume the hearing,
9 Judge, can I have a minute with Mr. Dynner before he goes to
10 the plant?

11 JUDGE BRENNER: Surely. Why don't you take five
12 minutes, if you want? Or we'll take fifteen minutes now as
13 our morning break, and then recess early for lunch.

14 (Recess.)

15
16
17
18
19
20
21
22
23
24
25

WRBagb 1

JUDGE BRENNER: Back on the record.

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

MR. BRIGATI: As a preliminary matter in this particular proceeding, Judge, Professor Christensen was asked to do a calculation in the evening.

Do you want to hear the number?

JUDGE BRENNER: I will leave it up to Mr. Stroupe. I thought you were going to point out as a preliminary matter that the County has just Professor Christensen and Mr. Eley on the stand right now. You can tell us why and how the situation might change, if you wish.

MR. BRIGATI: Yes. The reason for that configuration of the panel at the moment is because Mr. Bridenbaugh and Mr. Hubbard are marking up or reviewing the County's piston testimony with a view toward shortening it, and as soon as they are finished with that chore they will be available again to sit down on the panel.

I might note that that is a preliminary mark-up and Mr. Dynner will have to review it before we can make it available to the Board and to the parties.

JUDGE BRENNER: All right. If any questions -- if LILCO or any of the other parties had any questions involving the portions of the testimony which are severable, as we noted and discussed the other day, the portions sponsored by witnesses not here, they can hold those until the witnesses are here. There may be no such questions on

WRBagb 1 crankshafts, but we will decide that at the end and
2 accomodate anybody's desires.

3 Mr. Stroupe, you can continue your
4 cross-examination.

5 Mr. Brigati has made his offer and you can choose
6 the timing as you see fit.

7 MR. STROUPE: Thank you, Judge Brenner, maybe
8 that would be a good point to start with.

9 Whereupon,

10 STANLEY G. CHRISTENSEN -

11 and

12 G. DENNIS ELEY

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

15 CROSS-EXAMINATION (Continued)

16 BY MR. STROUPE:

17 Q Professor Christensen, have you had an occasion
18 to do the calculation relating to Lloyd's overnight?

19 A (Witness Christensen) Yes, I have.

20 Q And what did that calculation reveal?

21 A Yes. For a maximum pressure of 1680 pounds per
22 square inch, we have a U.S. brake horsepower figure of 7078.

23 Q Do you know off the top of your head, Professor
24 Christensen, what that would convert to in metric
25 horsepower?

WRBagb 1 A I would have to multiply it by some figure which
2 I will have to look up.

3 O Okay. Don't worry about that.

4 You are aware, are you not, Professor
5 Christensen, that the figure that was put into the record
6 yesterday for the same calculation was in metric horsepower?

7 A I cannot recall what figure was put into the
8 record yesterday.

9 MR. BRIGATI: I think for the sake of clarity, if
10 I could step in here, we will have a clearer record --

11 MR. STROUPE: I think the record is pretty
12 clear.

13 MR. BRIGATI: -- in terms of explaining or asking
14 Professor Christensen what number he used to calculate the
15 number he is now testifying about. It sounds pretty
16 confused to me right now.

17 MR. STROUPE: I'm perfectly happy with the record
18 from my point of view.

19 JUDGE BRENNER: All right.

20 Why don't you hold it for redirect if you think
21 it is necessary, Mr. Brigati?

22 BY MR. STROUPE:

23 O Professor Christensen and Mr. Eley, you are both
24 aware, are you not, that Lloyd's rules, CIMAC, the American
25 Bureau of Shipping, all contain provisions which allow

WRBagb 1 departures from the requirements of the rules or special
2 considerations based on data and calculations and things of
3 that nature being submitted to them?

4 A (Witness Christensen) I am, yes.

5 A (Witness Eley) Yes, there are special
6 considerations.

7 Q So it would be true, wouldn't it, gentlemen, that
8 if one has a diesel engine whose components do not meet the
9 stated rules of those three classification societies or
10 those three rules that indeed there is a method by which
11 detailed calculations and facts can be submitted that will
12 be considered by those various societies, is that not true?

13 A (Witness Christensen) That is so, yes. But what
14 I want to say is this, that I am well versed with these
15 calculations and I know of no calculations which you can
16 bring out to allow an engine which is designed for a
17 continuous rating of 3500 Kw whereby you can make it into an
18 engine which will run at 3900 Kw. You could have all the
19 calculations in the world that you like and you will never
20 prove that point, as we have seen here in our work that we
21 have done.

22 Q Well you're not saying, are you, Professor
23 Christensen, that under no circumstances would Lloyd's
24 rules, for instance, approve the crankshafts in the Shoreham
25 EDG's based on calculations and data that might be supplied

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 competed 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

WRBagb 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 stationary use. The answer is yes. I'm sorry, I
18 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
21 build engines for operation as marine or as stationary units
22 and there is no difference between the marine stationary
23 unit 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

WRBagb 1 propeller, then the engine will be identical to a stationary
2 engine with the exception of the thrust bearing and then you
3 will come from a quite heavy thrust bearing into an area
4 where you have what we might call a crankshaft location
5 bearing.

6 Q Does that complete your answer, Professor
7 Christensen?

8 A That completes my answer, yes.

9 Q Professor Christensen, do you recall yesterday
10 that I asked you a question as to how you would determine
11 the phase relationship between the stresses in each order?

12 A I do remember you asking me that, yes.

13 Q And you had occasion over the night to consider
14 how you would calculate the phase relationship between the
15 stresses in each order?

16 A No, I didn't --

17 Q Let me finish the question, please.

18 A I thought you had finished.

19 Q Did you have occasion last night to consider how
20 you would calculate the phase relationship between the
21 stresses in each order to enable you to sum the orders
22 thereby being able to calculate the crankshaft stresses, the
23 combined crankshaft stresses?

24 A That is a rather complicated question you asked
25 me. If you can ask me in parts so I can write it down as

WRBagb 1 you ask me, I will try to give you an answer.

2 Q You do recall, do you not, sir, our colloquy
3 yesterday about trying to determine the phase relationship
4 between the stresses in each order?

5 A I do, yes.

6 Q And you do recall, do you not, that I asked you
7 how you would calculate the phase relationship between the
8 stresses in each order?

9 A Yes, I do.

10 Q And then I asked you that question as to how you
11 would calculate the phase relationship between the stresses
12 in each order?

13 A Correct.

14 Q -- to allow you to arrive at a sum of the orders
15 which would give you the combined stresses operating upon
16 any particular crankshaft?

17 A Yes, I do.

18 Q Now are you able to tell me the methodology by
19 which you would do that?

20 A I think I could do that, yes.

21 As I said yesterday, I would make my crank angle
22 diagrams. From there I would go around in either the
23 clockwise or anti-clockwise direction and pick up the phase
24 relationships for the various orders.

25 And from there on I would take those various

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 it 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.

WRBagb 1 Q Professor Christensen, which book or text would
2 you use if you were going to come up with an answer to this
3 question?

4 A I could go to Nestorides book, which is a
5 handbook published by the British Internal Combustion Engine
6 Research Association. I would go to the books "Practical
7 Solutions to Torsional Vibration Problems," which is now
8 into five volumes which has been written by a publisher
9 called Kerr-Wilson. I have two editions of that, one
10 five-volume edition, another two-volume edition.

11 I have various other books on vibration, some
12 highly mathematical, some dealing with the things where you
13 can get specific answers to specific problems. They are all
14 highly mathematical in nature, they all involve a
15 considerable amount of knowledge in the areas of
16 differential equations and all of them give simplified
17 solutions to the differential equations.

18 If you think that I don't have the mathematical
19 ability to deal with stuff like that, then I am willing to
20 produce the syllabus for the examinations that I have passed
21 and you will see there considerable reference that knowledge
22 is required in the area that I am talking about now.

23 Q In what year, sir, did you pass the exam that you
24 just referred to?

25 A I passed that examination in 1948 and I believe

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 metallurgist 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

WRBagb 1 classification society rules. And some of that involves, in
2 my view at least, how the analysis and calculations would be
3 performed. And it also tests his knowledge of the area.

4 We will overrule the objection.

5 WITNESS CHRISTENSEN: Could I have the question
6 again, please?

7 MR. STROUPE: Yes.

8 BY MR. STROUPE:

9 Q Professor Christensen, isn't it true that in the
10 time period you refer to in the 1940's the methodology
11 utilized for adding the orders or summing the orders was the
12 SRSS method?

13 A (Witness Christensen) No, I cannot remember the
14 relative terms or acronym, initials or acronym --

15 Q Square root sum of the squares.

16 A That has been known from time immemorial in
17 dealing with electrical alternating current work, there is
18 nothing new about that. It is a means of getting a mean
19 force if we have a sinusoidal. If we have a force which is
20 following a sinusoidal function, then we can find the mean
21 force by using this root mean square value, just the same as
22 we find the mean voltage or the mean power in dealing with
23 an electrical problem which is following a sinusoidal.
24 There is nothing new in that, in fact, that is in textbooks
25 which I think there is some criticism being thrown at me for

WRBagb 1 using.

2 The square root sum of the method, as I say, is a
3 means and what might be used by some people is this method
4 because a mean stress is much lower than a maximum stress
5 and when we are dealing with torsional vibrations where we
6 are dealing with fatigue limits and also fatigue resistance,
7 we shouldn't deal with mean stresses, we should deal with
8 maximum stresses and that is what I have been looking at
9 when I have been looking at calculations.

10 Q You are aware, aren't you, Professor Christensen,
11 that square root sum of the squares is not a mean stress
12 method?

13 A It is in my book, if it is as you say it is.

14 Q Professor Christensen and Mr. Eley, isn't it true
15 that the draft CIMAC rules look at or analyze crankshafts in
16 terms of a factor of safety?

17 A (Witness Eley) Yes, they do.

18

19

20

21

22

23

24

25

WRBeb

1 Q And it is true, isn't it, that the draft CIMAC
2 rules calculate a factor of safety with regard to
3 crankshafts by predicting actual fillet stresses and
4 comparing that to a predicted value of the endurance limit
5 of the materials of the crankshaft?

6 A That's correct.

7 Q And will you agree with me, sirs, that these
8 predicted actual stresses are concentrated stresses rather
9 than the nominal stresses that Lloyd's, ABS and DEMA
10 utilize in their rules?

11 A Yes, they are stress concentrations.

12 Q And it is true, isn't it, that Lloyd's, DEMA and
13 ABS utilized nominal stresses rather than stress
14 concentrations in their rules?

15 A (Witness Christensen) The calculations which are
16 produced by Lloyd's for torsional stress values relate to
17 the stress in the circular section of the shaft. If you
18 want to find the stress acting at the point with which you
19 are referring you will have to take the summation of the
20 stresses and put them through various mathematical
21 procedures to come up with a maximum principal stress which
22 will be at some point where we have a stress raiser which,
23 in this case here of the Shoreham crankshaft, is in that
24 portion of the fillet which is between 120 degrees of the
25 lower part of the pin. The procedures there are going

WRBeb 1 further.

2 The CIMAC procedures are based on a concentrated
3 stress. That is why we are looking at safety factors.

4 The Lloyd's procedures are dealing with the
5 stresses in the circular part of the shaft which are the
6 stresses which are arising out of torsional vibration, and
7 they are usually the maximum stresses arising at that.

8 But what we have to remember is that the stress
9 in the circular part of the shaft is totally different --
10 from torsion is a totally different thing from the bending
11 stresses that are coming on the shaft and therefore, where
12 we have this concentration of stress, that is coming from
13 the summation -- I use the word "summation" here in the
14 normal accepted --

15 MR. STROUPE: Judge Brenner, I want to interrupt
16 the witness, and make this observation.

17 If the witness persists in giving this kind of an
18 answer to a question that can be answered with a simple Yes
19 or No and what I believe to be is a simple explanation, we
20 will be here for the next three days.

21 JUDGE BRENNER: Mr. Brigati, I don't want to get
22 into detail today, but the answer seemed excessive to me.
23 You can give your opinion.

24 MR. BRIGATI: Judge, Mr. Stroupe wants to know
25 what Professor Christensen knows about torsional vibration.

WRBeb

1 He is finding out.

2 MR. STROUPE: That was not my question.

3 JUDGE BRENNER: That wasn't his question,
4 Mr. Brigati. You see, that's the question that the witness
5 is answering but it is not the question that was asked.

6 Professor Christensen, you are going to have to
7 keep the question in mind better. As I think you have noted
8 here, we certainly give you the opportunity to make an
9 explanation, but we want a record adduced here that we can
10 put together and apply to the questions in controversy
11 before us.

12 Just keep the question in mind when you formulate
13 your answer, please. However, do not feel restricted from
14 giving an explanation, but to the question.

15 Mr. Brigati.

16 MR. BRIGATI: Without trying to contradict that
17 instruction at all, Judge, I would simply note that I
18 understood Mr. Stroupe's question to be a request for a
19 comparison between the CIMAC and Lloyd's calculations or
20 methods of comparing torsional vibration stress.

21 MR. STROUPE: In only one respect.

22 JUDGE BRENNER: Yes, I agree with Mr. Stroupe.
23 But we will take it from here in any event. I am agreeing
24 with him on that question and answer.

25 Go ahead, Mr. Stroupe.

WRBeb 1

BY MR. STROUPE:

2 Q Professor Christensen and Mr. Eley, isn't it also
3 true that the CIMAC draft rules assume that maximum bending
4 and maximum torsional stresses occur in the same location
5 and at the same time in the fillet radii of the crankshafts?

6 A (Witness Christensen) No person-- No. I think
7 the answer to that is No. I don't have the CIMAC rules
8 before me so I cannot make an evaluation on them.

9 Q Let me interrupt you, Professor Christensen.
10 If you would look at Suffolk County Exhibit 38,
11 which is the proposed CIMAC rules, that might help you.
12 To save time let me refer you to page 14, Section
13 5.1.

14 A I have read that now, yes.

15 Q Is your answer still No?

16 A I think here if we look at this, this is--

17 Q Professor Christensen, can I have a Yes or No
18 answer?

19 MR. BRIGATI: Objection. I don't think that--

20 JUDGE BRENNER: I will take care of it,

21 Mr. Brigati.

22 Now you're going too far the other way. Frankly,
23 I'm getting tired of the pendulum swinging back and forth,
24 that I keep having to police the witness and the questioner.
25 Because you got a little support before, Mr. Stroupe,

WRBeb

1 doesn't mean that you can jump in and interrupt him when he
2 gets three words out of his mouth of the answer.

3 Professor Christensen, proceed with the answer
4 you were going to give.

5 W*TNES CHRISTENSEN: First, I don't feel I can
6 give a Yes or No answer to this question. The reason is
7 (a), that the question is very, very complicated and I know
8 from my knowledge of languages, although I do not speak
9 French.

10 Now I think that this is a translation from a
11 French document and is a poor translation. That is the
12 first thing I want to say. And I know people who are
13 members of CIMAC and if we are pointing at this as something
14 to be looked at as being wrong, I think that they are taking
15 this line out of context.

16 What the line means, and I know this is what it
17 means from my knowlege of crankshaft design, is that at the
18 point where the two stresses -- that is, the bending stress
19 and the torsional stress -- coincide, although the bending
20 stress would be considerably less at that point, they are
21 taking it as the addition of these two stresses. That is
22 giving you a maximum stress.

23 And that I am very, very sure of because the
24 people who drafted these rules are experts in this area.
25 And they know, and I know, and everybody else knows that at

WRBeb

1 the point of maximum bending, which is usually about top
2 center or some point after that, is not the point where we
3 get maximum torsion always.

4 And then when we speak of maximum torsion we have
5 got to be very, very careful there about how we are using
6 the word "torsion." And we are dealing here with very, very
7 complicated areas which I get -- I won't say "befuddled" on,
8 but I am trying to make my answers short. And it is very
9 difficult to give short answers in the context of these
10 questions and deal with the subject thoroughly.

11 WITNESS ELEY: The rules do state that they
12 assume the maximum alternating bending stress and maximum
13 alternating torsional stress within a crankshaft occurs
14 simultaneously and at the same point. They assume that,
15 yes.

16 MR. STROUPE: Thank you, Mr. Eley.

17 BY MR. STROUPE:

18 Q Professor Christensen, you know that this rather
19 poor translation is your exhibit, do you not?

20 A (Witness Christensen) I do. But I think this
21 came from originally TDI, if I remember correctly.

22 Q Did you make any attempt to obtain a better copy,
23 or translation?

24 A We did, but we drew a blank. We are not an
25 engine builder, and most of this stuff is privy to engine

WRBeb

1 builders and subscribers to the CIMAC organization.

2 Q Mr. Eley and Professor Christensen, it is true,
3 isn't it, that with regard to the Shoreham replacement
4 crankshafts, the maximum bending stresses and the maximum
5 torsional stresses do not occur at either the same location
6 in the fillets or at the same time?

7 A Again, I could not give you a Yes or No answer to
8 that without thinking about it.

9 We are dealing with a very, very complicated
10 area. I would like to make some diagrams. I would like to
11 look at testimony. I cannot give you an answer to that
12 straightaway. I would have to look at quite a few things to
13 come up with an answer because, as I keep reiterating, we
14 are dealing in a very, very complicated technical area.

15 Q Were you here when Dr. Pischinger testified to
16 that effect, Professor Christensen?

17 A I'm sorry, could I have the question again?

18 Q Yes, sir.

19 Were you here when Dr. Pischinger testified to
20 the effect that the maximum bending stresses and the maximum
21 torsional stresses do not occur at either the same time or
22 the same location in the Shoreham replacement crankshaft
23 fillets?

24 A I thought I had said that earlier, generally as
25 applied to all crankshafts in general.

WRBeb

1 Q I'm not asking you about that. I'm asking you
2 about your observation of Dr. Pischinger's testimony.

3 A I listened to a lot of Dr. Pischinger's testimony
4 but I cannot remember fine detail of it.

5 Q Are you through?

6 A If you can refer me to the sections in the
7 testimony, then I will try and answer that better.

8 Q Mr. Eley, do you have any response to the
9 original question I asked?

10 A (Witness Eley) With regard to Mr. Pischinger's
11 comments, I did not hear those. But with the other comment,
12 that is an assumption made with regard to these rules.
13 Whether that would actually apply in practice, I don't
14 know. I wouldn't like to even make a guess.

15 Q Have either of you read the various FaAA reports
16 in this proceeding that deal with the original crankshafts
17 and the replacement crankshafts?

18 A Yes.

19 A (Witness Christensen) I have, yes.

20 Q And neither of you can recall anything in those
21 reports that dealt with the location of maximum bending,
22 maximum torsional stresses, and the time or the phase in
23 which they occur?

24 MR. BRIGATI: Objection to the characterization
25 of their testimony. They did not say that they could not

WRBeb 1 recall anything about the FaAA reports on that subject.

2 JUDGE BRENNER: The question is do they recall
3 it? I don't understand your objection, Mr. Brigati.

4 MR. BRIGATI: Maybe I misunderstood the question
5 then.

6 JUDGE BRENNER: Overruled.

7 WITNESS CHRISTENSEN: I have read the reports.
8 If you can give me the section of the report which you are
9 speaking of, I will try and answer that question. I don't
10 have the FaAA reports with me now.

11 WITNESS ELEY: I think I do recall that they were
12 at different positions, if my memory serves me correctly.

13 BY MR. STROUPE:

14 Q Were they at a different time?

15 A (Witness Eley) That's as far as my memory takes
16 me.

17 Q Thank you, Mr. Eley.

18 You are aware, are you not, based on the
19 testimony in this proceeding and the reports that you've
20 reviewed, that in regard to the Shoreham replacement
21 crankshafts the maximum bending stresses are less than the
22 maximum torsional stresses?

23 A (Witness Christensen) I am well aware of that,
24 and I can say, as a comment, that this is usually so with
25 pretty well all diesel engines today.

WRBeb 1 A (Witness Eley) Agreed.

2 Q Professor Christensen and Mr. Eley, you have
3 indicated, have you not, in both your written testimony and
4 your oral testimony, that you reviewed or checked the
5 calculations of TDI with regard to the draft CIMAC rules.
6 Is that correct?

7 A (Witness Christensen) That's correct, yes.

8 A (Witness Eley) Yes.

9 Q And I believe-- Strike that.

10 Have you made a determination as to whether those
11 calculations are correct or incorrect?

12 A (Witness Christensen) We have made a
13 determination on the material as presented and the input
14 data given that the calculations were correct.

15 A (Witness Eley) We used Mr. Yang's, Mr. Roland
16 Yang's input and we checked his figures on those sheets.

17 Q And would that be the information contained in
18 Suffolk County Exhibit 39?

19 A Yes.

20 A (Witness Christensen) Yes.

21 With regard to the checking of these
22 calculations, the only part that I checked was the
23 12x13-inch crankshaft section.

24 Q And would it be fair to assume, Mr. Eley, that
25 you checked the--

WRBeb 1 A (Witness Eley) The 13x12, yes.

2 Q Thank you, sir.

3 Could I please ask you to turn to the first sheet
4 of that Exhibit 39, and ask you if you can tell me what the
5 factor of safety, based on the calculated stress, was for
6 the 11x13-inch crankshaft, according to TDI?

7 A .6972.

8 Q Thank you.

9 Can you tell me what the factor of safety
10 calculation was by TDI, based on the calculated stress
11 concentrations for the 12x13-inch crankshaft?

12 A 1.0422.

13 Q And isn't it true, gentlemen, that the original
14 crankshaft, which TDI determined had a factor of safety
15 under CIMAC of .6972, operated for around 700 hours before
16 failure?

17 A (Witness Christensen) That is so, yes.

18 A (Witness Eley) It was around about those hours.
19 I don't recollect the exact hours, but it was around about
20 those. I don't know that all those hours were at full load
21 or overload. I don't know. I can't recollect exactly how
22 many hours were at each load.

23 Q Would that indicate to you, Mr. Eley, that there
24 is some inherent margin of safety within the safety factor
25 prescribed by the draft CIMAC rules itself?

WRBeb

1 Do you need to consult, Mr. Eley?

2 A I wonder if you could give me the question again,
3 Mr. Stroupe?

4 Q Yes.

5 Would the fact that TDI's calculated factor of
6 safety for the original 13x11-inch crankshaft was .6972 and
7 that it operated for about 700 hours in the Shoreham EDGs
8 before failing indicate to you that there was some inherent
9 margin of safety contained within the factor of safety under
10 the CIMAC rules?

11 A (Witness Christensen) I would like to take this
12 answer.

13 All rules have--

14 Q Professor Christensen, the question was to
15 Mr. Eley.

16 A I beg your pardon.

17 JUDGE BRENNER: Why? Why was the question just
18 to Mr. Eley?

19 MR. STROUPE: Because Mr. Eley asked me to repeat
20 the question and--

21 JUDGE BRENNER: He did that because you directed
22 it to him and then asked him about whether he needed to
23 consult, which I didn't understand either since there is no
24 objection to these two witnesses consulting with each other,
25 unless you have a particular reason.

WRBeb 1

We have been through this so many times now.

2

MR. STROUPE: Judge Brenner, I thought you told me yesterday that I could ask the question and it would be assumed tht if one agreed, the other would speak up. And I asked the question of Mr. Eley, and I just believe I had the right to ask the question of Mr. Eley.

7

JUDGE BRENNER: Why?

8

MR. STROUPE: Because I desire to do that, sir.

9

JUDGE BRENNER: Why? I'm interested in efficiency.

11

MR. STROUPE: Because I want to know what his independent opinion is on this.

13

JUDGE BRENNER: For a reason other than adducing the substantive information?

15

MR. STROUPE: For reasons that I think on cross-examination I should be allowed -- I respectfully submit I should be allowed to determine the independent opinion of Mr. Eley on this prior to the time that he hears an opinion from Professor Christensen.

20

JUDGE BRENNER: The whole idea of having a panel up there is to efficiently get the substantive testimony from the combined panel, except when there is particular reason. Almost always the particular reason to direct it at one witness is when you are questioning that witness' credentials or qualifications by whatever means, usually by

WRBeb

1 direct questions on qualifications, although not always.

2 Another reason is when you are following up and
3 probing further a particular prior answer by that witness.

4 And you have not given me a good enough reason on
5 this particular question, and we are going to let them
6 consult and act as a panel.

7 I can tell you that the number of moments I sat
8 here looking at LILCO's first panel, I believe it was,
9 talking to each other and writing to each other before
10 getting an answer was just an unbelievable space of time
11 between each answer, and we allowed it. And the County,
12 while cross-examining, did not object, I believe probably
13 primarily because they knew what our general approach to
14 panel procedure has been.

15 Maybe the witness who will answer will be
16 Mr. Eley, but let us just direct questions to the panel
17 unless there is a particular reason why not if we are
18 getting substantive information.

19 All right.

20 Why don't you restate the question to the panel.

21

22

23

24

25

WRBpp

1 WITNESS CHRISTENSEN: Is that for me or for
2 Mr. Eley?

3 JUDGE BRENNER: Whichever one of you wants to
4 answer the question.

5 WITNESS CHRISTENSEN: First, I would like to say
6 that we were not conferring just now.

7 JUDGE BRENNER: Professor Christensen, I'm going
8 to exercise my prerogative to interrupt.

9 WITNESS CHRISTENSEN: I beg your pardon?

10 JUDGE BRENNER: Let's just get a substantive
11 answer to the question -- that's the only thing you have to
12 worry about -- from either you or Mr. Eley.

13 WITNESS ELEY: Well, obviously the factor of
14 safety of .6972 was inadequate for the 11-inch x 13-inch
15 crankshaft, because it failed. All I can say is that the
16 12-inch x 13-inch crankshaft does have a higher factor of
17 safety in comparison to it. We still know that the shaft
18 does not comply with the IACS rules.

19 WITNESS CHRISTENSEN: Could I make a contribution
20 here? All rules have a factor of safety built into them.
21 The factor of safety in the CIMAC rules is based on
22 experience gained from many, many thousands of crankshafts.
23 What I am looking at here and thinking about here is should
24 an engine in a nuclear power plant -- should the crankshaft
25 there -- have a less factor of safety than these factors of

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, so 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.

WRBpp

1 BY MR. STROUPE:

2 Q Isn't it true that that page of the report shows,
3 among other things, that the measured stress -- the measured
4 stress upon the Shoreham replacement crankshaft is 24.6 Ksi?

5 A (Witness Eley) That's correct.

6 Q Now, can you take the figure, gentlemen, of 32.8
7 Ksi that you previously confirmed as the CIMAC predicted
8 actual stresses and divide that -- I'm sorry, the CIMAC
9 predicted endurance limit -- and divide that by the 24.6 Ksi
10 figure that you just gave me or confirmed to me?

11 A (Witness Christensen) Did you say 32.8?

12 Q Yes, Professor Christensen.

13 A I have a figure there of 1.333 reoccurring.

14 Q Thank you, sir.

15 JUDGE BRENNER: Mr. Stroupe, you did not mean to
16 ask them to perform the division, I presume?

17 MR. STROUPE: I have some followup questions,
18 sir.

19 JUDGE BRENNER: That's what I assumed. You
20 answered my question before I asked.

21 BY MR. STROUPE:

22 Q Wouldn't that indicate to you some true measure
23 of the factor of safety of the Shoreham replacement
24 crankshafts?

25 A (Witness Christensen) Yes.

WRBpp

1 Q And you agree, Mr. Eley?

2 A (Witness Eley) I would prefer to base the factor
3 of safety on the rules of the classification societies being
4 met.

5 Q I understand that, Mr. Eley. But do you agree
6 that that would be a representation of the factor of safety,
7 the 1.333?

8 A Yes. That factor of safety is based on that
9 crankshaft. The rules and regulations of the classification
10 societies base their safety factors on their experience of
11 all the crankshafts and, if you look at the American Bureau
12 of Shipping's submission, you would see that there are some
13 qualifying statements in there with regard to the factor of
14 safety also.

15 Q I understand that, Mr. Eley. My question to you
16 was: Wouldn't the calculation that was just made whereby a
17 figure of 1.333 was arrived at, represent a factor of safety
18 for the Shoreham replacement crankshafts?

19 MR. BRIGATI: And Mr. Eley answered the question
20 yes.

21 JUDGE BRENNER: All right. I anticipated that
22 objection coming. I'll be honest with you, I think he
23 answered it, I'm not absolutely positive. Let's get the
24 answer again, just to be sure.

25 Did you answer that question yes or, more to the

WRBpp 1 point, what's your answer now to that question?

2 WITNESS ELEY: Yes.

3 MR. STROUPE: Thank you, Mr. Eley.

4 BY MR. STROUPE:

5 Q Gentlemen, are you able to tell me the
6 approximate percentage difference between the stresses
7 predicted in the fillet area of the Shoreham replacement
8 crankshafts, under the CIMAC formula as calculated by TDI,
9 as opposed to the measured stresses in the fillet area of
10 the replacement crankshaft?

11 A (Witness Christensen) Could I have the page you
12 are referring to, to save me time, please?

13 Q I was not referring to a page. I was asking you
14 that generally. I'll be glad to refer you to Exhibit --
15 first of all, let me refer you to page 5 of 9, again, of
16 Suffolk County Exhibit 39.

17 Don't you see, sir, a figure of 39,106 psi -- I'm
18 sorry, 31,517?

19 A (Witness Eley) 31,517, yes.

20 Q And is that figure not the CIMAC predicted actual
21 stresses on the crankpin fillet?

22 A (Witness Christensen) Yes.

23 Q Let me refer you, again, to LILCO Exhibit C-17,
24 the same page, page 3-9.

25 A (Witness Eley) Yes.

WRBpp

1 Q And what figure do you see there, sir? Is it not
2 24.6 Ksi?

3 A 24.6 Ksi.

4 Q Taking those two figures, can you now calculate
5 the percentage difference between the predicted actual
6 stresses under the CIMAC formula, and the measured actual
7 stresses as set forth in FaAA's report?

8 A Yes.

9 Q Is it approximately 28 percent?

10 A (Witness Christensen) I am just putting the
11 figure down here to calculate.

12 (Pause.)

13 I made the figure 21 percent. That is based on
14 an input of 31,517 minus 24,600 divided by 31,571.

15 Q That is to say, is it not, Professor Christensen,
16 that the actual measured stresses are 21, approximately 21
17 percent lower than the CIMAC predicted actual stresses?

18 A On these values as presented here, yes. But I
19 think we have referred, earlier, to the facts that there is
20 some provision in the figures that are being given to us by
21 ABS on these figures, and I think they should be looked at
22 with the answers that we are giving now.

23 Q We will, indeed, look at those in a little
24 while.

25 Isn't it also true that the predicted actual

WRBpp

1 stresses are 28 percent higher than the measured actual
2 stresses?

3 A That is so, yes.

4 Q And wouldn't that give some additional evidence
5 of the conservatism or the inherent margin of safety in the
6 CIMAC rules?

7 A (Witness Eley) It still creates a problem in my
8 mind.

9 Q That's not the question, Mr. Eley. Can you give
10 me a yes or no to my question?

11 A Will you repeat the question, please?

12 Q Yes, I will.

13 MR. STROUPE: Judge Brenner, if I might just make
14 the general observation, I think we're taking so long
15 because I'm having to repeat question after question. I
16 prefer somehow not to have to do this because I think in my
17 own mind, I am not able to repeat the precise question every
18 time.

19 JUDGE BRENNER: Well, I agree with your
20 observation and I don't have a ready solution right now
21 other than to agree with your observation. But I have been
22 surprised at how many times you have had to repeat some of
23 your even shorter questions. But I guess you've got to
24 repeat it if he doesn't have it. We can have it read back.

25 MR. STROUPE: I understand that.

WRBpp

1

BY MR. STROUPE:

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

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

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

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

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

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

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

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

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

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

WRBpp

1 because you have all got competent Counsel representing all
2 parties -- but you started to give that explanation first
3 before you gave the answer. And then by the time we had the
4 question re-read, and then re-phrased, I think it was
5 forgotten that you, in fact, wanted to give an explanation.
6 So why don't you give it now?

7 WITNESS ELEY: Thanks, Judge Brenner.

8 If I might equate this with something: when one
9 gets a set of measured values, which is very near to those
10 of the theoretical values, one can give good credence to
11 those results. In fact, we've seen that Mr. Sarsten's
12 torsional vibration characteristics -- his figures give a
13 free-end amplitude, if my memory serves me correctly, of
14 0.69 when he used a summation of 24 orders. Stone and
15 Webster's measured calculations of free-end amplitude was
16 693. Very, very good coordination between the two results.
17 When you get that type of a situation -- that is the kind of
18 a situation that I like to see when I am considering a
19 crankshaft.

20

21

22

23

24

25

WRBagb

1 When one looks at these figures that were
2 submitted by the American Bureau of Shipping -- and I would
3 just like to refer to those. If you can look at the
4 conclusion on the ABS submission in Exhibit 43 of the
5 County's testimony, the conclusions -- Conclusion 2 stated:

6 "Note that the submitted
7 fatigue strength is higher than that
8 obtained by CIMAC...," and note three was:

9 "Note also that submitted
10 stress test results show lower stresses
11 than those calculated by either CIMAC or
12 ABS..." in-house formula.

13 JUDGE BRENNER: Mr. Eley, I am sorry, I could not
14 locate the page you were reading from on Exhibit 43.

15 MR. STROUPE: 34, Judge Brenner.

16 JUDGE BRENNER: You are going to relate this back
17 to your comment on the comparison of the numbers in the
18 context of CIMAC, are you not?

19 WITNESS ELEY: Yes.

20 So it can be seen from that page that the
21 American Bureau of Shipping had some discrepancies between
22 their calculation and what was actually found. And if one
23 uses those calculated values that safety factor margin will
24 be less than those measured.

25 So there is a disparity in the two sets of

WRBagb 1 readings. That disparity did not exist when you were
2 considering the torsional -- when you summed the 24 orders
3 and got a good correlation between the two. So there are
4 some doubts in my mind because of this.

5 I also note that the -- when one looks at the
6 Goodman diagram for the replacement crankshaft, that that
7 UTS of the material looks like it is along the 103 line. I
8 think there are some UTS's which are smaller than that, so
9 that could deplete the safety factor somewhat also.

10 BY MR. STROUPE:

11 Q Does that complete your answer, Mr. Eley?

12 A (Witness Eley) Yes, it does, Mr. Stroupe.

13 A (Witness Christensen) May I?

14 JUDGE BRENNER: Well I think not, Professor
15 Christensen, because we launched into this by allowing
16 Mr. Eley to give his explanation which I felt he did not
17 have the chance to give and I would like to go back to
18 Mr. Stroupe's questioning right now.

19 Mr. Stroupe.

20 BY MR. STROUPE:

21 Q Mr. Eley, isn't it almost always true that you
22 are going to have disagreement between calculated or
23 predicted actual stresses and measured stresses?

24 A (Witness Eley) I don't know.

25 Q You don't have a general opinion as to that?

WRBagb 1 MR. BRIGATI: Objection, asked and answered. He
2 gave a very candid answer.

3 JUDGE BRENNER: The cross-examiner is allowed
4 some reasonable follow up and that is still in the realm of
5 reasonable follow up.

6 WITNESS ELEY: As I said before, sometimes they
7 are the same, sometimes they are different. The more
8 accurate ones are when they are the same.

9 BY MR. STROUPE:

10 Q And isn't it true, Mr. Eley, that the
11 calculations you made reference to that Professor Sarsten
12 made were predictions of nominal stresses, not predictions
13 of actual stresses?

14 A (Witness Eley) Yes, they were, but they were
15 compared with the actual stresses that were made by Stone
16 and Webster on the torsionograph ratings.

17 Q But you know, don't you, Mr. Eley, that the
18 torsionograph doesn't measure actual stresses?

19 A The torsionograph measures the degree of free end
20 -- the amplitude of....

21 (The witness panel conferring.)

22 Yes, the torsionograph measures the amplitude of
23 free end rotation.

24 Q Well isn't it true, Mr. Eley, that the only
25 stresses you can calculate from using a torsionograph are the

WRBagb 1 nominal stresses, not actual stresses?

2 (The witness panel conferring.)

3 JUDGE BRENNER: If we are not going to be able to
4 get an answer to the question you can state that also and
5 that will be an answer if you don't know. But can you
6 answer the question?

7 WITNESS SLEY: I don't recollect an answer to
8 that question offhand.

9 JUDGE BRENNER: All right.

10 BY MR. STROUPE:

11 Q Gentlemen, on page 117 of your filed testimony in
12 the answer to the first question set out on that page you
13 use the term "Von Mises' criterion."

14 Can you tell me what that is?

15 A (Witness Christensen) Von Mises' criterion is
16 one of the methods of the various methods of failure. It is
17 sometimes called "Henky Mises'" and has various other names
18 in different countries.

19 Q And do you know what Von Mises' stress is?

20 A Yes, I think I do.

21 Q And what is it?

22 A It is the stress-related to failure -- if I
23 remember correctly, it is a stress related to a certain form
24 of failure.

25 And again I am trying to quote from memory in a

WRBagb 1 complicated area where the material goes plastic. I think
2 that is the one there.

3 Q Isn't Von Mises' stress a methodology for
4 combining sheer stress or torsional stress with direct
5 stresses or bending stresses?

6 A There are various methodologies. And as I say,
7 as I have said earlier, I often have to go back to books for
8 reference.

9 In this case here I can quote the other various
10 methods of failure. But to get accurate definitions for
11 these various things, I have to go back to books. I cannot
12 carry all this mass of data in my head.

13 JUDGE BRENNER: Professor Christensen, let us
14 just use an answer as an illustration. It was a short
15 direct question. The answer was you don't know, right?
16 Is that the answer?

17 WITNESS CHRISTENSEN: No, it is not an answer "I
18 don't know." I know what it is related to but I can't give
19 definitions for it that are accurate.

20 JUDGE BRENNER: You didn't know the answer to the
21 question, right?

22 MR. BRIGATI: I think he just explained what h
23 he --

24 JUDGE BRENNER: Wait a minute, Mr. Brigati, the
25 lesson here is to the efficiency of the rest of the day

WRBagb 1 because I am not going to sit through an afternoon that
2 proceeds at the pace of this morning.

3 Why don't you repeat the question?

4 MR. STROUPE: Let me see if I can simplify it a
5 little.

6 JUDGE BRENNER: No, let's get the same question.

7 MR. STROUPE: I have one a little more simple
8 than that.

9 JUDGE BRENNER: My point is it was susceptible to
10 a very direct answer, whatever your answer was, and you went
11 roundabout before even coming close to the answer and even
12 there I don't think you answered it directly, although we
13 could draw certain inferences from your answer from what you
14 said as to what your answer is.

15 It is not my joy in life to go through 15 lines
16 of a transcript when we are putting together our decision to
17 try to infer what the answer might have been that the
18 witness had in mind. And that's the problem, you see, we
19 are going to be dealing with a cold transcript later.

20 WITNESS CHRISTENSEN: I understand.

21 JUDGE BRENNER: Okay.

22 Mr. Stroupe?

23 BY MR. STROUPE:

24 Q Professor Christensen, isn't Von Mises' stress an
25 invariant of the stress tensor?

WRBagb 1 A (Witness Christensen) On that question I will
2 have to say that I would have to go back to my books. At
3 this point in time I don't know, but I will know what a
4 tensor is and I will know what Von Mises' criterion is but
5 again I have to go back to referencing complicated areas.

6 Q Do you know, sir, how the CIMAC rules utilize Von
7 Mises' stress?

8 A I think I do, yes.

9 Q And how is that, sir?

10 A Again I say I would have to refer back to
11 textbooks.

12 Q You don't know today, that is what you are
13 telling me?

14 A I know how to use the textbook to get an answer.
15 If I had not been into that area before, I could not look at
16 a textboo! and get an answer.

17 That is, I think, fairly obvious to anyone: that
18 you can take a textbook in a complicated area, if you don't
19 know the subject you will not get an answer. If you do know
20 the subject, you can come up with an answer very quickly.

21 Q At the time you wrote this testimony did you know
22 what Von Mises' stress was?

23 A Yes. I think you will find that I have mentioned
24 another name for that, Von Mises' criterion, in a deposition
25 that I gave out at Hicksville.

WRBagb

1 But again I am in areas of complication. When I
2 give answers, I like to be factually definite and use the
3 correct definitions. I am not trying to evade the point but
4 I cannot say I don't know because I do know but I don't know
5 that actual definition.

6 Q Mr. Eley, in your explanation of the safety
7 factor a few moments ago you made reference to the ABS
8 documents that the County has attached as Exhibit 43.

9 Would you please turn, sir, to that exhibit?

10 A (Witness Eley) Yes.

11 Q At numbered page 28 there it is dated, I believe,
12 16 April 1984 -- page 29.

13 A Yes, 28.

14 Q 29, I'm sorry.

15 A 29, okay.

16 Q Do you have that reference?

17 A Yes, I've got it.

18 Q Isn't that in fact a calculation by the American
19 Bureau of Shipping pursuant to the CIMAC method of a factor
20 of safety?

21 A Yes.

22 Q And what factor of safety does ABS arrive at
23 pursuant to the CIMAC method?

24 A It says: "For web in way of crankpin fillet,"
25 1.16.

WRBagb 1 Q 1.166, is it not?

2 A 1.6643.

3 Q And you know, don't you, sir, that the --

4 JUDGE BRENNER: Wait a minute. You said it

5 wrong.

6 WITNESS ELEY: I beg your pardon, Judge Brenner,

7 it is 1.16643.

8 BY MR. STROUPE:

9 Q And you know, don't you, sir, that the CIMAC
10 rules have a minimum required safety factor of 1.15?

11 A (Witness Eley) Yes.

12 Q So isn't it true that ABS determined by utilizing
13 the CIMAC method that the Shoreham replacement crankshafts
14 met the CIMAC rules?

15 A Not according to page 32.

16 Q And do you know where the figure of .1044 came
17 from?

18 JUDGE BRENNER: What figure, Mr. Stroupe?

19 MR. STROUPE: 1.044.

20 JUDGE BRENNER: I don't think that's what you
21 said the first time.

22 MR. STROUPE: I was wrong. It should be 1.044.

23 BY MR. STROUPE:

24 Q Would you turn over to page 31? Maybe I can save
25 some time here.

WRBagb 1 A (Witness Eley) Yes, I see it.

2 Q And isn't that a factor of safety that ABS
3 determined by utilizing its in-house method?

4 A Yes, it is.

5 Q And it is not a CIMAC safety factor, is it, sir?

6 A No.

7 Q Can you tell me how that figure shows that indeed
8 the Shoreham replacement crankshaft did not meet CIMAC?

9 A (Witness Christensen) The page we are looking at
10 is headed up "Crankshaft Safety Factor by CIMAC Method," and
11 they do come to a figure which we will agree is 1.16643.

12 But I think we should have a look also at other
13 pages here so that we can get a complete picture of this.

14 MR. STROUPE: Well I don't think there has been
15 an answer to my question, Judge Brenner. And if Mr. Brigati
16 wants to bring this out on redirect it is perfectly possible
17 but I don't think this should be taking my time.

18 JUDGE BRENNER: Why don't you restate the
19 question -- I hesitate to make you do that -- or we can get
20 it reread.

21 MR. STROUPE: No, I will do it.

22 WITNESS ELEY: Well --

23 JUDGE BRENNER: Wait, let's get the question.

24 Pay attention both of you while he gives the
25 question again.

WRBagb 1

Go ahead.

2

BY MR. STROUPE:

3

Q I will try a little different version.

4

Mr. Eley, you indicated that in your view the 1.044 figure shown on page 32 was some evidence that ABS had determined that the Shoreham replacement crankshafts did not meet the CIMAC rules.

8

Isn't it true, sir, that the 1.044 figure on page 32 has nothing to do with the CIMAC rules?

9

10

A (Witness Eley) It says on page 32 it is the CIMAC theoretical fatigue limit.

11

12

Q Is that the figure, the same figure arrived at by using the CIMAC method on page 29?

13

14

A No.

15

Q And do you have any reason to doubt, sir, the safety factor arrived at by ABS on page 29 utilizing the CIMAC method of 1.16643?

16

17

A It would appear so.

18

19

Q Have you reviewed these calculations or checked them?

20

21

A The review I did was of the TDI calculations.

22

23

A (Witness Christensen) Could I come in here with an answer to that question? And that is that this calculation is based on a computer program. We do not have the computer program.

24

25

WRBagb 1 Q Isn't it also based on the CIMAC rules, Professor
2 Christensen?

3 A It would appear so from the heading at the top of
4 the page, yes.

5 Q You had access to those rules, did you not, sir?

6 A I had access to the rules as presented by us
7 following the search which came from TDI.

8 Q Let me ask you to turn now to Suffolk County
9 Exhibit 39.

10 ~ You have stated in your testimony both orally and
11 written, haven't you, that you reviewed these calculations
12 by TDI that are contained within Suffolk County Exhibit 39?

13 A (Witness Eley) Yes.

14 Q And don't the CIMAC rules require the calculation
15 of torsional stresses as an input?

16 A (Witness Christensen) I have to say I believe
17 they do because I cannot carry every phrase of the CIMAC
18 rules in my head. And if you will give me a reference to
19 where you are referring to in the CIMAC rules so I can look
20 it up, it would make the proceeding much faster and make it
21 much easier so that we can come up with valid answers.

22 Q Well Professor Christensen, isn't it true that
23 you would have to do a torsional stress calculation to
24 calculate a safety factor under any rule?

25 A Not necessarily so. It depends on how you are

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 oil
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

WRBagb 1 top of Sheet 5 of 9.

2 A (Witness Eley) We accepted Mr. Yang's input.

3 JUDGE BRENNER: I am a little confused. You mean
4 you accepted the work by the author of this County Exhibit
5 39, is that what you mean, Mr. Eley?

6 WITNESS ELEY: Yes.

7 BY MR. STROUPE:

8 Q And isn't that input a very important input
9 indeed in calculating this factor of safety under the CIMAC
10 rules?

11 A (Witness Christensen) Yes, it is an important
12 input.

13 Q You didn't have any way of checking that input,
14 did you?

15 A No.

16 Q So you don't know whether these calculations are
17 accurate or not?

18 A We know that they are accurate on the material
19 presented to us.

20 Q So you really just checked the mathematics, is
21 that correct?

22 MR. BRIGATI: Asked and answered.

23 WITNESS ELEY: Yes, on page 118 we say so in our
24 testimony. We said no, not directly, however we have
25 reviewed TDI's calculations under the IACS rules, a copy

WRBagb 1 of which is attached as our Exhibit 39.

2 JUDGE BRENNER: I would have overruled the
3 objection, which is why I didn't stop him. When somebody
4 makes an objection you have to stop and then we will rule on
5 the objection before you proceed. It is just another
6 roadblock in your way.

7 WITNESS ELEY: Okay, Judge Brenner.

8 JUDGE BRENNER: That is the procedure.

9 WITNESS ELEY: Okay.

10 JUDGE BRENNER: Especially when it is your own
11 counsel, as he will tell you later.

12 MR. BRIGATI: You are a mind reader, Judge.

13 JUDGE BRENNER: I have had a past life, you know.
14 Go ahead.

15 BY MR. STROUPE:

16 Q Professor Christensen, you are aware, are you
17 not, that the methodology by which you determine the
18 adequacy of the design of the webs of the replacement
19 crankshafts for Shoreham differs from the methodology
20 utilized by Messrs. Woytowich, Giuffra and Blanding of ABS
21 as well as from the methods utilized by Professor Sarsten
22 and Mr. Henriksen?

23 A (Witness Christensen) I do not agree with your
24 statement.

25 Q Why not?

WRBagb

1 A Because I have read carefully the deposition of
2 Mr. Woytowich, I have looked at other figures on this and I
3 think -- I not only think, I am sure that the testimony
4 supports my views.

5 Q Well isn't it true, Professor Christensen, the
6 ABS witnesses in their depositions indicated in their
7 opinion the webs on the Shoreham replacement crankshafts met
8 ABS's rules?

9 A They did give that, but nobody had produced the
10 calculations on which that assumption was based. It is just
11 a tick-off, "web okay," there are no calculations there
12 supporting that view which one can discuss.

13 A (Witness Eley) I think Mr. Woytowich said in his
14 deposition that he had not performed that calculation
15 himself, if my memory serves me correctly.

16 Q Well you are aware, aren't you, Mr. Eley, that
17 the ABS determined the webs of the Shoreham crankshafts met
18 ABS's requirements?

19 A I am aware it said "web okay." But I think as I
20 said before that Mr. Beshouri did advise in his deposition
21 that he hadn't performed that calculation himself.

22 Q Aren't you also aware that Professor Sarsten
23 determined and stated in his testimony that the webs of the
24 Shoreham replacement crankshaft met ABS's rules?

25 A (Witness Christensen) I am aware of that, yes.

WRBagb 1 A (Witness Eley) Yes.

2 Q Have you had a chance to look at his
3 calculations?

4 A (Witness Christensen) I have had a chance to
5 look at them, yes, but I disagree with them.

6 Q Why do you disagree with them?

7 A Because there is a statement in the deposition
8 given by Mr. Woytowich which eventually finishes up that you
9 cannot bring into the calculation the value for any metal
10 which is not there.

11 MR. STROUPE: Can I have just a moment, Judge
12 Brenner?

13 JUDGE BRENNER: Yes.

14 As long as there is a break, just to straighten
15 things out in my own mind because we had a lot of names
16 tossed in, we were discussing -- you gentlemen were
17 discussing the ABS deponents, I think I have got those three
18 names right. Then you mentioned Mr. Beshouri. Now he is a
19 TDI employee, correct?

20 WITNESS ELEY: Mr. Beshouri and Mr. Yang are both
21 TDI. Mr. Giuffra, Mr. Woytowich --

22 JUDGE BRENNER: I know. Thank you. I think it
23 is Mr. Yang, right, isn't it, Y-a-n-g?

24 MR. STROUPE: He is with TDI.

25 WITNESS ELEY: Yes.

WRBagb

1 JUDGE BRENNER: When you said what sounded to me
2 like "Young," did you mean?

3 WITNESS ELEY: It was "Yang," Y-a-n-g.

4 MR. STROUPE: I would like to have marked now as
5 a cross-examination exhibit, I believe it will be Number 42,
6 C-42, an excerpt which I will represent came from the
7 deposition transcript of the ABS witnesses on July 18, 1984,
8 pages 129 through -30.

9 JUDGE BRENNER: All right. If you have the right
10 number as you are handing them out or after -- what were the
11 page numbers again?

12 MR. STROUPE: 129 through 130, I believe.

13 JUDGE BRENNER: I take it those pages are not
14 included in County's Exhibit 43 and that is why you are
15 handing them out?

16 MR. STROUPE: I believe that is right.

17 MR. SCHEIDT: That is correct, Judge Brenner.

18 JUDGE BRENNER: Thank you.

19 All right. So it is LILCO Diesel Exhibit C-42
20 for identification.

21 (Whereupon, excerpted pages 129
22 through 130 of 7/18/84 ABS witness
23 deposition were marked as LILCO
24 Diesel Exhibit C-42 for
25 identification.)

WRBagb 1

BY MR. STROUPE:

2 Q Would you please take a moment, sirs, and read
3 that?

4 (Panel reading document.)

5 JUDGE BRENNER: Now we are reading this for the
6 purpose of seeing what the testimony was of the ABS
7 deponents and not of LILCO's counsel on those pages, is that
8 correct?

9 MR. STROUPE: That is correct. As you will see,
10 I didn't get to finish either.

11 (Pause.)

12 BY MR. STROUPE:

13 Q Have you had a chance to read these two pages?

14 A (Witness Christensen) I have read them many
15 times before.

16 A (Witness Eley) Yes.

17 Q Could you tell me, Professor Christensen, what
18 the ABS witnesses say in these two pages with regard to
19 sizing of the crankshaft webs inconsistent with the
20 methodology you utilized?

21 A (Witness Christensen) I am going to refer to
22 various pieces. I am going to say this: that the
23 methodology I used conforms to the usual customs and
24 practice used in crankshaft design. And when you start
25 asking me questions here, then I think I can answer them

WRBagb 1 as they come up rather than giving a long speech now.

2 Q Well did you utilize what you consider to be the
3 usual and customary methods in crankshaft design for sizing
4 these webs or did you utilize the methods utilized by ABS?

5 A I utilized the methods which would most likely be
6 used by ABS in the situation of looking at a crankshaft
7 very, very thoroughly.

8 One of the things that I must say also is that
9 these ABS rules to which we are referring, in this section
10 of the rules it has not been altered since 1952 or 1953 and
11 I have a very, very good idea on the meaning of the rules.

12 What we should look at is the actual rules
13 themselves I think, also, as well as the deposition here.

14 Q Do you have a better idea of the rules than the
15 ABS personnel?

16 A By virtue of my age and experience, I am sure I
17 have in this very, very particular area. Witness Blanding,
18 he starts off by saying: "I'm not sure what the question
19 is regarding the re-entrant fillet."

20 Q Professor Christensen, isn't it necessary when
21 you are interpreting a rule of a classification society
22 where there is any doubt to refer to the classification
23 society personnel themselves to get their interpretation of
24 their own rules?

25 A This is exactly what we did in the deposition.

WRBagb

1 Q But I thought you just told me that you utilized
2 what you considered to be the custom and standard methods of
3 sizing crankshaft webs rather than what ABS indicated.

4 MR. BRIGATI: Objection to that characterization
5 of his testimony, he did not say rather than what ABS
6 calculated.

7 JUDGE BRENNER: The objection is sustained. You
8 are going to have to repeat the question to him.

9 And part of the reason you are right,
10 Mr. Brigati, is because your witness did not answer the
11 question as it was posed earlier. But nevertheless at this
12 time your objection is sustained.

13 BY MR. STROUPE:

14 Q Professor Christensen, didn't you tell me that
15 you utilized what you considered to be a customary and
16 standard method of sizing crankshaft webs in making your
17 calculations for the Shoreham replacement crankshaft webs?

18 JUDGE BRENNER: That part we have. It was the
19 second part that caused the problem.

20 MR. STROUPE: I understand, but I wanted to get
21 the first part clear.

22 JUDGE BRENNER: The answer to that part is yes,
23 he just said that. We all know it. Go to the next part.

24 BY MR. STROUPE:

25 Q And indeed you did not use the methodology

WRBagb 1 specified by the ABS witnesses in this deposition, did you?

2 A (Witness Christensen) I said that I used the
3 usual customs and practice and I said that --

4 MR. STROUPE: I am going to interrupt, Judge
5 Brenner. I would like a yes or no answer.

6 JUDGE BRENNER: Answer the question, Professor
7 Christensen, please.

8 WITNESS CHRISTENSEN: The answer is yes, I used
9 what the ABS said. What the ABS said supports my views.

10 BY MR. STROUPE:

11 Q How does it support your views?

12 A (Witness Christensen) First of all, there is
13 some unsureness by the ABS people. We start off with
14 Witness Blanding saying "I'm not sure what the
15 answer is regarding re-entrant fillets," then Witness
16 Woytowich gives a definition there. Witness Woytowich does
17 say "I believe that our normal practice would
18 be to measure that dimension from the boundary
19 of the actual crankshaft material at one
20 fillet to that at its opposite fillet
21 rather than constructing the arbitrary lines
22 of the face of the web and going between
23 them."

24 What I have done there is produced a section
25 which is showing you the boundary from metal to metal. I

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

2 Q Did you go -- Did your calculation going 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

WRBagb

1 section of the crank web in the longitudinal direction.
2 From there I drew the arbitrary line which they refer to
3 between the line of the crank pin where it intersects the
4 web and the line of the journal where it intersects the web
5 and I think that gave me an angle of 24 degrees or
6 thereabouts.

7 From there I did the geometrical projection,
8 taking into account the circularity of the negative fillet
9 or the re-entrant fillet because where this circularity is
10 does remove a lot of metal.

11 The drawings which are shown in our testimony are
12 the boundaries from the side of the web following along the
13 line of the re-entrant fillet and coming back to the web
14 again on the one side and on the other side we have what is
15 commonly referred to as a positive fillet. And I have taken
16 that into account, whereas normally this is not taken into
17 account in normal practice because this is regarded as an
18 extra safety factor.

19 MR. BRIGATI: Judge, for the sake of clarity of
20 the record and only that -- this being a very complicated
21 area -- Professor Christensen's calculations are in Exhibit
22 40 and it might be helpful to tie your question into a plan
23 or a sketch that is included in that exhibit to illustrate
24 the point that he is trying to describe in words.

25 JUDGE BRENNER: I think that is a good

WRBagb 1 suggestion.

2 Can you do that, Professor Christensen? Your
3 Counsel is talking about Figure 1 in your Exhibit 40.

4 What I was going to ask next -- and keep this in
5 mind so you will know where I am heading but then we will
6 return to having you describe what you did in terms of your
7 figure -- I also, after you complete that, want to look at
8 the figure that Professor Sarsten has included in the
9 Staff's Exhibit 1, and if you don't have a copy we'll get
10 you one, and you tell me what you think he did wrong in
11 terms of his figure.

12 But let's return to your figure now and we will
13 accept your Counsel's suggestion.

14 WITNESS CHRISTENSEN: Yes.

15 JUDGE BRENNER: Let me just comment: after we
16 get these explanations we will break for lunch and then
17 everybody will have time to consider them if they need that
18 time.

19 Go ahead.

20 WITNESS CHRISTENSEN: Yes. My sketch here is the
21 actual section of the web obtained by geometrical projection
22 showing the curvature of the fillet as it goes around the
23 pin. This is a re-entrant fillet, sometimes referred to as
24 a negative fillet because it does remove metal.

25 The boundary of the metal removed is the two

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 to 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 degrees.

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.

WRBagb

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25

JUDGE BRENNER: Do you have Staff's Exhibit 1 in front of you, particularly the drawing which is the last part of that exhibit?

WRBpp

1 WITNESS CHRISTENSEN: Yes, I have that in front
2 of me, Judge Brenner.

3 JUDGE BRENNER: I don't want to mislead you.
4 There is also a description before the drawing by Professor
5 Sarsten of what he did. And if you haven't read that
6 recently it may be we should break now. But if you think
7 you are quite familiar with it, we can proceed now.

8 WITNESS CHRISTENSEN: Yes, I am familiar with it.

9 JUDGE BRENNER: All right.

10 Could you give us your opinion of what you think
11 Professor Sarsten did wrong in the way he selected the
12 dimensions of the web to apply in his calculations?

13 WITNESS CHRISTENSEN: Yes. The line of the
14 section through the web does not follow the arbitrary line
15 mentioned earlier. That line should intersect where the
16 line of the crankpin enters into the web and where the line
17 of the journal enters into the web, without the fillets.
18 That is the arbitrary line normally referred to.

19 That is the first thing that I think has been
20 overlooked in viewing this in relationship to the ABS
21 rules. This does not really represent the metal to metal
22 through the full width of the section as you come off the
23 paper or go below the paper. This is just a section in one
24 plane. The drawing that I have made takes into account the
25 section right across the plane. And this is where I think

WRBpp 1 the discrepancy arises.

2 JUDGE BRENNER: All right. Thank you.

3 I think we can break at this point and then come
4 back to the subject with any followup questions by you,
5 Mr. Stroupe. We'll let you get back to your game plan.

6 MR. STROUPE: Well, you asked some of the
7 questions I would have asked.

8 JUDGE BRENNER: I'm sorry.

9 MR. STROUPE: I'm just saying that we have been
10 moving along.

11 JUDGE BRENNER: Let's break until 1:30. We'll
12 take a few extra moments over the lunch break.

13 (Whereupon, at 11:50 a.m., the hearing in the
14 above-entitled matter was adjourned, to reconvene at 1:30
15 p.m., this same day.)

16

17

18

19

20

21

22

23

24

25

WRBeb 1

AFTERNOON SESSION

2

(1:30 p.m.)

3

JUDGE BRENNER: Good afternoon. We are back on
the record.

5

Whereupon,

6

STANLEY G. CHRISTENSEN,

7

G. DENNIS ELEY,

8

and

9

DALE G. BRIDENBAUGH

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

12

JUDGE BRENNER: I don't see other Counsel so I
13 guess there is nothing to report regarding pistons.

14

MR. STROUPE: I was just going to make an inquiry
15 of Counsel for the County as to when we may be able to get
16 our hands on a copy of the amended -- or corrected
17 testimony.

18

JUDGE BRENNER: I guess they are still working on
19 it.

20

MR. BRIGATI: Mr. Dynner just returned from the
21 plant, and he is at the moment meeting with Mr. Hubbard to
22 review Mr. Hubbard's initial run at reducing the testimony.
23 I will go back and tell Mr. Dynner that we would like it as
24 soon as possible. I think he is aware of that.

25

JUDGE BRENNER: Yes, he is aware of that.

WRBeb

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

MR. BRIGATI: I would also like to note that Mr. Bridenbaugh is now in his accustomed place on the panel. Mr. Hubbard will be joining him after he has finished with Mr. Dynner, explaining the changes.

JUDGE BRENNER: Fine. And whenever Mr. Hubbard is ready and you want him back, you just tell us at that time and he can go back.

MR. BRIGATI: Thank you, Judge.

JUDGE BRENNER: We are going to have to have an off-the-record discussion on scheduling first by the end of the day. In fact a little before the end of the day might be a good time, because the Board has some complex scheduling matters and the parties need to tell us some things, including about the piston testimony and then some other scheduling things, and we need to tell the parties some things.

So I think it is better if we just do it in chambers and then whatever we resolve, we will put on the record. So we can use that occasion to discuss, at least in the Board's presence in the first instance, where the piston testimony is procedurally and substantively.

And maybe the best thing to do would be at around 4:30 we'll stop the hearing and take up these other matters, and then come back on the record at the end of the day just to record what we've discussed and resolved, if anything.

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 finishing 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 O 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?

WRBeb 1 A (Witness Christensen) No, I don't think so.

2 Q Will you please refer to Exhibit Number 1
3 attached to the Staff's testimony, in particular the drawing
4 attached thereto, and use that to explain to me how you
5 believe he did not measure from metal to metal?

6 A He is measuring from metal to metal in a vertical
7 plane. You cannot take the moment of resistance about those
8 measurements as they are shown there because they are in the
9 vertical plane. You must come into the horizontal plane,
10 then tilt it to 24 degrees before you can come up with the
11 true section across the crank web which is under
12 consideration.

13 Q Will you agree with me, sir, that the ABS rules
14 contemplate assuming a rectangular section cut through the
15 web when sizing the web?

16 A Yes, I would agree with you there. That would be
17 normal if there are no undercuts from re-entrant fillets.

18 When you have undercuts from re-entrant fillets,
19 you have to go back to the first provision made in the ABS
20 rules, which I think states that the moment of resistance of
21 the web in bending must be .6 of the moment of resistance of
22 the pin in bending.

23 Q Will you agree with me, Professor Christensen,
24 that in the formula utilized under the ABS rules, W is the
25 width of the web while T is the thickness of the web?

WRBeb

1 A I would just like to look here a moment because
2 different rules have different variables, and I am used to
3 many rules.

4 W is given there as the effective width of the
5 web.

6 Q And is T given as the thickness of the web?

7 A T is given as the thickness of the web there,
8 yes.

9 Q And is the formula that ABS sets forth in its
10 rules, Section 34.17.4, WT^2 is greater than or equal
11 to $0.35 D^3$?

12 A That is stated there, yes.

13 Q And isn't it true, Professor Christensen, that
14 that formula which I just stated for the record does not
15 consider any fillets, either re-entrant or otherwise?

16 A That formula does not consider any fillets. You
17 are finishing up with a straight rectangular section if you
18 utilize that formula. You are not finishing up with metal
19 to metal, as has been stated in the deposition.

20 Q Isn't it true, Professor Christensen, that there
21 is no way you can take that formula set forth in Section
22 34.17.4 of the ABS rules and arrive at the figure you
23 arrived at for your web thickness?

24 A There is no way that you can do that, no. But
25 what we are looking at here in making an assessment of any

WRBeb

1 crankshaft, particularly in this area here, is to look at
2 what has been said by the ABS in their deposition where I
3 think they say boundary of the metal to the boundary of the
4 metal.

5 And then if we come back to the earlier section
6 it does state there very, very plainly that the proportions
7 of the crank webs ought to be such that the effective
8 resisting moment of the web in bending is not less than 60
9 percent of the resisting moment of the minimum required
10 diameter of pins and journals in bending.

11 Then that sets forth, after that, a simple way to
12 do this problem if there is no undercut. If there is
13 undercut, then you have got to go back to the first
14 statement.

15 Q Professor Christensen, looking at the drawing
16 attached to the Staff's Exhibit 1, the calculations of
17 Professor Sarsten, will you agree with me that T is
18 represented on that figure as 4.965?

19 A I would agree with you that T is represented as
20 4.965, yes. But we-- I think I would like to give an
21 illustration here. I don't want to be too long-winded about
22 it.

23 But if I'm looking at chain cables on the bottom
24 of a drydock removed from a ship, I don't pay interest in
25 the strongest link, I pay interest in the weakest link, and

WRBeb

1 I will make some assessment on the weakest link.

2 When I am studying the strength of a crankshaft I
3 will study the areas which I considered are most prone to
4 failure. This is exactly what I have done.

5 If there is any doubt about the correctness of
6 the two versions here, all you have to do is to take my
7 moment of resistance, compare it with the moment of
8 resistance which you could get from these values here. And
9 in common engineering practice we do not take highest
10 values.

11 In this case here we would take the lowest values
12 which I have arrived at by considering metal-to-metal
13 boundary.

14 Q Professor Christensen, isn't all you have to do
15 is to look at the fact that ABS indeed approved the web
16 sizing on the replacement crankshafts?

17 A They mentioned in the papers--

18 Q Could I get a Yes or No, please, sir?

19 MR. BRIGATI: Objection to the form of the
20 question. It is not established that ABS did in fact
21 approve the web size, Judge.

22 JUDGE BRENNER: Well, there was an earlier
23 question on that, you may recall. And I recall the answer.
24 I think the question is acceptable, given the fact that they
25 are expert witnesses here who can straighten it out. It was

WRBeb 1 not so compound or complex. And if you are worried about
2 it, I at least have not forgotten your earlier question and
3 answer of your witness.

4 But we will allow the question and you can come
5 back on redirect if you think there is confusion.

6 WITNESS CHRISTENSEN: Could I just have the
7 question again, please?

8 JUDGE BRENNER: The question was: Isn't it
9 sufficient to just look at the fact that ABS has approved
10 the web size for the replacement crankshaft?

11 WITNESS CHRISTENSEN: It would appear that they
12 have approved it, yes. But I see no calculations as to how
13 they obtained the approval in this very, very critical area
14 of the crankshaft.

15 JUDGE BRENNER: Mr. Stroupe.

16 BY MR. STROUPE:

17 Q Professor Christensen, could I ask you to turn to
18 page 120 of your testimony, please, sir?

19 Professor Christensen, you are indeed aware, are
20 you not, sir, that there is no evidence of any maximum
21 cylinder pressures in the Shoreham EDGs in this proceeding
22 that are measured at a figure higher than 1720 psi?

23 A (Witness Christensen) I believe, if I remember
24 correctly, when the engine is operating at 3900 Kw there are
25 higher pressures.

WRBeb 1 Q What about at 3500 Kw?

2 A At 3500 Kw, I think the highest figure that I
3 could fine, 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,

WRBeb 1 the crankshaft web sizes met ABS rules?

2 A That is true again, but Professor Sarsten's
3 figures only show you a section taken in a vertical plane
4 through the web and two sections of the journal. What we
5 have to look at here is the section coming out of the paper
6 and going underneath the paper, because that is the section
7 in bending.

8 The section we are looking at here is a vertical
9 section which gives no relationship to the moment of inertia
10 across the plane of bending or the moment of resistance
11 across the plane of bending.

12 Q Professor Christensen and Mr. Eley, did either of
13 you do any independent calculations or analyses under the
14 Kritzer-Stahl criteria utilized by Dr. Pischinger?

15 MR. BRIGATI: Objection. Asked and answered. It
16 is on page 120 and 121 of our testimony.

17 MR. STROUPE: Let me withdraw the question and
18 ask another question.

19 BY MR. STROUPE:

20 Q Have you done any calculations--

21 JUDGE BRENNER: I was willing to leave it, just
22 to make sure that the gap in time would not result in a
23 different answer.

24 MR. STROUPE: I was going to ask them if they had
25 done any calculations since they filed their testimony.

WRBeb

1 WITNESS CHRISTENSEN: No, I have not --

2 WITNESS ELEY: No.

3 WITNESS CHRISTENSEN: -- under the Kritzer-Stahl
4 criteria, the reason being that I think they are more
5 related to automotive practice which is high-speed engine
6 practice.

7 BY MR. STROUPE:

8 Q So I would be correct, would I not,-- Strike
9 that.

10 It is true, isn't it, that in coming to any
11 conclusions that you came to in your answer on 121 of your
12 testimony, you relied solely upon the deposition testimony
13 of Dr. Pischinger?

14 A (Witness Eley) That's correct.

15 A (Witness Christensen) Yes, that is correct.

16 Q And have you had occasion to review
17 Dr. Pischinger's testimony as filed in this proceeding?

18 A I have not had a look at the transcripts. I have
19 not been asked to, and I have not looked at them. But I can
20 well remember Dr. Pischinger replying to a question by
21 Judge Brenner relating to web thickness that he thought it
22 might be a quarter of an inch thicker than what his
23 calculations were.

24 I may have that a little bit out of context, but
25 I think the purpose of this is true, that he would have

WRBeb 1 liked to have seen a thicker web.

2 Q Don't you also recall, Professor Christensen,
3 that he indicated the fact that he would have liked to have
4 seen a thicker web were he designing this crankshaft had no
5 effect upon his conclusion as to the adequacy of the
6 crankshafts?

7 A I cannot recall that.

8 Q You are aware, are you not, that Dr. Pischinger
9 in his testimony filed in this proceeding stated his opinion
10 that under the Kritzer-Stahl criterion, the replacement
11 crankshafts at Shoreham were suitable for unlimited
12 operation at 3500 Kw?

13 MR. BRIGATI: I object to the question on the
14 grounds of relevance.

15 JUDGE BRENNER: I am wondering myself what the
16 point is of asking so many questions as to "Do you recall
17 what so-and-so said," and I have hesitated to jump in
18 because every time I hear it, I expect that it is going to
19 be a foundation to something coming up. But there are times
20 when it has not been.

21 And I don't care whether he heard testimony or
22 not as long as I heard it and see it in proposed findings
23 and read it in the transcript, unless you are going to ask
24 him something based on it.

25 MR. STROUPE: I was going to ask him if he

WRBeb 1 agreed with it, which I think is a legitimate question.

2 JUDGE BRENNER: Why don't you ask him that
3 question directly, instead of worrying about whether he
4 heard the earlier one.

5 And I understand that if you get an objection you
6 might then have to back up for foundation, and it may be
7 that you did it for that reason.

8 I don't mean to be critical but in the interests
9 of efficiency, try to ask the question directly and then, if
10 it creates problems, I will understand if you go back to
11 your other approach.

12 BY MR. STROUPE:

13 Q Professor Christensen, do you have an opinion as
14 to whether or not the replacement crankshafts at Shoreham
15 are suitable for unlimited operation at 3500 Kw under the
16 Kritzer-Stahl criterion?

17 A (Witness Christensen) I have made no evaluation
18 under the Kritzer-Stahl criteria. But I would like to add
19 this, and that is the Kritzer-Stahl criteria are one formula
20 which you can use to calculate the strength of crankshafts.

21 I have used Lloyd's figures because they are
22 based on scientific input, and they are based on a long
23 record of looking at crankshafts. They have been subjected
24 to continual updating, and I think they give us the truest
25 way of looking at a crankshaft. And that is why I have
reverted to them always.

WRBpp

1 Q Do you agree with Dr. Pischinger's testimony that
2 the Kritzer-Stahl criteria is very conservative criteria as
3 it relates to crankshafts?

4 A I don't know.

5 A (Witness Eley) I could not read it. It was in
6 German.

7 Q Is it correct that neither one of you did any
8 independent calculations for purposes of the torsional
9 vibrational stresses under ABS's rules?

10 A That is correct. I discussed this with -- when
11 we first went into this I discussed this with my Counsel --
12 and I explained to them that there were these torsional
13 vibration rules and they suggested that I submit these for
14 consideration by the American Bureau of Shipping.

15 I had a meeting with the American Bureau of
16 Shipping in this regard. And they advised me that it was a
17 conflict of interest. So I couldn't have those rules done
18 by American Bureau of Shipping as I originally wanted to
19 do. And what we then had to rely on was the deposition of
20 the American Bureau of Shipping and the product of the
21 information that was given to us there.

22 Q Well, didn't you also rely, Mr. Eley, upon the
23 calculations -- forced vibratory stress calculations -- made
24 by FaAA?

25 A I would prefer to rely on Mr. Sarsten's

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 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

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 indicated 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

WRBpp

1 arriving at this figure which summed 24 orders?

2 A That's correct.

3 Q And you know, don't you, that ABS does not sum 24
4 orders for purposes of calculating torsional vibratory
5 stresses under their rules?

6 A No, I don't know that at all.

7 Q Have you had a chance to review the ABS
8 calculations and material attached to the County's
9 testimony --

10 A Yes, I have.

11 Q -- as Exhibit 47?

12 A Yes.

13 Q Could you please turn to that exhibit?

14 A Yes.

15 Q My pages are not numbered, but let me direct you
16 to the page.

17 JUDGE BRENNER: You're probably using the wrong
18 book.

19 MR. STROUPE: I may well be.

20 I believe it is page 26. It says on the top,
21 "The critical speed for the five and one-half order is:".

22 WITNESS ELEY: Yes, I have that page.

23 MR. BRIGATI: I believe that's page 14, Judge.

24 JUDGE BRENNER: It is certainly not the page
25 Mr. Stroupe gave, since it doesn't go that far.

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

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 contracts 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 46084.5 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

WRBpp

1 Shipping only calculates two orders.

2 Q But that was not the question I asked you,
3 Mr. Eley. What I asked you was, isn't it true that ABS has
4 indeed approved the torsional critical speed arrangement for
5 the Shoreham EDG's?

6 A Based on the submitted data to them they advised
7 that it would be suitable for use at sea as a generator.

8 Q And that indicated that the torsional critical
9 speed arrangement was indeed approved, did it not?

10 A Yes.

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

WRBagb

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

4 MR. BRIGATI: No, Judge.

5 JUDGE BRENNER: All right.

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

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

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

17 I am surmising. It's not very clear but that's
18 wt it is.

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

21 Let me put it this way:

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

WRBagb

1 WITNESS ELEY: Yes, Judge Brenner. When they
2 summed only two orders they got a value of 4701.4 psi. For
3 this actual material the allowable was 4608.5 psi for all
4 the orders and the 4701.4 is in excess of that and that was
5 to the 1983 rules. The '84 rules did not come into effect
6 until -- Could I just check that?

7 (Pause.)

8 They did not come into effect until the 8th of
9 May, 1984.

10 I would just like to read this, Judge Brenner:

11 "Major changes in the 1984 rules are
12 indicated in the following list."

13 And this "following list" specifies that 34471 of
14 their rules was changed to clarify the torsional vibration
15 requirements for classification. These changes were
16 approved by the technical committee on the 8th of November,
17 1983 and became effective on the 8th of May, 1984.

18 JUDGE BRENNER: Can you tell us what you were
19 just quoting from, please?

20 WITNESS ELEY: It is the American Bureau of
21 Shipping's "Rules for Building and Classing Steel Vessels,
22 1984." And this is the part which gives the major changes
23 in those rules. It is an updating of the '83 rule book,
24 Judge Brenner.

25 JUDGE BRENNER: When you gave me your explanation

WRBagb

1 of the marginal load, 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 4005 based
4 on the marginal load 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.

WRBagb 1

BY MR. STROUPE:

2 Q What, if anything, does that tell you?

3 A (Witness Eley) I recollect what they said. They
4 said it did not meet the '83 rules but it did meet the '84
5 rules.

6 Q They said that in this letter?

7 JUDGE BRENNER: Mr. Stroupe, they are reading the
8 letter, I guess, as they have the right to do. I am not
9 sure what you are looking for in your question other than
10 having them read the letter.11 MR. STROUPE: My original question was if they
12 knew whether ABS had approved the torsional critical speed
13 arrangement under the 1983 rules or the 1984 rules.14 JUDGE BRENNER: I thought you had an answer to
15 that.16 WITNESS ELEY: If my memory serves me
17 correctly --

18 JUDGE BRENNER: Mr. Eley, wait a second.

19 MR. STROUPE: I think I did but then Mr. Eley
20 added that they stated they did not approve it under the
21 1983 rules and I asked him was that in the letter.22 MR. BRIGATI: And I would suggest that the letter
23 does speak for itself.24 JUDGE BRENNER: Well no, it is not that simple
25 because he wants to probe back to Mr. Eley's bases for the

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 What 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."

WRBagb 1 A Yes.

2 JUDGE BRENNER: For the sake of the record it is
3 page 20 of the officially numbered exhibit.

4 MR. STROUPE: Again I don't have a number on it
5 and I will put one on it.

6 WITNESS ELEY: Yes, the lowest value of safety
7 factor that the American Bureau have ever passed before is
8 right in the top right-hand corner, which was 1.34. And
9 there is a comment as to that on the right-side of that
10 figure. That is the sheet I have in front of me now.

11 BY MR. STROUPE:

12 Q And isn't it true that ABS calculated a range of
13 safety factors using various methods from 1.044 up to 1.565?

14 A (Witness Eley) Yes, they did and they stipulate
15 that four of those are low and two of them are okay; one is
16 okay but marginal they say.

17 Q And it is true, isn't it, that ABS calculated
18 factors of safety of 1.224 and 1.306 with no allowance for
19 shot-peening?

20 A That is correct and that is below their desired
21 minimum of 1.34 which is the lowest they have ever specified
22 as being passed by any of the manufacturers.

23 Q These figures are higher than the minimum safety
24 factor with regard to CIMAC, are they not, sir?

25 MR. BRIGATI: Objection to the relevance of that

WRBagb 1 question. He is comparing different rules entirely,
2 different safety factors, different assumptions, no
3 establishment that there is any relationship between those
4 numbers at all.

5 JUDGE BRENNER: That is a very interesting
6 objection. I am going to overrule it because we allowed the
7 County to undertake a lot of cross-examination of witnesses
8 for the parties along those lines -- I think in some cases
9 over similar objections -- with the point that the
10 witnesses could explain and straighten it out.

11 So you are not on firm ground there and it is
12 overruled. There are some other potential reasons that I
13 don't want to get into because it involves possible
14 interpretation or misinterpretation on my part as to what is
15 being done on some of these handwritten pages by the ABS.
16 But what I have said is sufficient to overrule the
17 objection.

18 WITNESS ELEY: I am sorry, Mr. Stroupe, would you
19 repeat the question, please, sir?

20 JUDGE BRENNER: It is understandable,
21 Mr. Stroupe.

22 MR. STROUPE: I understand. I am prepared.

23 BY MR. STROUPE:

24 Q Isn't it true that both of these factors of
25 safety, the 1.224 and the 1.306 calculated by ABS with no

WRBagb 1 allowance for shot-peening are higher than the minimum
2 required safety factor of 1.15 under the CIMAC rules?

3 A (Witness Eley) As you pointed out to us this
4 morning, Mr. Stroupe, those safety factors, those calculated
5 in the ABS in-house method, the sheet before the ABS
6 in-house method is the CIMAC method.

7 The answer to your question is yes, that safety
8 factor is a higher number than 1.16.

9 Q And that safety factor you just referred to
10 calculated under the CIMAC method was 1.166, was it not,
11 sir?

12 A That 1.0....

13 (Witness reviewing document.)

14 JUDGE BRENNER: We already have the testimony
15 from this morning, Mr. Stroupe, did you want to get back
16 into --

17 MR. STROUPE: I thought he said he just referred
18 to it. He can find it very easily.

19 JUDGE BRENNER: You can point him to the page, if
20 you want, to get back into it but as I say we already have
21 it.

22 BY MR. STROUPE:

23 Q If you turn back three pages from page 20, which
24 I believe would be page 17, don't you see a safety factor of
25 1.166 entitled, "Crankshaft Safety Factor by CIMAC Method?"

WRBagb 1 A (Witness Eley) Yes, I do.

2 Q Getting back to page 20 of Suffolk County Exhibit

3 47 --

4 A Yes -- There is a figure of 1.224 --

5 Q Let me finish my question. I haven't asked you a
6 question yet.

7 Isn't it true that when ABS utilized an allowance
8 for shot-peening of 20 percent they arrived at safety
9 factors of 1.450 and 1.565 respectively?

10 A Yes, that's true.

11 Q And isn't it true that if ABS had allowed only a
12 5 to 10 percent increase in the factor of safety as a result
13 of shot-peening, all of the factors of safety on this page
14 20 would be at or above 1.1?

15 A I don't understand the question.

16 Q Isn't it true that if ABS had only allowed a 50
17 to 10 percent -- Let's strike that.

18 If ABS had allowed a 6 percent increase in the
19 factor of safety as a result of shot-peening, isn't it true
20 that --

21 A Increase in which factor of safety?

22 Q Let me finish, Mr. Eley.

23 Isn't it true that all of the factors of safety
24 set out on page 20 of Suffolk County Exhibit 47 would be
25 above 1.1?

WRBagb 1 A If you add 6 percent to 1.044, is that what you
2 mean?

3 Q Can you just look at that and eyeball it and see
4 if indeed those figures would rise up to the level of 1.1?

5 MR. BRIGATI: Judge, is Mr. Stroupe testing
6 Mr. Eley's mathematical ability?

7 JUDGE BRENNER: Apparently.

8 Mr. Stoupe, what are you doing?

9 MR. STROUPE: I just thought he could make that
10 calculation in his head very simply. I will move on to
11 something else.

12 WITNESS ELEY: Yes, it would look as though it
13 would be above 1.1 to me if you add 6 percent to 1.044,
14 yes.

15 JUDGE BRENNER: I don't know why you kept
16 directing him to all the figures. Mr. Eley is right, there
17 is only one under 1.1.

18 MR. STROUPE: Yes, I understand that.

19
20
21
22
23
24
25

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 exclusively
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 that
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?

WRBpp

1 A It would not affect torsional stresses, but we
2 would have to go right back to the front pages in the ABS
3 rule book to see how that would affect the whole of the
4 engine -- not only the torsional stresses -- the whole of
5 the engine.

6 O Did ABS approve anything other than the torsional
7 critical speed arrangement for the Shoreham replacement
8 crankshafts?

9 A I think they approved -- without going back to
10 the letter -- that the engine would be approved for service
11 as a generator on board a ship. But there is a big "but"
12 there. And the big "but" is this: under ABS rules, if you
13 have a problem with an engine which may cause you to lose
14 your ABS class, you are duty-bound to report that, because
15 that can have an effect on whether the class is continued.
16 And in this case here, if that had been reported, then I
17 think ABS would have wanted to know a lot more about the
18 engine, and I cannot believe that ABS would pass any engine
19 with a cracked cylinder block or give approval to an engine
20 with a cracked cylinder block.

21 O Professor Christensen, if you look at Suffolk
22 County Exhibit 44, specifically the letter from the American
23 Bureau of Shipping, dated 3 May 1984. Isn't it true that
24 that letter refers to approval of the torsional critical
25 speed arrangement?

WRBpp

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

MR. BRIGATI: Objection. The document speaks for itself.

JUDGE BRENNER: No, it doesn't. Overruled. Whether or not this witness can add anything to it is something we will determine after we hear from the witness. In addition, since he is still reading, I'll give you the other reason. It is, undoubtedly, foundation leading to followup on the cross-examination of this witness.

WITNESS ELEY: It does specifically refer to torsional vibration characteristics, yes.

BY MR. STROUPE:

Q Now, isn't it true that block cracking itself of the nature experienced at the Shoreham EDG's, has no effect upon a torsional critical speed arrangement of the crankshaft?

A (Witness Christensen) Not in the way that we would look at critical speeds in shafting and the torsional vibration characteristics of the system. But it could have an enormous impact on crankshaft stresses.

A (Witness Eley) I don't think that the block cracking, as such, would be attributable to the torsional vibration problem.

Q Thank you, Mr. Eley.

A May I just add, the torsional vibration problem that you're referring to on the crankshaft -- because I have

WRBpp

1 my views on what is causing that cracking?

2 Q You'll get an opportunity to express that.

3 A No doubt I will.

4 Q Can you tell me how block cracking, such as has
5 been experienced, or crack-like indications on the blocks at
6 the Shoreham EDG's, can affect the sizing calculations,
7 including the allowable horsepower, under ABS's formula?

8 A (Witness Christensen) It would have no effect on
9 the sizes of the crank block.

10 Q And can you tell me how that crack-like
11 indications experienced on the Shoreham EDG cylinder blocks
12 could have any affect upon the calculation of a factor of
13 safety or safety factor?

14 A Yes. It would have no effect on the safety
15 factor of the crankshaft as such.

16 Q That's what I was referring to.

17 Do you want to finish your answer?

18 A There is a big "but" to it, but it would affect
19 the safety factor of the whole engine. And this is the
20 point that I wanted to bring out. It affects the safety
21 factor -- it affects the safety of the whole engine, without
22 using the word "factor."

23 Q It's true, isn't it, that none of these safety
24 factors that we have been discussing this afternoon make any
25 attempt to make a determination as to the safety of the

WRBpp

1 overall engine but, indeed, relate to crankshafts?

2 A They wholly relate to crankshaft stresses taken
3 under particular conditions.

4 Q Mr. Eley, did you have something to add?

5 A (Witness Eley) No.

6 Q On page 123 of your testimony, in footnote number
7 130, it is indicated that Dr. Pischinger, FaAA's diesel
8 expert, believes that the T-sub-n values used by FaAA in its
9 calculation are very reasonable the reference to the
10 Pischinger deposition at 110?

11 A Yes, I see that.

12 Q Isn't it true that the T-sub-n figures that
13 Dr. Pischinger was referring to in his June 21, 1984
14 deposition at page 110, was the FaAA May 22, 1984
15 replacement crankshaft report and not the October 31, 1983
16 report?

17 A (Witness Christensen) I don't know without going
18 back to these reports.

19 A (Witness Eley) I'm not sure. I think it was the
20 April-May report.

21 Q And those T-sub-n figures would be significantly
22 different, would they not, Mr. Eley, from the October 31,
23 1983 FaAA report?

24 A I don't believe there were significant
25 differences. I think the first one had theoretical values

WRBpp

1 and the latter had -- they were values calculated from a
2 diagram, a pressure-time diagram -- pressure crank angle
3 diagram.

4 Q Professor Christensen and Mr. Eley, on page 127
5 of your testimony, you indicate that ABS performed its
6 calculations and reached its conclusions on the assumption
7 that the crankshafts were shot-peened properly, and the
8 shot-peening would, in fact, increase the fatigue limits of
9 the crankshafts by 20 percent; isn't that correct?

10 A Yes.

11 Q Isn't it true that the ABS witnesses stated in
12 their depositions that the 20 percent increase that had been
13 claimed on the submittal was a value they had seen quoted
14 often, and that some of the people involved with
15 shot-peening and ABS actually quote a higher value?

16 A I don't recollect that at all.

17 A (Witness Christensen) I don't know, unless you
18 could give us a page in the deposition which we could refer
19 to.

20 JUDGE BRENNER: Mr. Stroupe, I'm trying to
21 understand where you may get, in terms of findings, with
22 this question. I would keep quiet if I thought it was the
23 only question. I don't know how far you're going to get
24 into it.

25 MR. STROUPE: I thought I had an excerpt from the

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 that was 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.

WRBpp

1 A (Witness Christensen) Can I comment here, also?
2 We did not do any calculations on safety factors. When we
3 look at a crankshaft under Lloyd's rules, there is that
4 in-built safety factor. The safety factor which you have
5 calculated your values on, if my memory serves me correctly,
6 is based on three crankshafts that failed. We should
7 consider them a case of one, because they are identical
8 crankshafts. The safety factors put into Lloyd's rules for
9 crankshafts are based on many, many thousands of crankshafts
10 over a long time period with many, many updatings and much
11 input.

12 Q Professor Christensen, do you know what in-built
13 safety factor on Lloyd's is?

14 A I could not tell you; no.

15 A (Witness Eley) It's inherent to the formula.

16 Q But you don't know what it is, Mr. Eley, do you?

17 A I don't think it is quoted, no.

18 Q Professor Christensen and Mr. Eley, if you were
19 given the task of assessing the adequacy of a given
20 crankshaft for a given engine, where you had given loads and
21 given speeds, would you feel more confident in your
22 assessment of the adequacy of that crankshaft, based on
23 experimental test data, such as measured stresses in the
24 fillet areas of the crankshaft, and the actual material
25 properties of the crankshaft? Or would you feel more

WRBpp

1 confident by relying upon classification societies, such as
2 Lloyd's and ABS?

3 A (Witness Christensen) I would feel happier with
4 the results of experimental data, but not on the results of
5 a very, very small number of experiments with three
6 crankshafts of the same type. I would prefer the input to
7 be from many, many crankshafts. I don't want to go on but I
8 know that Lloyd's have done an enormous amount of research
9 into stress calculations and crankshafts, and what I would
10 like to do in a case of -- if I was presented with a
11 question like you have given us there -- I would present
12 that data to Lloyd's, and they would put that data into a
13 computer program and come up with much more valid answers
14 than I can come up with by older fashion calculations.

15 Q Mr. Eley, would you like to respond to that
16 question?

17 A (Witness Eley) Knowing the background and the
18 experience that Lloyd's has, with regard to the sizing of
19 crankshafts, I would say that it should be compliant with
20 its rules in order to give me the classification -- in order
21 to give me an assurance that those crankshafts are suitable
22 for the purpose for which they are intended.

23 JUDGE BRENNER: I'm sorry, Mr. Eley, I'm not
24 quite clear on whose rules you think the crankshaft should
25 comply with. I heard you with Lloyd's rules and then -- but

WRBpp

1 you added the phrase "or the classification society rules."
2 I want to be sure I understand what you meant by that.

3 WITNESS ELEY: Can I just explain, Judge Brenner?

4 JUDGE BRENNER: Yes.

5 WITNESS ELEY: When an engine is built -- and
6 this is the procedure that I'm used to using -- there is an
7 independent body which gives a complete check of all the
8 components at all times. They don't just do it
9 theoretically, they do the whole thing. An independent
10 surveyor comes in and surveys each component as it is being
11 produced, as it is being forged, as it is being assembled.
12 And a complete independent goes through the whole gambit of
13 the building of the engine. I would prefer that if a
14 classification -- when an engine is being built it should be
15 built to the classification society's rules, with the
16 supervision of the experienced surveying staff that are
17 capable of assessing the quality as it's being manufactured,
18 as it's being assembled, and as it's being run.

19 JUDGE BRENNER: Well, do you mean all
20 classification society rules? That's why I wasn't sure of
21 your phrase.

22 WITNESS ELEY: I see.

23 JUDGE BRENNER: I also wasn't sure if you meant
24 CIMAC or, as I said, all classification societies?

25 WITNESS ELEY: I wanted to make it clear, Judge

WRBpp

1 Brenner, that this was the normal procedure that was adopted
2 when an engine is built. And this independence of any
3 association with the engine builder or whatever, assures --
4 gives a guarantee of performance, I feel.

5 In answer to your question, I think that all the
6 major classification societies have a specific standard.
7 Some are more stringent than others. It would be prudent to
8 manufacture to most of those standards. And if I might
9 refer you to one member of DEMA, I know that they do build
10 to all those standards, or I think that term was, they meet
11 the requirements of most, if not all.

12 JUDGE BRENNER: Well, we may pursue this more
13 later. I don't want to get in your way, Mr. Stroupe.

14
15
16
17
18
19
20
21
22
23
24
25

WRBeb

1 BY MR. STROUPE:

2 Q Isn't it true, Mr. Eley, that one of the reason
3 you would prefer to rely on classification society rules for
4 a task such as this is because -- if you are not capable
5 mathematically or training-wise of performing the sort of
6 analysis that FaAA performed on these replacement
7 crankshafts?

8 A (Witness Eley) I have not performed an analysis
9 similar to that of FaAA's, no.

10 Q I didn't ask you if you had. I asked you if the
11 reason that you would prefer to rely upon the classification
12 societies for a task such as this is because you do not have
13 the capability of performing an analysis -- an assessment of
14 the replacement crankshafts such as that performed by FaAA?

15 A No, that is not true.

16 Q It is not true that you don't have the capability
17 or not true that that is not one of the reasons?

18 A That is not one of the reasons. I think I have
19 already explained to Judge Brenner what my reasons were for
20 compliance with the classification societies' rules.

21 A (Witness Christensen) Can I make a contribution
22 here? And that is this, that so far as I am concerned, the
23 whole question is one of safety, not whether some test on
24 one crankshaft proves one point or the other. The whole
25 question is on safety, not on a matter of somebody's

WRBeb

1 calculations, but on a whole gamut of input, based on
2 experience rather than some specialists in various areas
3 coming forward and making their contribution to the thing as
4 a whole.

5 A (Witness Eley) Might I just add, Mr. Stroupe,
6 that each area of an engine is a very complex piece of
7 equipment. Each part is interrelated on one another, and--
8 Well, take Lloyd's as one classification society, for
9 instance.

10 They have a team of experts who do nothing else
11 but torsional vibrational analysis. They spend their lives
12 doing nothing else. It is an extremely complex subject, and
13 their experience is second to none. And most classification
14 societies have this type of talent.

15 MR. STROUPE: Judge Brenner, I have no further
16 questions. I think I lived up to my obligations in
17 completing.

18 JUDGE BRENNER: You did in terms of timing. I
19 didn't set a time limit because I thought your estimates
20 continued to be fair, given the pace of the way things have
21 unfolded.

22 Staff?

23 MR. GODDARD: The Staff has no cross-examination
24 of this panel.

25 JUDGE BRENNER: Very well.

WRBeb

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

EXAMINATION BY THE BOARD

BY JUDGE FERGUSON:

Q Professor Christensen and Mr. Eley, I have a few questions I would like to ask to try to clear up a few points that have concerned me.

As I look back through the material that was submitted on your qualifications, Professor Christensen, I see that you worked at one time for Lloyd's Registry of Shipping. Is that correct?

A (Witness Christensen) That's correct, yes.

Q I also see as I look on page 2 of those qualifications the statement that during the period 1949 through 1950 you worked on approval of machinery design, boiler and pressure vessel design, stress analysis, investigation of shafting system, torsional vibrational characteristics, torsional vibration characteristics. Is that correct?

A That is correct, yes.

Q Now what I want to focus on very briefly is the last category there that is listed in the sentence that I just read, namely, that when you were working at Lloyd's Register of Shipping, you worked on torsional vibration characteristics.

A At some part of my time there, yes.

Q Very good.

WRBeb 1 A Not all the time.

2 Q I understand.

3 Keeping that in mind let me ask whether or not
4 you did in fact do any calculations that would involve your
5 summing orders, vibrational orders?

6 A Yes, we did work in that area.

7 Q I see.

8 Did you ever do a calculation that required that
9 you sum the orders in problems similar to the problems that
10 we have been discussing in this hearing? That is, have you
11 summed more than-- Well, why don't you tell me how many
12 orders you have summed?

13 A What we did there was we would look at the higher
14 orders and see what stresses were coming -- that we were
15 coming up with. And if they were looking within reasonable
16 bounds, then the crankshaft would be passed. If they were
17 looking to be up near the limits, then further work would be
18 done on them, and further investigation work would be
19 carried out.

20 If we were not happy then we would carry out
21 experimental work on the ship when the ship was undergoing
22 sea trials to confirm our findings that were obtained in the
23 office.

24 Q For the time being let's just stick with the
25 calculations.

WRBeb

1 A Yes.

2 Q When you mentioned "higher orders," would you
3 tell me what you mean by "higher orders"?

4 A Yes, sir. Higher orders, that is an order with a
5 higher number, say a 12th order or a 24th order, or
6 something of that nature.

7 But we looked at usually the first three orders
8 in these days. Then we may, if there were some doubt
9 arising there, look at a fourth order.

10 Q I see.

11 We are still talking about the 1949 to 1950
12 period? Is that correct?

13 A That is correct, sir, yes.

14 Q Did you in fact sum 24 orders in that time
15 period?

16 A No, not in that timeframe. The summation of 24
17 orders could be done earlier without a computer, but it was
18 a very, very laborious procedure, just as the same-- It was
19 a laborious procedure for us in those days without a
20 computer.

21 Since we have had the computer, that has opened
22 up the whole area of torsional vibration characteristic
23 investigation. BICERA, I can say from books that I have
24 mentioned this morning, talks about going up to 72 orders to
25 get a higher degree of accuracy.

WRBeb

1 Q So then it is fair to say that in the 1949 - '50
2 period you did not use computers, you did not sum 24
3 orders. Is that a fair statement?

4 A That is true, Judge. Yes, sir.

5 Q Have you, since the advent of computers, summed
6 more than the three orders that you indicated that you
7 summed during the '49 - '50 period when you were working
8 with Lloyd's?

9 A No, Judge. I have only had access to a computer
10 within about the last year, and then I only have access to
11 that for work associated with the students, but not for
12 outside consulting work.

13 Q I see.

14 Then it is fair to say that you have never had an
15 opportunity of actually summing 24 orders?

16 A That is true, Judge, yes.

17 Q Let me turn briefly then to something that does
18 not need a computer, and that is the discussion that we had
19 concerning Exhibit -- LILDO Exhibit 41 for identification.
20 This is the exhibit, you will recall, that is entitled
21 "Rules and Regulations for the Classifications of Ships -
22 Part 5 - Main and Auxiliary Machinery - Chapter 2, Oil
23 Engines."

24 Do you have that in front of you?

25 A I have that in front of me, yes.

WRBeb

1 Q We had some discussion concerning the formula
2 that is used in that exhibit for determining the power
3 rating of engines, and that formula is found on the second
4 page of that exhibit. Is that correct?

5 A I have that before me, yes, Judge.

6 Q There are actually two formulas there, so let's
7 just focus on the first one.

8 I believe you characterized that formula as being
9 something other than an empirical formula. Is that correct?

10 A I did characterize it that way, yes.

11 Q Could you tell me what-- Could you remind me how
12 you characterized the formula?

13 A I cannot remember the actual words I used, but I
14 said it was more -- but it amounted to me saying that it was
15 more than an empirical formula.

16 Q Okay, that's what I would like to know.

17 What more is it?

18 A Well, when this formula was originally
19 calculated when I worked at Lloyd's, I was with the man who
20 made the first calculation -- made up the first formula for
21 the calculations of the crankshaft. His name was Anderson.

22 The formula was based on the normal input
23 characteristics if we do this from first principles by
24 taking a web and a half a crank pin and then we go through
25 the application of a torsional stress and a stress arising

WRBeb

1 out of the pressure in the cylinders which is creating a
2 bending moment, and the tension and compressive stresses
3 arising out of that bending moment.

4 That was the basis input for the formula.

5 Then we are going back to the years -- I think it
6 was 1920 or 1922 -- when diesel machinery was becoming much
7 more prominent onboard ship, and then Lloyd's, through their
8 relationship with engine builders, got input sizes of
9 crankshafts that were built by the various engine builders,
10 together with pertinent data. And that was how the first
11 Lloyd's rules were formed.

12 And I think the maximum pressure at that time was
13 somewhere of about the order of 600 psi. Since then there
14 has been much work done on the formula. This is the result
15 today.

16 Q Do I interpret what you say correctly when you
17 said the formula was originated from -- may I say first
18 principles and then modified later? Is that what you are
19 implying?

20 A Yes, that is what I am testifying, that it was
21 built up from the very basic engineering principles that I
22 have just mentioned. And then from the relationship of the
23 sizes they were able to make up a formula which would be
24 applicable and which would show that the crankshaft could
25 comply with the rules.

WRBeb

1 But in these days that I am speaking of, there
2 was no question of calculating -- although the problem of
3 torsional vibration was known, there was no calculations
4 made on that score at that time.

5 Q Thank you.

6 But in any event, this formula can be used.
7 As indicated in the note beneath it, the power rating is to
8 be not less than the power rating based on Chapter 1,
9 Section 3.3, and we looked at that earlier and we focused on
10 Section 3.3 of Chapter 1, which was the second part of
11 Exhibit 41.

12 Do you have that in front of you?

13 A I will have to look for that, Judge.

14 Q Okay.

15 A No, I don't seem to have that here.

16 (Document handed to the witness panel.)

17 Q It is entitled "General Requirements for the
18 Design of Construction Machinery."

19 Do you have that now?

20 A Yes, I have it now, yes.

21 Q And what I would like to focus on is Paragraph
22 3.3.1, the last part of that paragraph. Are you still with
23 me?

24 A Yes, I'm still with you. Yes.

25 Q And I'm reading. It says -- quote:

WRBeb

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

Q And that paragraph is a paragraph that states:

"Auxiliary engines coupled to electric generators are to be capable under service conditions of developing continuously the power to drive the generators at full rated output and, in the case of oil engines and gas turbines, of developing for a short period (15 minutes) an overload power of not less than 10 percent."

A It does state that, yes.

Q And then we did a calculation I remember of determining what 10 percent beyond the 3900 kilowatts was, and that number was of course higher than the 3900 kilowatts.

A That is so, yes, Judge.

Q And it was your testimony that the engine should be capable of performing under that higher figure continuously.

Is that correct?

A No.

Q That is, 10 percent beyond 3900?

A No.

The continuous figure that I would apply here would be the 3900 figure, then 10 percent over that for one-quarter of an hour.

Q Okay.

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 ashorel.

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

WRBwrb 1 consideration at Shoreham?

2 A I would not know, I don't have enough information
3 to make any assessment of that, no.

4 Q Do you see-- Maybe I should begin with: is it
5 correct that you stated that there is no difference between
6 marine engines and stationary engines so far as
7 manufacturers are concerned, except for, perhaps, some
8 bearing considerations? Was that the testimony you gave?

9 A That was my statement, yes. If could just
10 illustrate that more.

11 This is taken out from various trade data and a
12 very wide knowledge of what goes on with diesel engine
13 builders.

14 Q All right.

15 Now let me interrupt my questions to you,
16 Professor Christensen, and ask you, Mr. Eley: do you agree
17 with that?

18 A (Witness Eley) Yes, I do.

19 Q Okay.

20 Then, based on your testimony, I assume that the
21 design of stationary engines, "with the qualification that
22 you gave, namely, perhaps some qualification so far as
23 bearings are concerned, there are no considerations that
24 should be different for land-based versus marine engines; is
25 that correct?

WRBwrp

1 A (Witness Christensen) I would just like to
2 clarify the point on bearings. The bearings that I refer to
3 is the thrust bearing which takes the thrust from the
4 propellor. That would not be the same in a land-based
5 engine because it does not have to take propellor thrust.
6 But you must locate the crankshaft in one regular running
7 position. It's the usual custom and practice to call that a
8 crankshaft location bearing, but it is often referred to in
9 everyday parlance as the "thrust bearing." But they are two
10 different bearings, really. But the rest of the engine is
11 the same.

12 A (Witness Eley) Judge Ferguson, there are other
13 minor differences which are not really relevant here. But
14 the way the cooling is supplied to the engine is somewhat
15 different. You normally get a saltwater supply, which is
16 slightly different over a freshwater supply, et cetera. But
17 they are not really relevant to what we're talking about
18 here. There are minor differences.

19 Q Many of the questions that have been asked so far
20 have had to do with vibrations of the crankshaft. Are you
21 telling me that there are no vibratory sources that would be
22 present in marine applications that are different than those
23 on stationary applications?

24 Either member of the panel may answer.

25 A (Witness Christensen) The vibratory sources are

WRBwrb

1 many in machinery. The torsional vibration characteristics
2 would be classified in exactly the same manner for a land
3 engine as for a marine engine. Where other vibration is
4 concerned, it is really non-relevant to this, because we
5 have vibration on a ship which is coming from what we refer
6 to a propellor excitation.

7 Q Well, that's what I'm trying to get at, that's
8 what I'm trying to understand, Professor Christensen. Are
9 there are sources of vibration that a designer would feel
10 important, depending upon whether the engine was used in a
11 marine application versus a stationery application?

12 A No; propellor excited vibration would not come
13 into the piece.

14 Q Then there are differences?

15 A There are differences on board a ship, as I think
16 we all discussed yesterday. But, in the ultimate, it would
17 make no difference to the actual design of the engine
18 whether it was for a shore-based installation or for a
19 marine installation.

20 A (Witness Eley) Judge Ferguson, there are some
21 propellor induced vibrations on the main engines.

22 I would like to make one point here, if I may, and
23 that is that the DEMA requirements, the stress levels are
24 very high compared to the other classification societies.

25 I know of an engine manufacturer in DEMA that has

WRBwrb 1 advised me that if they had stress levels which were near to
2 those of DEMA's limits, they would consider fitting
3 detuners.

4 The actual words were that the majority of their
5 stress levels didn't go beyond 2000 psi, and if they had an
6 engine whose crankshaft stress levels were even close to
7 that of DEMA's, we would seriously consider fitting a
8 detuner, since the stresses mentioned in DEMA were very
9 high.

10 MR. STROUPE: I'm going to move to strike that
11 answer, Judge Brenner. It's based totally on hearsay.

12 JUDGE BRENNER: I don't even understand what it is
13 he's saying.

14 MR. STROUPE: It appears he was reading from
15 something.

16 JUDGE BRENNER: I know, but.... Wait a minute. I
17 don't want to interrupt Judge Ferguson.

18 JUDGE FERGUSON: Hold on just a minute.

19 (The Board conferring.)

20 JUDGE BRENNER: Well, the motion to strike is
21 denied. You can come back and ask him what he is basing it
22 on. We may find out in the next question or two ourselves.

23 You are saying "detuner," is that it?

24 WITNESS ELEY: D e t u n e r.

25 BY JUDGE FERGUSON:

WRBwrb

1 Q Mr. Eley, perhaps it will help the record if you
2 will tell us what you were reading from a moment ago.

3 A (Witness Eley) Okay. It was a telephone
4 conversation with a Mr. Don Ginter of Colt Industries in
5 Beloit, Wisconsin, and a Mr. Joe Smith, of their diesel
6 design testing department. Mr. Don Ginter is in the diesel
7 engine analytical department.

8 Q I think I'm still having some difficulty in
9 understanding, perhaps, what both of you are saying. I
10 think I understand that we are always talking about diesel
11 engines that are connected to electrical generators. We are
12 not talking about a main engine in a marine -- on a ship;
13 okay?

14 A Yes, Judge Ferguson.

15 Q So let's put the propellor aside, let's put the
16 main engine aside, and talk only about the diesels that
17 drive generators.

18 Now, if we can start from that point, am I correct
19 in understanding that both of you are saying that there are
20 no differences between the design considerations that one
21 must have for those engines versus stationary engines? Is
22 that correct?

23 A (Witness Christensen) That is what I am saying,
24 Judge: there are no differences in the design for stationary
25 engines and marine engines.

WRBwrb 1

Q Okay.

2

A (Witness Eley) I agree with that, Judge Ferguson,

3

yes.

4

Q And by saying that, I assume you're also saying

5

that when we do a vibrational analysis we look at -- we will

6

expect the same vibrational spectra to occur, whether the

7

generator -- the diesel is either on a marine -- in a ship

8

or on land; is that correct?

9

A (Witness Christensen) That's correct. And that

10

is shown in the DEMA rules, because the allowable stresses

11

are the same for marine engine as for stationary engine

12

application.

13

Q Professor Christensen, you have, I think, made a

14

point emphatically on many occasions that you are concerned

15

about safety, and that's the overriding consideration in

16

everything that you have testified on so far; is that

17

correct? --the safety of the engine?

18

A That's correct, Judge.

19

Q You have stated, I also believe, that the safety

20

is measured by the meeting of certain criteria by the

21

classification societies. Or is it more than that?

22

A It is based on the work of the classification

23

societies, yes.

24

Q Okay.

25

A (Witness Eley) Could I add something there, Judge

WRBwrb

1 Ferguson?

2 Q Go right ahead.

3 A When an engine is originally built to a
4 classification society's rules and regulations, one doesn't
5 just finish with the classification society as of that time;
6 one needs to maintain class. Consequently, on a regular
7 basis those engines are inspected by an independent surveyor
8 with the experience to assess the suitability of its
9 continued use.

10 That is also an extremely critical factor in the
11 safety features of any types of diesel engines.

12 Q I wanted to get back to that, Mr. Eley. I did
13 make a note when you gave us a description of that before.
14 Since you brought it up, let's stick with that for a moment.

15 These independent surveyors that you indicated who
16 should be present as the engine is manufactured and after it
17 has been assembled, these independent surveyors --
18 experienced surveyors, I believe you described them -- what
19 criteria do they use for evaluating the safety of the part
20 that's being manufactured, or the engine after it's built?

21 A They use their experience together with the rules.

22 Q Their experience together with the rules.

23 A That's right. They must be continually compliant
24 with their rules. But they also base it on years of
25 experience.

WRBwrb 1

Q I see.

2

So I guess both of you are telling me that the rules -- compliance with the rules is the important factor. Experience is also helpful; is that right?

3

A Experience is extremely important, Judge Ferguson.

4

Q Did you want to say something, Professor

5

Christensen?

6

A (Witness Christensen) Yes. I was going to remark

7

that the way they would survey individual items is dependent on the item, but they will be looking for what we refer to as wear patterns. If there seems to be undue wear occurring in certain localities they will investigate that further, and either come to a yes or no decision as to what future action is taken.

8

Q Is that covered by rules?

9

A It is covered in the rules in the first part, all classification societies' rules, because they do draw up and draft up the rules for classification continuing surveys.

10

Q Is there anything that the surveyors would do that is not covered by the rules?

11

A Yes. They are using their own experience in looking at a part. All classification societies have a lot of their own in-house rules, which are very often too complicated to write up into a general rulebook. And these general in-house rules are also being continually updated.

12

13

14

15

WRBwrb 1 They are not always available to the general public.

2 Q Let me ask the question once again: Is there
3 anything that the surveyor would do that is not covered by
4 the rules?

5 A (Witness Eley) Oh, yes, quite a considerable
6 amount, Judge Ferguson. If I might just give you a very,
7 very simple example.

8 If you're taking a bearing to bits, a bottom end
9 bearing, say, with a bolt passing through it, there is a
10 specific survey period, a computerized survey period which
11 is given to you which you must maintain up to date. And
12 when that period comes up, the surveyor comes on board and
13 tests those various components.

14 Now, there's all kind of practical experience that
15 he has to be able to give him the capability of assessing
16 the suitability of the particular component for further
17 use. And some of these are very, very simple, indeed.

18 I might just say that the bottom-end bolt could be
19 tested by its ring. I know this sounds unusual, but all of
20 the-- There are various techniques involved that these
21 classification societies have over years of experience, that
22 are essential to keep that engine in good running and good
23 working condition.

24 I'm trying to cite--

25 A (Witness Christensen) Mr. Eley has just mentioned

WRBwrb

1 the survey of a bottom-end bearing, or a "bid end bearing,"
2 as it's commonly called in land parlance. The bolts,
3 obviously, holding the bearing parts together, are subjected
4 to enormous stresses arising out of the inertia of the
5 parts.

6 Normally the procedure is to remove the bolt and
7 hang them on a piece of string, give them a blow with a
8 hammer and see if they ring.

9 I had experience of this where this has been done,
10 and there was a doubtful ring in the bolt. We then
11 subjected that bolt to--

12 Q May I interrupt you, Professor Christensen?
13 That's very interesting, but let me just stop you there.

14 Using that one example, how would a surveyorl-- Is
15 there a rule covering the ringing of the bearing?

16 A (Witness Eley) No, there isn't, you see. That's
17 why I gave you that silly little example, to explain to you
18 that the rule is not necessarily there to cover for all
19 aspects of this; that the guy's experience is also a
20 critical factor.

21 I gave you that silly example just to explain that
22 there are many, many other things that the surveyor has
23 under his belt that he can utilize in that kind of a
24 situation to maintain that plant in good operating
25 condition.

WRBwrb

1 Q That's very interesting. I hadn't realized that
2 that was the case.

3 But since you brought that up, let me ask another
4 question related to that.

5 Do you think it would be-- I would assume that
6 some surveyors might have hearing efficiencies that are
7 different than other surveyors. Do you think it would be
8 helpful if there was a more scientific way of determining
9 the condition of the bearing hanging on the string?

10 A There are quite a lot of other ways, Judge
11 Ferguson. That example was just an example; okay? I'm just
12 trying to get my idea across that the surveyor's experience
13 is also---

14 The point I'm trying to make is that the
15 surveyor's experience in running diesel generators is an
16 extremely important issue.

17 Could I just cite another example?

18 Q Excuse me. I think you've gotten that point
19 across. Let me see if I can get another point across.

20 I thought I interpreted your two positions as
21 being one where we must apply the rules of the
22 classification societies and we must use experience. But
23 somehow, in all of your testimony -- much of your testimony,
24 I got the impression that some of the newer techniques of
25 analysis should not carry as much weight as the experience

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

WRBwrb

1 the available tools that you have in the mathematical
2 analysis of things, which we can do today so easily with a
3 computer program. And Lloyds used these techniques in their
4 research department, and spent enormous amounts of money, so
5 that they can come up with rules which bear a relationship
6 with real-life practice.

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

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 MR. 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 Keen gauge
25 and the Piezo electric crystals. But we didn't, or at least

AGBpp

1 I don't remember, get from you your understanding of the
2 accuracy of pressure measurements of flush mounted crystals
3 in the cylinder.

4 Have you had direct experience in using these
5 instruments?j

6 A (Witness Christensen) I have, yes.

7 Q And can you tell me a little bit about how one
8 assures accuracy? Are they calibratable, for example?

9 A Yes, you can calibrate them, yes.

10 Q Would that be a normal practice before making
11 measurements?

12 A That is normal; yes.

13 Q And if one followed that practice and were
14 measuring pressures in the ranges we've been talking about,
15 say 1500 to 1800 psi, what kind of accuracy could be
16 achieved?

17 A I think the accuracy of the transducers is given
18 somewhere about some plus or minus 5 percent, some as low as
19 plus or minus 2 1/2 percent, I believe, if my memory serves
20 me correctly.

21 Q Well, is that the manufacturer's rating, or is
22 that the accuracy that can be achieved by calibration?

23 A That is the accuracy of the rating by the
24 manufacturer for that specific piece.

25 Q So by calibration, would it be possible to make

AGBpp 1 more accurate measurements?

2 A Yes; the calibration is relatively easy. In the
3 instruments I have used, it is done with a capacitor.

4 Q And what kinds of accuracy can be achieved?

5 A Of the orders of the figures I have given. But
6 you have to take into account the accuracy of the process
7 right through from start to finish. There are a lot more
8 other electronic instruments there before you get the final
9 digitalized read-out.

10 Q I guess I still haven't gotten the bottom line as
11 to what accuracy one could achieve, using a scientific
12 approach in calibration, understanding the errors of
13 potential read-outs, be they digital or otherwise, and
14 whatever other installation problems one might have. But in
15 a carefully done measurement of pressures, and calibrating
16 the crystals and the instrumentation, what accuracy can be
17 achieved?

18 A The figures quoted within plus or minus 5
19 percent, if I remember correctly.

20 Q You're telling me that some figures are quoted
21 somewhere. Where were those quoted?

22 A They are quoted in various technical books
23 dealing with transducer processes. They are quoted in
24 equipment manufacturer's catalogues.

25 Q But based on your own experience, do you have an

AGBpp

1 idea of what could be achieved, if you were to carry out
2 such a calibration or pressure measurement?

3 A In the work that I have done at King's Point, we
4 have had such wide variations in the values that we have
5 obtained, we are still working in this area when we have the
6 chance.

7 Q So, based on your own experience, you're unable
8 to give me a numerical answer; is that correct?

9 A What I would call a accurate figure, I can't give
10 you a real accurate figure, I can only quote from sources.

11 Q Thank you.

12 A (Witness Eley) May I add something to that,
13 Judge Morris?

14 Q Certainly.

15 A From the data that was given to us with the 720
16 degrees data, I plotted that data on a pressure volume
17 diagram. And then got a preliminary measurement of the area
18 of that diagram and I got that particular diagram to be 91.3
19 percent of the full rated load condition.

20 Q Do you infer from that, Mr. Eley, something about
21 the accuracy of the measurements that can be made with a
22 Piezo electric quartz crystal?

23 A That particular unit on that engine was working
24 at full load. I'm not saying that the engine wasn't
25 developing 3,500 kilowatts, what I am saying is that unit

AGBpp 1 was not developing one-eighth of that.

2 Q Do you recall the question I just asked?

3 A Yes, I do. That the -- if that was indeed
4 accurate. If the Piezo electric instrument was accurate,
5 then that would have been the case, that that unit was
6 developing only 91.3 percent of its full power.

7 Q I'm not asking about the power developed. I'm
8 trying to find out how well one can measure the pressure in
9 the cylinder using the Piezo electric device?

10 A I can't really answer that.

11 Q Thank you.

12 Professor Christensen, given a crack of this size
13 of several microns, let's say, in the Shoreham crankshaft,
14 is it your opinion that under the loads that the crankshaft
15 will see that crack will propagate?

16 A (Witness Christensen) Generally, yes.

17 Q What is the basis for your conclusion?

18 A First of all, it would depend where the fault,
19 several microns in size, was located. If it was in a highly
20 stressed area, then we would expect the crack to propagate.
21 If it is in an area of virtually zero stress, then it would
22 not propagate.

23 Q Can you describe to me, at least qualitatively,
24 what stress field such a crack would need to see in order to
25 propagate?

AGBpp

1 A I couldn't answer that at this point, no.

2 Q Would the propagation depend on anything besides
3 the magnitude of the stress?

4 A Yes, it would depend on the magnitude of the
5 stress and the number of cycles that it's put through.

6 Q Well, have you done a calculation to show whether
7 or not such a small defect, I'll call it, would propagate?

8 A No, I have not. Not for the crankshafts or for
9 other parts of these engines, no.

10 Q Thank you.

11 I hesitate to come back to the subject that Judge
12 Ferguson was inquiring about, but I'm still somewhat
13 uncertain of the basis for your conclusions on how one
14 defines continuous operation. I take it that you believe
15 that continuous operation for the Shoreham diesels should be
16 taken as at 3900 kilowatts; is that correct?

17 A That is correct.

18 Q The reason I'm confused is because I'm not expert
19 in the area, and I've looked at a lot of documents for the
20 first time in the last several months, one of which is an
21 IEEE standard. It's IEEE standard 387-1984, whose title is,
22 "Standby Power Supplies for Nuclear Power Generating
23 Stations." I don't know whether you have that in front of
24 you or not, I'll read a section from it.

25 A I know of the document, but I don't have it in

AGBpp

1 front of me.

2 Q In paragraph 3.7.2, entitled, "Short-term
3 rating," and I paraphrase: "Short-term rating is the
4 output that can be maintained for two hours in any
5 24-hour period, without exceeding the manufacturer's
6 design limits, and without reducing maintenance
7 intervals for continuous rating."

8 So, to me, the "continuous rating" would not be
9 the rating for which the machine must be capable of
10 operating for two hours in any 24, but some lower level.

11 And I find that somewhat inconsistent with the
12 Lloyd's register, paragraph 3.61, which you've interpreted
13 to say that that rating, which was 3900 for the
14 Shoreham diesel, should be considered as the continuous
15 rating.

16 A That is based on the strength of crankshafts, in
17 effect. And what a normal -- and I think the way a normal
18 engine designer would interpret this -- would be that he
19 would get his specification, he would know these rules, and
20 I think he would base his design -- I know I would -- on a
21 3,900 rating as the design rating, even though that is the
22 rating for the two-hour period. That is what I do and I
23 think most manufacturers would do that because of the
24 problem of meeting the rules, which states that that must be
25 achieved every 24 hours, and this is where the test comes

AGBpp

1 in.

2 Q You can understand my problem in that the IEEE
3 standard does not seem to be consistent with that
4 understanding on your part.

5 A That does appear so, but I think we've got to get
6 back to what I will call initial design basics. I think
7 that rule that they put in there is a very good rule because
8 it found that the crankshafts in the -- the previous
9 crankshafts -- were undersize. And I'm going to say that
10 that is an excellent rule. It is up to the designer to
11 supply an engine which will meet these rules.

12 Q Well, under any of these rules for the 10 percent
13 or 5 percent overpower requirements, what is the concern?
14 Is it only torsional vibrational stress or is it something
15 else?

16 A It is the -- that is part of it, the torsional
17 vibration stress. There is also the bending stresses, which
18 are occurring at this higher level of power. They make
19 their input and the ability of the crankshaft to meet this
20 on a very, very long-term basis, rather than a 700 hour
21 basis or -- I think it was 700 hour basis -- of the
22 crankshafts that failed. I think that answers the question.

23 Q Well, I'm not sure it does in my own mind. If
24 one considers the, what I guess is called -- well, I don't
25 know what it's called -- but it's been referred to as the

AGBpp 1 curve with the knee in it, the S-N curve?

2 A The S-N curve, yes.

3 Q And so that a given stress level, one is
4 concerned about the number of cycles, which would be many
5 more than 700 hours, I guess.

6 A Yes. Normally, on that S --

7 Q I take that back. If I can interrupt myself?

8 A Oh, I beg your pardon, I thought you had
9 finished.

10 Q I think I misspoke in saying that ten to the
11 seventh cycles would be more than 700 hours. I believe
12 that's about equivalent. But in talking about two hours in
13 any 24, then we're not talking about ten to the seventh
14 cycles at the overload condition, are we?

15 A I don't quite understand the question, Judge, I'm
16 sorry.

17 Q It's all right; my fault. If, as at Shoreham,
18 there is a continuous rating for the engine and, also, a
19 requirement for capability to function at 10 percent of 5
20 percent higher power level for shorter periods of time, it's
21 not clear to me that the allowable stresses should be the
22 same level for those two different conditions of operation.

23 A Generally in safety, coming back to your S-N
24 curve, we would design on stresses which are on the flat,
25 bottom part of the curve, coming some little way beyond the

AGBpp

1 knee if it is on a normal scales. That is what we would
2 design the maximum stresses out and we would design the
3 stresses coming onto the crankshaft that, what is referred
4 to in IEEE, as the two-hour overload rating. We would
5 design the crankshaft stresses to be within those figures on
6 the S-N curve.

7 O Thank you.

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

AGBeb 1

(The Board conferring.)

2

BY JUDGE MORRIS:

3

Q I would like to again return to an area I already visited, and this was page 20 of County Exhibit 47, the hand-written calculation sheet with the title "Safety Factors."

7

JUDGE BRENNER: While all the parties are looking, I should note for the record what the parties undoubtedly realized longer in advance than I did earlier this afternoon.

11

County Exhibit 43 contains much of the same information, so Mr. Stroupe, when I disagreed with your pagination, I think the problem was I was looking at it in another exhibit.

14

15

MR. STROUPE: I think I probably used both of them at one time or another.

16

17

JUDGE BRENNER: It doesn't matter.

18

BY JUDGE MORRIS:

19

Q Am I correct that ABS did its calculations under ABS rules?

20

21

A (Witness Christensen) I believe that, yes.

22

Q Did ABS do any calculations under any other society's rules?

23

24

A They do refer to CIMAC rules, yes.

25

Q The distinction I want to draw is whether or not

AGBeb 1 they did calculations under the other society's rules, or
2 whether they compared their own results with the allowable
3 stress limits given in the other rules.

4 A I don't know, Judge.

5 Q Mr. Eley, could you help on that question?

6 A (Witness Eley) I interpreted the safety factors
7 on this page to be lower safety factors by their in-house
8 rules than they have ever given in a desired minimum for it
9 before.

10 Q Excuse me, Mr. Eley, for interrupting. May I
11 repeat the question? And maybe I should start at the
12 beginning.

13 Is it your understanding that ABS made
14 calculations under ABS rules?

15 A Yes.

16 Q Do you know whether or not ABS made calculations
17 using other societies' rules?

18 A Yes, they did the crankshaft safety factor by the
19 CIMAC method.

20 Q Pardon me. I didn't hear you.

21 A They made the crankshaft safety factor by the
22 CIMAC method, which Mr. Stroupe pointed out.

23 Q Well, I am trying to distinguish between
24 comparing the result with an allowable limit stated in a
25 rule with having made a calculation according to a

AGBeb 1 different society's rules. Do you understand that
2 distinction?

3 A I don't know.

4 Q Thank you.

5 JUDGE BRENNER: Just to be clear, you don't
6 understand the distinction, or you understand the
7 distinction but don't know the answer?

8 WITNESS ELEY: Don't know the answer.

9 JUDGE BRENNER: Which assumption were you
10 operating under when you answered Mr. Stroupe's questions on
11 that subject?

12 WITNESS ELEY: Might I just explain how I
13 interpreted the safety factors?

14 JUDGE BRENNER: I would like you to try to answer
15 my question directly so I can then understand the answer in
16 relation to my question when I think about it later.

17 I can state the question differently, and let's
18 try that, as soon as I find the page.

19 WITNESS ELEY: Okay.

20 JUDGE BRENNER: I am looking at Exhibit 47, if
21 that is the one you have. Otherwise I will find the page in
22 the other exhibit.

23 WITNESS ELEY: Yes, I've got it. I've got 47,
24 yes.

25 JUDGE BRENNER: Look at page 17. Near the top,

AGBeb 1 although not the first line, it states:

2 "Crankshaft safety factor by CIMAC
3 method."

4 WITNESS ELEY: Yes.

5 JUDGE BRENNER: Do you recognize this as one of
6 the pages you referred to and were referred to in your
7 questions and answers with Mr. Stroupe?

8 WITNESS ELEY: Yes.

9 JUDGE BRENNER: All right.
10 What do you think this page represents?

11 WITNESS ELEY: The CIMAC-- The IACS rules, the
12 CIMAC rules. This is a calculation in accordance with
13 those.

14 JUDGE BRENNER: I'm sorry, did you say this is a
15 calculation in--

16 WITNESS ELEY: -- in accordance with those.

17 JUDGE BRENNER: With what?

18 WITNESS ELEY: Done by the American Bureau of
19 Shipping.

20 JUDGE BRENNER: A calculation in accordance--

21 WITNESS ELEY: By the CIMAC method. By the CIMAC
22 method, done by the American Bureau of Shipping in
23 accordance with their computer program.

24 JUDGE BRENNER: How do you know that?

25 WITNESS ELEY: I assume it from the fact that it

AGBeb

1 says "Crankshaft Safety Factor by CIMAC Method" on the top.

2 JUDGE BRENNER: Okay.

3 And that is the premise you were operating under
4 when you answered Mr. Stroupe's questions?

5 WITNESS ELEY: Yes.

6 BY JUDGE MORRIS:

7 Q Professor Christensen, there is still an area
8 that I feel I don't fully understand, and perhaps we could
9 get at it by looking at your answer to the question at the
10 bottom of page 113, and carrying on to page 114 of the
11 County's prefiled testimony.

12 A (Witness Christensen) Yes, I have that.

13 Q Do you have that?

14 And is it your conclusion with respect to Lloyd's
15 rules that they are -- that they provide the greatest margin
16 of safety?

17 A Yes, generally I think that is correct from work
18 that I have done in this area.

19 Q And we have heard some specific uses of margins
20 of safety where a particular strength of the material was
21 calculated versus -- I mean the actual stress was calculated
22 with respect to the strength of the material and that ratio
23 could be used as a safety factor.

24 A In the CIMAC rules the calculated strengths are
25 used in finding the safety factor.

AGBeb 1 Q But in your answer on page 114, did you have in
2 mind other types of safety factors?

3 A No, I was not specifically referring to the term
4 "safety factor" but overall safety for the crankshaft,
5 without going into calculations of safety factor because, as
6 you have seen later, there are many ways of calculating
7 safety factors, and I didn't want to get bogged down with
8 the various way.

9 I preferred to use Lloyd's rules as they stood on
10 their own merit.

11 Q Well, encompassed in the phrase "margin of
12 safety," what things did you have in mind?

13 A The ability for the crankshaft to continue and
14 function without any problems whatsoever.

15 Q Well, what factors do you consider that could
16 give rise to problems? For example, the torsional
17 vibrational stress level, the number of cycles, and so
18 forth? What things like that did you have in mind when you
19 used that phrase "margin of safety"?

20 A I meant the overall margin of safety which the
21 rules of Lloyd's take into account overall, with all of the
22 other in-built factors built out of long years of
23 experience.

24 That is what I was particularly referring to,
25 rather than specific calculations under anybody's rules or

AGBeh 1 under anybody's method as to specific factors of safety.

2 Q So is it correct that your meaning was the
3 general understanding of the conservatisms within Lloyd's
4 rules as compared to others?

5 A Generally, yes, I would agree there because for
6 me, ultimate safety was the factor that I was considering
7 here.

8 Q And you made reference several times to the -- I
9 think you said many thousands of crankshafts which Lloyd's
10 in effect has in its data bank. Is that correct?

11 A That is correct.

12 Q Do the rules take into account that even though
13 designs might be the same and materials specifications might
14 be the same that there would be variations among those
15 thousands of crankshafts?

16 A That takes those factors into account, and they
17 do have some failures, notwithstanding the conservative
18 values that we mentioned here.

19 Q Were those failures -- did they occur in
20 crankshafts which met Lloyd's rules in every respect?

21 A Yes. I have a lot of access to those failures
22 and generally speaking, there is a reason for it. It can
23 come from many reasons: operation, manufacture, quality
24 control.

25 But the percentages of failures, to get any

AGBeb

1 figure which is valid, you have to equate the figure to 100
2 years of service. I don't want to complicate the issue, but
3 you've got to equate the factor to 100 years of service for
4 a particular crankshaft, and you come up with a decimal
5 fraction of a number, not even a one.

6 I mention this because this is to get what I
7 would call a pertinent statistic.

8 Q I'm not sure I understood what you told me.

9 A I'm sorry. I am trying to be simple and short.

10 But what I am saying is that Lloyd's rules take
11 all factors into account in the matter of safety, and that
12 is the reason why I would go to Lloyd's rules because I feel
13 here that the ultimate safety is the concern that we are
14 here addressing.

15 Q Well, has Lloyd's taken into account all those
16 factors that contribute to safety? Has it correctly taken
17 into account the variations which could be on the
18 detrimental side in manufacturing a thousand crankshafts?

19 A Yes, that is taken into account in the rules
20 which cover the whole gamut of manufacturing from the basic
21 seal through the forging through to the finish machining and
22 various treatments which you can use to extend the fatigue
23 limits.

24 Q Well, if the Lloyd's rules then in effect cover a
25 band of possible as-built crankshafts, is this one of the

AGBeb 1 ways in which the Lloyd's rules are conservative?

2 A No.

3 If I could illustrate a point?

4 Q Yes?

5 A The manufacture of steel which is used in
6 crankshaft forgings and crankshaft castings is now much,
7 much better than it was in the past, and this betterment of
8 steel manufacture -- that is, the manufacture of the raw
9 steel -- is taken into account in the rules.

10 And this is what I referred to as updating the
11 rules, as distinct from changing a formula.

12 Q So are you telling me that some conservatism has
13 been taken out of the rules, based on better control of
14 material properties and better knowledge?

15 A That is what I am saying, Judge. And this comes
16 out from the modern use of instrumentation which is used in
17 modern research which we didn't have years ago.

18 JUDGE MORRIS: Thank you, gentlemen.

19 That is all I have at this time.

20 WITNESS CHRISTENSEN: Thank you.

21

22

23

24

25

AGBagb 1

BY JUDGE BRENNER:

2 Q Gentlemen, is my memory correct that you believe
3 that the ABS rules for crankshafts are essentially the same
4 for diesels on ships, whether those diesels are used for
5 generator purposes or main propulsion purposes?

6 A (Witness Christensen) Generally I would say the
7 ABS rules are the same. There might be minor differences
8 here and there relative to between a crankshaft for a
9 generator and a crankshaft for a main engine, but basically
10 they are the same right the way through.

11 A (Witness Eley) Yes.

12 Q Do you have an opinion, with a bases for the
13 opinion, as to why the ABS letter of May 3rd, 1984, which is
14 County Exhibit 44, stated that "The ABS would have no
15 objection....," -- and I don't have to read all the words,
16 you are familiar with them and I see that you now have it in
17 front of you -- for the use on diesel generator sets on an
18 oceangoing vessel. Were they trying to draw some
19 distinction and, if you have an opinion on that, tell me
20 what your basis is for the op'nion.

21 A (Witness Christensen) I have no opinion on it
22 which I could validly bring out because I don't know, Judge,
23 what they were getting at here except the fact that they did
24 say that they would, in effect, approve it as it was
25 presented if the torsionals were presented to them for use

AGBagb

1 on a diesel generator on a ship. That is all I can say,
2 what I can read there, Judge. I don't know of any other
3 thing there that they were getting at.

4 I must presume if we were to look at the
5 submittal letter we might get an answer from that where we
6 would see what TDI have asked for in what is referred to as
7 the submittal letter.

8 Q Mr. Eley, since you are not jumping in, I will
9 assume you have nothing to add.

10 A (Witness Eley) Nothing to add to that.

11 Q Mr. Eley, I believe it was you who referred to
12 what I am looking at as the numbered page 22 in County
13 Exhibit 47, it is the handwritten page labeled
14 "Conclusions," in the ABS handwritten material.

15 A Yes.

16 Q Do you have that in front of you?

17 A Yes.

18 Q All right.

19 You said you harbored some doubt, I believe, as
20 to the results of the analyses performed by persons on
21 behalf of LILCO through their consultants given the notes
22 two and three on that page.

23 Am I correct?

24 A Yes.

25 Q Am I also correct that you performed no analyses

AGBagb 1 of the fatigue strains submitted for the crankshaft to ABS?

2 A No, I have not, Judge Brenner.

3 Q Okay.

4 And I mean to direct the questions to Professor
5 Christensen also, I'm sorry I did not do that.

6 A (Witness Christensen) No, I understood that,
7 Judge. I made no calculations.

8 Q I didn't restrict it to calculation, unlike some
9 other question, I was asking any sort of study or analyses.

10 A Yes, I looked at this and it would appear to me
11 through my examination that what they are basing their
12 figures on is on the tests from three generator engines as
13 against stresses which would be calculated under the CIMAC
14 rules which would be based on much, much more input.

15 Q Turning to point number three on that same page,
16 can both of you tell me what your specific disagreement is
17 with the submitted stress test results, and include in that
18 answer whether you have performed your own analyses whether
19 it be calculations or some other form of analyses.

20 A (Witness Eley) I have not performed any
21 calculations, Judge Brenner, on that. It was the difference
22 between the stress test results and the calculated stress
23 and the calculated stress by the CIMAC and the ABS method.
24 Those methods seemed higher -- gave higher ratings in
25 accordance with this sheet which will give you a lower

AGBagb 1 safety factor. This was pointed out by Mr. Woytowich in his
2 conclusions in item two and three.

3 Q Let me ask the question of you a little
4 differently, Mr. Eley, and then we will allow Professor
5 Christensen to add if he wants to:

6 You stated you harbored some doubt as to the
7 stress test results given that particular conclusion in
8 point three. So I am inferring from that that you would
9 like the Board to find that there is something deficient in
10 the stress test results and for us to not credit those
11 results but, rather, for us to credit your view of how the
12 calculations should have been made under either CIMAC or
13 ABS.

14 A The point I tried to make was that if there had
15 been closer agreement they would have been more credible to
16 me.

17 A (Witness Christensen) Could I state the thing in
18 slightly different words, and say that the tests there are
19 based on three samples, if we use everyday words; but the
20 figures obtained from other sources are based on many, many
21 more samples.

22 Q One last point. I may be getting my terms very
23 confused here, Professor Christensen, so help me out if you
24 can.

25 Do you recall your answering certain questions of

AGBagb 1 Mr. Stroupe's involving a methodology, I believe, labeled a
2 mean sum method?

3 A I do remember my answer, sir, in that area.

4 Q Have I labeled the methodology correctly?

5 A No, but I understand what you mean.

6 Q Well help me out. What would be the correct
7 label?

8 A I think you are referring to what is sometimes
9 said as the root of the sum of the squares and which I....

10 Q Let me stop you. I am aware of that. But I
11 thought you described the root of the sum of the squares
12 method as being a mean sum method, but maybe I have that
13 wrong.

14 A The value that I was referring to, the way I
15 answered that question was what we would refer to as a root
16 mean square value which I said gave a mean value for the
17 stress as distinct from a peak value.

18 Q Could you explain to me why the root of the sum
19 of the square method gives a mean value, in your view?

20 A Yes. This is a method where we get a mean from
21 the curvature of what would be technically or mathematically
22 referred to as the sinusoidal. And the nearest way I can
23 depict the sinusoidal is by looking at the McDonald Arch,
24 that is something like a sinusoidal.

25 And what we were looking at there is the height

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 weight, but I am assuming an oscillation which is forced

AGBagb

1 by one forcing function, possibly in an X direction, and
2 another oscillation which may or may not be in phase which
3 might be in the Y direction.

4 A No, I think that clouds the issue for me a little
5 bit, because what we are getting now is various sinusoidals
6 which are not running in phase. Then we would have to
7 utilize other means to bring them in phase.

8 Q Well what would be appropriate on a crankshaft;
9 is everything in phase, are all the orders in phase?

10 A No, they are not, no. Various orders are in
11 phase with one another.

12 Q I'm sorry, you said....

13 A I said various orders are in phase with one
14 another and this would be dependent on the crankshaft crank
15 angles, the number of cylinders and the firing order.

16 Q So some orders may be in phase but may some other
17 orders not be in phase?

18 A That is correct, yes. You have got to take
19 various orders which some orders are in phase with one
20 another and others are not in phase with one another.

21 Q And how does one combine those to get a resultant
22 amplitude of vibration?

23 A This I referred to this morning and I said -- to
24 come back to that -- I can't carry this material in my head
25 and I would have to refer to books on this matter to come up

AGBagb 1 with something which is valid. I always refer to books if I
2 am in an area which I am not quite certain of. And even if
3 I am certain of it, I will sometimes confirm by going to
4 books.

5 Q It is perfectly understandable, I consult books
6 myself.

7 But if you had only two orders which were out of
8 phase, could you combine those by the square root of the sum
9 of the squares?

10 A You would be able to take -- if they were maximum
11 values, you would be able to take them together and add them
12 together and you know that so many times in some longer unit
13 of time they will match up and come in phase and then they
14 will go out of phase.

15 This I think is referred to, if I remember
16 correctly, as the beat in music where you have two notes
17 really the same coming together and then drifting apart, you
18 get a beat. I use that as a simplification of it.

19 Q I understand your explanation but I think we have
20 exhausted the subject right now. Thank you.

21 JUDGE BRENNER: We have completed our
22 questioning. We went a little later than we said we would
23 because I thought it would be better for you, Mr. Brigati,
24 to have the completion of our questions at this point at
25 least overnight in preparing your redirect.

AGBagb

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

We are ready to adjourn for the day and have the off the record discussion on the various scheduling subjects, and involved in that will be the subject of the County's piston testimony and other related things.

And we will just adjourn for the day and then when we come back tomorrow morning we will put on the record whatever needs to be put on the record based on the off the record meeting with the parties and the Board and we will also pick up with the testimony -- the redirect of the County's witnesses on crankshafts.

And I hope there is no doubt in anybody's mind that we are certainly going to complete this panel tomorrow; I hope we do that easily because there will be some other things to discuss. And based on the estimates we had before we should be able to do that.

All right. So we will be adjourned for the day and the witnesses are excused.

(The witness panel temporarily excused.)

(Whereupon, at 4:55 p.m., the hearing in the above-entitled matter was recessed, to reconvene at 9:00 a.m., the following day.)

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 Plant,
Unit 1)

DOCKET NO.: 50-322-OL

PLACE: Hauppauge, L.-I., New York

DATE: October 3, 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

Reporter's Affiliation
Ace-Federal Reporters, Inc.