

ORIGINAL

UNITED STATES
NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:

LONG ISLAND LIGHTING COMPANY
SHOREHAM NUCLEAR POWER STATION

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50-322-0L

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UNITED STATES OF AMERICA

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NUCLEAR REGULATORY COMMISSION

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BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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In the matter of: :

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SHOREHAM NUCLEAR POWER STATION : Docket No. 50-322-OL

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(Long Island Light Company : :

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State Office Building

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Veterans Memorial Highway

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Hauppauge, New York

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Monday, September 24, 1984

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The hearing in the above-entitled matter was

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convened at 10:30 a.m., pursuant to notice.

16

BEFORE:

17

JUDGE LAWRENCE BRENNER,

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Chairman, Atomic Safety and Licensing Board

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JUDGE PETER A. MORRIS,

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Member, Atomic Safety and Licensing Board

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JUDGE GEORGE A. FERGUSON,

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Member, Atomic Safety and Licensing Board

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Washington, D.C. 20036

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C O N T E N T S

	Witness	Direct	Voir Dire	Cross	
2	Arthur Sarsten)				
3	Adam Henriksen)	23,234		23,237	
4			23,256	23,274	
5					
6					
7					
8					
9					
10					Received
11	NRC Staff Diesel Exhibits 1 through 4				23,236
12	1 - PNL Evaluation of Crankshaft Dimensions				
13	2 - PNL Analysis of Torsional Stresses for Sum of				
14	24 Orders of Vibration				
15	3 - PNL Analysis of Stress Levels for Single Orders				
16	4 - ABS letter to TDI, 5/3/84				
17					
18	INSERTS				
19	NRC Staff Diesel Exhibits 1 through 4				23,236
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PRESIDING JUDGE: Good morning. We are on the record.

We will note the usual appearances. I don't see any Counsel for the State present, but we do have Counsel for the Staff, LILCO and Suffolk County present.

We have come preliminary matters to take up before getting to the testimony of the Staff's witness.

One minor, brief preliminary matter is that the Board has reviewed the Proposed Resolution of Suffolk County Diesel Generator Contention regarding some of the heads. In principle, it is acceptable to us and we have no problem with it.

As a minor point it appeared to the Board on preliminary reading that with respect to Paragraph E, which starts on page 3, the procedure spelled out there deals with the barring over and rolling over of the engines and checking the engines after that procedure, but does not spell out what the engines are being checked for and what the criteria or criterion would be for that check.

Under Paragraph F, which seems to deal with a different routine surveillance procedure, there is an explanation of that. If the parties believe the explanation in F applies to E, it was not clear to us on reading the express agreement that it is to be so applicable.

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I think we understand what is involved here. Perhaps we have misread something, and I just leave it as a suggestion to the parties as something they might wish to check.

Presumably the object of Paragraph E, like the object of Paragraph F, is the detection of any leakage.

MR. DYNNER: Judge Brenner, I should say for the record I think we will check this. It is our understanding, and it is stated in here, that there will be a modification to the existing procedure that LILCO has already in place for barring over, and we will check that procedure to make sure it is clear that the criteria are correct.

I should also state for the record that over the weekend I did confirm that this resolution is authorized and acceptable to our client. I have mentioned to Mr. Ellis that one of the things we would like an understanding on that is not specified in here is that documentation of inspections will be promptly furnished to the County. But I think that is a detail we can arrange.

And I have sent the copies of the resolution to the Special Counsel to the Governor for signature on behalf of the State of New York. As soon as that is returned, it will be returned to me and I will distribute the copies to the parties.

JUDGE BRENNER: All right. I don't want to get

WRBeb 1 further into the details of an agreement which is still in
2 the negotiation stage, albeit final negotiation stage, and
3 we can leave it where it is right now for purposes of the
4 record.

5 Do you have a timeframe in mind as to when you
6 will have a final agreement for our approval?

7 MR. DYNNER: No.

8 MR. ELLIS: Judge Brenner, Mr. Dynner just spoke
9 to me no more than five minutes ago. It won't take LILCO
10 very long at all, but we do need to look into this latest
11 request to see how it was handled in the past. And I think
12 generally documentation available to the Staff they can
13 obtain from the Staff, but I will have to look into that.

14 As far as LILCO is concerned, the time that we're
15 talking about is very minimal, this week I would hope.

16 JUDGE BRENNER: We would not like it to drift
17 beyond this week if at all possible to avoid that. We are
18 making schedule decisions, some of which we will discuss in
19 a moment, based on the supposition that the cylinder head
20 issue is going to be settled. And it would certainly not
21 assist our schedule plans to find out beyond this week that
22 that assumption is incorrect.

23 We don't expect to find that out but
24 nevertheless, I think we will all feel better if the
25 agreement is executed and approved this week.

WRBeb

1 All right. On Friday morning, September 21, the
2 Board obtained a copy of LILCO's Motion to Admit
3 Supplemental Testimony on Suffolk County Contention
4 Regarding Cylinder Blocks, and the supplemental testimony
5 was attached. Apparently the motion had been delivered to
6 our offices some time before Friday morning, I believe late
7 Thursday.

8 We have also received at the locus of the
9 Washington National Airport this morning Suffolk County's
10 response to LILCO's motion, and we appreciate that the
11 logistics were such that we were able to receive it then
12 because it gave us an opportunity to read Suffolk County's
13 answer.

14 I assume, but let me check, that the other
15 parties have also received and read the paperwork I just
16 described.

17 MR. FARLEY: I just received it, Judge Brenner,
18 about ten o'clock, and hurriedly tried to read it.

19 JUDGE BRENNER: All right, when you filed your
20 motion late Thursday.

21 Staff?

22 MR. GODDARD: Staff similarly received a copy at
23 ten o'clock and is in the process of reading it now.

24 JUDGE BRENNER: It is only a few pages.

25 Did the Staff receive LILCO's motion on Friday?

WRBeb 1

MR. GODDARD: Yes, Friday evening.

2

JUDGE BRENNER: I don't understand that.

3

4 was hand-delivered a copy at my home in Fairfax County,
5 Virginia. As of approximately two-thirty in the afternoon
6 on Friday, I inquired of Mr. Edwin Reese, who is on the
7 service list in this case, and he had not at that time
8 received a copy of LILCO's motion and supplemental
9 testimony.

10

JUDGE BRENNER: I don't want to dwell on it.
11 There was a previous problem in this case with service of a
12 LILCO document on the Staff. And whatever problem occurred
13 -- and I don't know on which end the problem occurred -- it
14 should not happen again.

15

MR. FARLEY: Judge, I confirmed that it was
16 delivered to the Staff at 3:55 on Thursday.

17

JUDGE BRENNER: As I said, I am not inquiring
18 into at which end the problem occurred.

19

Let me ask LILCO: Does the County's answer
20 correctly represent LILCO's position in the matter?

21

MR. FARLEY: No, Judge Brenner.

22

JUDGE BRENNER: Can you tell us your position
23 then?

24

MR. FARLEY: Yes, sir.

25

First of all, we delivered it to Mr. Dynner's

WRBeb 1 office on Thursday evening. Now I realize he was en route.
2 The first I heard from Mr. Dynner was at 3:35 p.m. on Friday
3 afternoon.

4 Getting to the merits of the matter, we are in
5 agreement that the subject matter of the supplemental
6 testimony is relevant and material. Both sides agree to
7 that.

8 As to his characterization of it as significant
9 new information, we do not agree with that. From very early
10 in this proceeding, he knew from the June report and even
11 before that, the preliminary report from FaAA about cam
12 gallery cracking, he new about the stud-to-stud cracking,
13 and he knew that as far as FaAA or LILCO knew at that time
14 -- and it was also true as of the date of the filing of the
15 testimony -- that there were no circumferential cracks in
16 the original 103.

17 Now at the time we filed the testimony on August
18 the 14th, it was true and correct, to the best of our
19 knowledge and information.

20 The problem was that people are continuing to
21 document the matters that we have set forth in the
22 testimony, and in the course of that documentation, two
23 significant things occurred.

24 The first was that -- and we had to go to
25 California to confirm this -- that....

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JUDGE BRENNER: Let me interrupt. And if you think you still want to proceed the way you were proceeding, I will allow it.

My question was whether the County has correctly represented your position in the matter. I should have been more specific.

MR. FARLEY: I beg your pardon. Yes, sir.

JUDGE BRENNER: The position with respect to the fact that the County is not entitled to any discovery of the new matter, and to the fact apparently that you believe we should proceed with LILCO's testimony on the cylinder blocks immediately after completing the Staff testimony on crankshafts.

MR. FARLEY: Yes, sir, you do correctly understand our position.

JUDGE BRENNER: On reading your supplemental motion, it struck me, as it struck the County in their answer, that LILCO was very careful not to disclose when they knew this information other than stating some time after August 14th.

So when did you know that there was going to be some supplemental information along the lines filed?

MR. FARLEY: On September the 6th, in the telephone conversation that he refers to, we advised him that it was likely that we were going to file supplemental

WRBeb

1 testimony. But at that particular time the work had not
2 been done. We had only learned at that time that it was
3 necessary to conduct a further investigation.

4 So then the work proceeds from September 6th, and
5 it was only last Thursday that we knew -- approximately
6 in the last ten days that we knew what the results of this
7 further investigation were. And as soon as we knew, we
8 advised the Board and we advised the parties.

9 JUDGE BRENNER: What work had not been done by
10 September 6th? You said you knew something on September
11 6th, but "the work" had not been done.

12 MR. FARLEY: The first thing, your Honor, was
13 that we were aware that an inspection report confirming that
14 cam gallery cracks were less than 3/8ths inches deep could
15 not be located, and the photographs dealing with that
16 situation were not sufficient so that necessitated an
17 independent FaAA measurement of the cracks.

18 Secondly, an additional examination and analysis
19 were performed to assess the deeper cracks by, one,
20 non-destructive inspection of the surface and the depth, and
21 the second, a destructive sectioning of portions of the old
22 103 block.

23 Thirdly, we learned for the first time at the end
24 of the week before last that the data reduction used by TDI
25 in connection with its strain gauge data that is referred to

WRBeb 1 in our testimony was not accurate, and the basic data that
2 is referred to in that strain gauge data could not be
3 verified.

4 So then we proceeded further with a piece of the
5 old 103 block top with the deepest stud-to-stud crack and
6 cut that up, and that showed, rather than being .5 inches
7 deep, it was only 3 inches deep.

8 JUDGE BRENNER: Excuse me. A lot of this is in
9 your testimony. What I'm not clear on is what was done
10 several weeks ago as opposed to what you first learned about
11 late last week?

12 MR. FARLEY: I would say essentially,
13 Judge Brenner, it was the error in the data reduction of the
14 TDI strain gauge data and secondly, it was the completion of
15 the destructive examination of a portion of the old 103
16 block.

17 JUDGE BRENNER: September 6th is when LILCO first
18 knew it would have to supplement its testimony on that
19 blocks. Is that what you're telling me?

20 MR. FARLEY: I'm sorry, your Honor, I didn't hear
21 you.

22 JUDGE BRENNER: Were you telling me that
23 September 6th is the earliest date at which LILCO it would
24 have new information causing a need to supplement its
25 testimony on the cylinder blocks?

WRBeb

1 MR. FARLEY: We did not know that we would have
2 it on that day. We knew that we had to proceed with these
3 further investigations.

4 JUDGE BRENNER: You did not inform the Board of
5 that.

6 MR. FARLEY: No, sir, because we didn't have the
7 results.

8 JUDGE BRENNER: We were engaged in complex
9 matters with regard to the schedule of the proceeding at
10 least prior to that date, and issued a ruling in connection
11 with the Staff's motion to delay the beginning of the
12 proceeding. The hearing, if I'm correct in my memory -- and
13 it fades with time very rapidly in these hearings -- started
14 on September 10th, so September 6th was a rather important
15 date with respect to -- not as a particular date but
16 relative to the start of the hearing and relative to the
17 motions before us before the Staff regarding schedule.

18 It was an important timeframe with respect to
19 scheduling, and I would submit to you that LILCO was less
20 than forthright in the matter of scheduling at least by
21 remaining silent with respect to this matter during that
22 period.

23 MR. FARLEY: I won't argue with the Board.

24 JUDGE BRENNER: You can argue with us. I put it
25 out for you to respond.

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(Laughter.)

MR. FARLEY: On September 6th when we were talking about scheduling, we scheduled -- we told the Board that we wanted to schedule the block testimony last. And one of the reasons we wanted to do that was because we did not know what these further investigations were going to reveal.

JUDGE BRENNER: Yes, but also during the July and August timeframe, LILCO was ready for hearing the day before we were talking about the schedule in each instance, to exaggerate the matter slightly, but not much. And even as late as the September, the early September timeframe, and I frankly don't remember the date we ruled on the Staff's motion but it was probably the last week of August or in that timeframe, LILCO was saying it was ready for hearing.

That's different than saying we are ready on three of the four issues and we need some accommodation on the fourth issue.

MR. FARLEY: Judge, we were ready. Nobody-- From the very beginning nobody has known that there were any circumferential crackings on these blocks until old 103 was cut up last week.

Now everybody knew about the stud-to-stud crack, including the County and the Staff. We thought it was five inches. When we cut up the old block we find out it is

WRBeb 1 three inches.

2 On the cam gallery cracking, I have already
3 related that we were relying on inspection reports in
4 connection with the testimony and in connection with our
5 representation that we were ready on the block. We find out
6 that the inspection reports were not available; the
7 photographs that are available are insufficient, and so that
8 necessitates the further investigation.

9 JUDGE BRENNER: I'm not criticizing the further
10 investigation. I'm criticizing the lack of notice that
11 these matters were on-going at that time, and the notice to
12 us that you did not have results yet, and as a result, we
13 should hold off on scheduling the block testimony.

14 From time to time even after this hearing started
15 we have had some complex scheduling matters that had to come
16 before us because the parties could not work it out, and
17 this certainly would have been a factor in that rather
18 complex consideration.

19 Let me leave it at that.

20 MR. FARLEY: Your Honor, obviously the County and
21 LILCO have a difference of opinion but I respectfully submit
22 that the three areas on which we want to submit supplemental
23 testimony are not matters of substance. No opinions or
24 conclusions have been changed, and we should be permitted to
25 proceed with the block testimony.

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1 JUDGE BRENNER: We're going to let the
2 supplemental testimony in. That's our starting point. The
3 problem is what adjustments need to be made in the schedule
4 as a result of that, if any.

5 Staff, let me get your position on the matter.

6 MR. GODDARD: It may be surplusage for the Staff
7 to state that it clearly feels this information is new and
8 significant in light of the Board's decision to admit this.
9 The Staff feels that it is of such significance that further
10 discovery, as requested by Suffolk County in their motion,
11 the need for supplemental testimony, and the need to review
12 that supplemental testimony will be required. Again, in the
13 Staff's view, in light of the Board's comment, the only
14 question apparent to us is how much time should be devoted
15 to these matters and the scheduling of that timeframe.

16 JUDGE BRENNER: Do you have any suggestions along
17 those lines?

18 MR. GODDARD: No. I think that is more
19 appropriately a point to be raised by Suffolk County. The
20 staff would take a position based upon Suffolk County's
21 request for additional time. I will acknowledge that the
22 NRC Staff has been informed of certain of the destructive
23 and nondestructive examination results prior to this time.
24 I don't know -- I don't believe that's the case for Suffolk
25 County.

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1 JUDGE BRENNER: Well, the County has made a
2 suggestion, although a little vague as to its particular
3 timeframe. They want to stop the hearing cold after your
4 witness completes his testimony on crankshafts -- your
5 witnesses. What is the Staff's view in that regard?

6 MR. GODDARD: The Staff would definitely prefer
7 to complete the crankshaft testimony because of the pending
8 nonavailability of Dr. Sarsten.

9 JUDGE BRENNER: The County's willing to do that
10 but they want to stop the hearing after that.

11 MR. GODDARD: The Staff would support a
12 suspension of the hearing insofar as it relates to blocks.
13 I have not had an opportunity to discuss with the NRC Staff
14 and their consultants whether or not we should proceed
15 forward on piscons. And in the event the issue of cylinder
16 heads is not settled, whether we should proceed on that
17 issue as well prior to any break in the hearings for the
18 purpose of discovery or preparation of supplemental
19 testimony on cylinder blocks.

20 JUDGE BRENNER: When can the Staff go ahead on
21 pistons?

22 MR. GODDARD: I would prefer to discuss that with
23 my clients during the noon break and report back to the
24 Board at the start of this afternoon's session, if that
25 would be permissible?

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JUDGE BRENNER: Could you go ahead this week on pistons as a possibility? I'll give you a chance for that discussion but I want to know what the parameters might be now.

MR. GODDARD: Dr. Laity informs me that there is a possibility we could proceed on pistons as well as crankshafts.

JUDGE BRENNER: All right.

We don't want to stop the hearing before that scheduled break the week of October 8 and we don't intend to stop the hearing. So given that as your starting point, Mr. Dynner, we would want to go ahead with the County's testimony on crankshafts first and then pistons, perhaps after the Staff's testimony on pistons, depending on what assist to their witness problems this adjustment in the schedule might give them.

If you have a strong need to go ahead with pistons before crankshafts, we'll consider it, but it would have to be strong.

When could we go ahead with the County's witnesses on those subjects. I have observed many of the County's witnesses present throughout this hearing and I will note that for the record.

MR. DYNNER: Well, I just have to ask the Board's indulgence to try to check with that and report back to you

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1 at the noon break.

2 JUDGE BRENNER: All right. That's the bad news
3 for you based on your motion, not all of which we agreed
4 with with regard to that matter. That is your asserted need
5 for further time to prepare your witnesses for cross
6 examination after all this time it does not weigh heavily on
7 our mind.

8 We do consider the fact that many of your
9 witnesses overlap to be a factor, but not a controlling one.
10 Because you have many witnesses and many counsel, and you
11 can have lead witnesses and lead counsel taking care of
12 discovery on the blocks, while other lead witnesses and lead
13 counsel are here.

14 You also have a period of time, namely the one
15 week already scheduled, when you will not be in hearing.
16 And you can use that to prepare additional testimony.

17 If you think that would not be sufficient, you
18 can tell me why now.

19 MR. DYNNER: The County's testimony on both the
20 crankshafts and the pistons involves, as you know,
21 Dr. Anderson as one of the key witnesses.

22 From what I have seen on the LILCO supplementary
23 testimony, much of it, if not most of it, will deal with
24 metalurgical matters that would necessitate, in particular,
25 Dr. Anderson's involvement. I anticipate, although I am not

WRBpp

1 making this request at this point. But I anticipate that it
2 may well be that one of the things Dr. Anderson wants to do
3 is ask for a physical inspection of the blocks and of the
4 103 block that was sectioned.

5 I learned this morning, for the first time, and
6 I'm very disturbed about the fact that, apparently, there
7 were also meetings held late last week on Thursday and/or
8 Friday between the Staff and LILCO, in which inspections of
9 the blocks were carried out and various discussions held.
10 And I say I'm disturbed because it's been the past practice,
11 as you know, that whenever discussions of any seriousness or
12 magnitude involving this litigation were held, such as TDI
13 owner's group, they were held open and transcripts were
14 taken of those meetings.

15 JUDGE BRENNER: If what occurred is, as you
16 stated, that it would be inconsistent with past practice,
17 what you have, I think, a right to expect would continue to
18 be the case unless and until informed otherwise by the Staff
19 and/or LILCO.

20 MR. DYNNER: Yes, sir.

21 To get back for a moment to my reaction to the
22 scheduling, I would anticipate that, with cooperation from
23 LILCO in furnishing us discovery, and with the possibility
24 of a physical inspection in the offing that, giving us the
25 week of the 8th only, might not be enough. And that it may

WRBpp

1 well be that we will need the following week. One week, in
2 other words, to do a physical inspection when Dr. Anderson
3 would presumably be free to do that. And then the following
4 week to evaluate his findings and prepare our supplemental
5 testimony.

6 So that is just my very quick, gut reaction to
7 what you've said on the blocks.

8 JUDGE BRENNER: All right. We will consider
9 that.

10 Have you considered the fact that starting on the
11 27th of this week, Dr. Anderson can begin doing whatever it
12 is he needs to do and he will have from the 27th until
13 Sunday, which will be the 30th, to work things out. Then if
14 he has to be in hearing here the following week, and based
15 on our desires he would be, he would also then have the
16 afternoon of the 4th through the 14th during that break to
17 do his work.

18 In addition, I could understand why you would
19 need him, based on what you've stated, to both assist in
20 discovery and possible preparation of supplemental testimony
21 on the blocks. And also to be here testifying on the other
22 subjects.

23 However, assisting in discovery is not the same
24 as having to be present for discovery. You have other
25 witnesses who you are relying on and with direction from

WRBpp

1 Dr. Anderson, presumably, they can do a lot in terms of
2 assisting either at depositions or formulating discovery
3 requests, and so on.

4 Incidentally, the only type of discovery we have
5 in mind would be documentary discovery, depositions, and
6 perhaps, inspection. In other words, no interrogatories
7 other than, perhaps, some simple requests for identification
8 of when were certain things done.

9 MR. DYNNER: Yes, sir.

10 I think I have taken those time elements into
11 account. I think that as we said in our response to LILCO's
12 motion, it is a fact that our witnesses have not been --
13 have not had the benefit of preparation of their own cross
14 examination which is normal in these cases. Insofar as to
15 this point, some of them, as you know, including
16 Dr. Anderson, has been absent most of the time. And others
17 have really been focusing their attention to dealing with
18 the cross examination that is going forward.

19 And we will have to use, I believe, every free
20 second in preparation of our witnesses for their cross
21 examination. It is not simply a matter of getting up there,
22 as you well know, and answering questions without having
23 carefully reviewed what they've said and then prepared.

24 And so, I'm not trying to be argumentative, but I
25 would think that, given the Board's unwillingness to suspend

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1 the hearing for any period of time, then we're going to have
2 to really break our backs to get our witnesses prepared for
3 cross examination. And that would include over the holiday
4 period this week.

5 JUDGE BRENNER: Does the Staff have a position
6 with respect to its need for time on the cylinder blocks,
7 and also whether the time I outlined would suit that need?
8 Your previous comments seem to support the County, but I
9 need to hear more particularly as to what the Staff thinks
10 it needs, with respect to cylinder blocks.

11 MR. GODDARD: The Staff's need for time with
12 regard to the cylinder block would be involved primarily
13 with the review of the LILCO supplemental testimony as
14 opposed to examination on the samples taken from the old 103
15 block.

16 JUDGE BRENNER: Don't you think you need to see
17 those?

18 MR. GODDARD: We already have, Judge Breener.
19 Dr. Bush has examined those specimens. To the extent that
20 additional examination would be required, the Staff is of
21 the opinion it would take a minimum of time.

22 Our primary time concerns would be with review
23 of the testimony, the preparation of our own supplemental
24 testimony and, finally, a review of -- and response if
25 required -- to supplemental testimony prepared by Suffolk

WRBpp 1 County in this proceeding.

2 JUDGE BRENNER: We're not going to have staggered
3 testimony filing timeframes now.

4 MR. GODDARD: Staff appreciates that.

5 JUDGE BRENNER: That was an unusual accomodation
6 last time which the staff turned around out of context after
7 that.

8 Putting that aside, if we were to set a date for
9 the receipt of supplemental testimony, if any, by the Staff
10 on cylinder block for near the end of the week of the 8th --
11 either the 11th the 12th, in that timeframe -- what would
12 the Staff think of that proposal?

13 MR. GODDARD: The Staff would be ready to file
14 supplemental testimony by that time.

15 Did you also ask, Judge Brenner, for our position
16 with regard to the County's request for, I believe, a
17 two-week suspension?

18 MR. GODDARD: No, I did not. But you're free to
19 offer it.

20 MR. GODDARD: The Staff would support it.

21 JUDGE BRENNER: Why?

22 MR. GODDARD: By virtue of our evaluation of the
23 significance of the testimony received from LILCO with
24 regard to the magnitude of exchanges in prior testimony as
25 opposed to any forewarning of the Staff's evaluation of the

WRBpp

1 significance for the operability of the blocks overall. The
2 Staff feels that a two-week period would be appropriate.
3 This has been discussed with the ELD management. The Staff
4 would not oppose the County's request for two weeks for
5 discovery and preparation of testimony.

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1 JUDGE BRENNER: I have not discussed the Board's
2 view on the significance of the testimony or lack thereof so
3 far, I merely said our starting point would be that we would
4 admit it. The main stimulus for that is all the parties
5 seem to agree on that point, so it did not call for much of
6 an analysis by us. It's new and if it required a ruling by
7 us we would have ruled, even over opposition, that it would
8 have to come in in order to give an accurate, factual
9 picture of the present state of affairs. That's different
10 than saying it's highly significant.

11 And in fact, if you want my personal opinion as
12 one Judge, while I think some of it might become significant
13 and that's why I agree that discovery is appropriate, based
14 on what we've seen so far the County's answer in my mind
15 exaggerates the significance of it. The cam gallery --
16 rather the stud-to-stud cracks go to three inches instead of
17 five and a half inches. The camshaft gallery cracks, in the
18 view of LILCO at least, are less of a problem than they were
19 before. On the circumferential cracks, I offer no opinion.
20 I don't know enough at this time --

21 MR. GODDARD: Excuse me, Judge Brenner, if I
22 might respond briefly.

23 JUDGE BRENNER: So why are you saying that --

24 MR. GODDARD: Perhaps you misinterpreted my
25 comments or perhaps I misspoke them. What I indicated was

WRBagb 1 they appear to the Staff to be significant in view of the
2 changes to previous testimony. We are not offering any
3 opinion at this time as to the overall significance. That
4 was the intent of my comment.

5 JUDGE BRENNER: Well your comment, however, was
6 in the context of the length of time needed for preparation,
7 including both discovery and preparation of possible
8 supplemental testimony. And it was in that context that you
9 used the description "significant." And when somebody uses
10 that context then we are in that context that usually means
11 there's a lot going on here, that a lot of time is needed.
12 And I don't see it, based on what we have in the motion
13 other than the circumferential cracks, about which I offer
14 no opinion.

15 The Staff itself does not need a two-week hiatus,
16 am I correct?

17 MR. GODDARD: That is correct.

18 MR. DYNNER: Judge Brenner, since we're
19 discussing schedule I raise at this time the question as to
20 whether anything else is going on -- on-going in terms of
21 the matters at hand that could have any kind of real impact
22 on the case or on the scheduling. I am aware that
23 discussions are on-going between LILCO and the Staff
24 considering the testing of one or more of the engines. If
25 there is agreement on that that could, of course -- again

WRBagb 1 we're back to saying Okay -- what kind of testing is there
2 is not the issue, but the results of that testing could be
3 very significant to this hearing. And I don't know anything
4 about whether there is going to be agreement or not, I have
5 not been involved directly in those discussions. But it
6 seems to me as long as we're discussing this whole thing we
7 should get everything out on the table.

8 JUDGE BRENNER: Well I suppose it's in the nature
9 of the adversary process that whenever the Board says one
10 thing it seems to get exaggerated from the point of view of
11 a party who believes it might support them on something
12 else.

13 I gave you some support and did it purposefully
14 in terms of the fact that the County may have been excluded
15 -- and I emphasize the "may," I don't know what went on and
16 I'm not going to undertake a collateral inquiry -- but may
17 have been excluded from some significant results of
18 destructive examination of the old 103 block and some
19 non-destructive examination as well. I tend to put some
20 significance on that based on our expectations given the
21 past performance in this case that when the Staff is going
22 in to perform some major observation, whether it be called
23 an inspection or not, that the County was usually involved
24 -- not in performing the inspection itself necessarily but
25 in knowing what was going on and being able to observe and

WRBagb 1 then being able to follow up if it wished to later. My
2 comment was in that context.

3 Now it sounds like you're talking about some
4 possible on-going discussions between the Staff and LILCO
5 with respect to inspections or surveillances that may make
6 the Staff's equivocation less equivocal from LILCO's point
7 of view I suppose.

8 That type of discussion is perfectly permissible
9 and it's expected to go on, just as discussion between the
10 County and any other party would not be surprising, even of
11 a bi-lateral nature.

12 Now if it gets to the point of something
13 significant that might affect either the substance or the
14 schedule of this proceeding, we would expect to hear about
15 it promptly.

16 I have already given my opinion that in my view
17 we did not promptly hear about the possible effect on the
18 schedule of LILCO's on-going work with respect to those
19 cylinder blocks on a timely basis and I assume that they
20 will not err again in the near time frame in that regard.

21 So they have all these remarks to consider. But
22 the mere discussions among parties is not prohibited. I
23 don't expect them to come to me every hour and say Oh by the
24 way two people on our staff talked about this subject and
25 maybe we're going to make some headway on it; that's a

WRBagb 1 wholly different matter.

2 You're nodding "yes," maybe I've made my point.

3 MR. DYNNER: Yes, I was nodding. I did not mean
4 to -- my remarks should not be interpreted as a criticism of
5 the Staff having some meetings of that nature with LILCO
6 without our being present. I was only raising the issue,
7 which I think you have responded to, about the possibility
8 of other significant matters being -- maybe having an
9 impact.

10 But enough said. I was nodding in response to
11 that aspect of your remarks.

12 JUDGE BRENNER: It was my belief -- getting back
13 to schedule -- that we would complete the Staff's testimony
14 on crankshafts today. We have taken some time away from
15 that project and my estimate may prove to be wrong, but that
16 was my expectation.

17 Does anybody know anything that would disabuse me
18 of that notion?

19 The County?

20 MR. DYNNER: No, sir.

21 JUDGE BRENNER: LILCO?

22 MR. ELLIS: Judge Brenner, I am under the
23 impression that Dr. Sarsten will be the witness and I have
24 submitted a cross-examination plan relating strictly to
25 Dr. Sarsten, and I would certainly hope we could finish

WRBagb 1 today.

2 JUDGE BRENNER: I thought he was going to be up
3 there with Witness Henricksen also.

4 MR. ELLIS: I was not aware of that. I thought
5 it was just Dr. Sarsten.

6 JUDGE BRENNER: They are co-authors of almost all
7 the answers.

8 Staff, can you enlighten us?

9 MR. GODDARD: Dr. Sarsten and Mr. Henricksen are
10 co-authors of much of the testimony, excluding that dealing
11 with analysis of torsional vibrations and --

12 JUDGE BRENNER: They'll be up there together?

13 MR. GODDARD: They will be up there together,
14 yes.

15 The Staff would also empanel with them Dr. Bush,
16 who has already testified as to two questions in the
17 crankshaft area; solely for the basis of expediting matters
18 if it turns out that some of the questioning crosses back
19 into the line of the two answers which he has already spoken
20 to.

21 JUDGE BRENNER: I would not be in favor of that.
22 We have finished the opportunity for cross-examination on
23 that. He was expressly noted to be up there for that.

24 MR. GODDARD: Very good.

25 JUDGE BRENNER: I have enough trouble making

WRBagb 1 progress on new ground.

2 MR. GODDARD: All right, Judge Brenner.

3 MR. DYNNER: Can I add one other element which
4 may impact your ruling on the scheduling matters?

5 JUDGE BRENNER: Surely.

6 MR. DYNNER: Professor Sarsten, it is my
7 understanding this will be his last week -- next week will
8 be his last week.

9 MR. GODDARD: Next week.

10 MR. DYNNER: I would like to request that the
11 Board permit us to proceed next out of turn with the
12 cross-examination of the Staff witnesses on pistons. That
13 would give us the opportunity, first of all, to make sure
14 that we have Professor Sarsten's cross-examination
15 completed. Secondly, it would give us -- since this is a
16 short week, the holiday period this week -- to do some
17 witness preparation so that our witnesses will be better
18 prepared to start next week.

19 So I would just like to throw that out as a
20 request for consideration.

21 JUDGE BRENNER: Well I had precisely that in mind
22 when earlier this morning I asked the Staff if they could go
23 ahead with their testimony on pistons. I'm not going to
24 order them to do it if they say they can't, but if they say
25 yes, we will do that precisely for the reasons you indicated

WRBagb 1 so that you will not have to bring all your witnesses in
2 here for a short week. That's the main reason. And the
3 fact that we will give you some other time for further
4 witness preparation is a bonus.

5 MR. GODDARD: Judge Brenner, the Staff will be
6 amenable to proceeding on that basis and having the Staff
7 panel on pistons cross-examined immediately after
8 Dr. Sarsten and Mr. Henriksen are cross-examined on the
9 crankshafts.

10 JUDGE BRENNER: All right. We'll do that. That
11 will be our testimony for this week. If we have only half a
12 day left on Wednesday, we will not require the County
13 witnesses to be here to begin their testimony for that half
14 a day unless they are here anyway.

15 Are they here anyway?

16 MR. DYNNER: No, sir. Professor Anderson is not
17 here and others -- as you can see Professors Christensen and
18 Mr. Ely and Mr. Hubbard are here but those are the three who
19 are here. The others are not.

20 JUDGE BRENNER: All right.

21 Next week, Monday, we would start with the
22 County's testimony on crankshafts. Unless there is a strong
23 reason to do business first, we would prefer taking up
24 crankshafts first.

25 Then we will go to the County's testimony on

WRBagb 1 pistons whether it occurs before or after the break and our
2 schedule depends on when it would occur.

3 Then after the break -- we will decide how long
4 the break shall be -- we will start with LILCO's testimony
5 on cylinder blocks either right away or after completion of
6 the County's testimony on pistons, if that has not yet been
7 completed. And then we would go, in turn, to the County and
8 Staff on cylinder blocks.

9 That's all we have in terms of preliminary
10 matters.

11 Does anybody have anything else?

12 We will let you know about the length of the
13 break as soon as we have decided.

14 MR. ELLIS: Judge Brenner, the cross-examination
15 plan which we delivered to the Board this morning is just
16 for Dr. Sarsten.

17 JUDGE BRENNER: I believe, and my memory may be
18 incorrect, that Mr. Henriksen is not the sole author of any
19 answer so a plan geared to Professor Sarsten will
20 necessarily cover all the pertinent answers anyway.

21 MR. ELLIS: I think all of those areas are areas
22 that are not Professor Henriksen's, they are all Professor
23 Sarsten's.

24 JUDGE BRENNER: Unless you have an objection, we
25 will let them act as a panel and they can both respond.

WRBagb

1 LILCO is going to cross-examine first and then the County.

2 MR. ELLIS: That's right, Judge Brenner.

3 JUDGE BRENNER: Okay. We can swear the witnesses
4 in.

5 MR. GODDARD: The Staff calls Professor Arthur
6 Sarsten and Mr. Adam Henriksen to the stand.

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1 JUDGE BRENNER: Why don't you introduce them,
2 then we can swear them in?

3 MR. GODDARD: The Staff calls Mr. Arthur Sarsten
4 and Mr. Adam Henriksen to the stand. Professor Sarsten is
5 sitting on the right of the panel.

6 JUDGE BRENNER: All right.

7 Whereupon,

8 ARTHUR SARSTEN

9 and

10 ADAM HENRIKSEN

11 were called as witnesses and, having been first duly sworn,
12 were examined and testified as follows:

13 DIRECT EXAMINATION

14 BY MR. GODDARD:

15 Q Professor Sarsten and Mr. Henriksen, I ask you if
16 you have before you a copy of the NRC Staff testimony, the
17 relevant pages being page 9 through page 21 inclusive, and
18 Exhibits 1 through 4 thereof?

19 A (Witness Sarsten) We do.

20 Q Insofar as each of you are identified therein as
21 the sponsors of answers to individual questions--

22 JUDGE BRENNER: Mr. Goddard, I think you have the
23 pages wrong. It would be 9 through the middle of 18.

24 MR. GODDARD: You are correct, 9 through the
25 middle of page 18, and Exhibits 1 through 4.

WRBeb

1 BY MR. GODDARD:

2 Q I ask you, to the extent that you are identified
3 as the witness sponsoring such answers, whether they are
4 true and correct to the best of your knowledge?

5 A (Witness Sarsten) They are.

6 A (Witness Henriksen) They are.

7 Q Although not prepared by you, to some degree are
8 the Exhibits 1 through 4 true and correct to the best of
9 your knowledge, to the extent that you have relied upon them
10 in your testimony?

11 A (Witness Sarsten) They are.

12 A (Witness Henriksen) They are.

13 Q Are there any corrections to that testimony that
14 you would like to make at this time, prior to it being
15 introduced into evidence?

16 A (Witness Sarsten) Exhibit 2 shows a preliminary
17 plot of the torsional vibratory stresses in the TDI
18 eight-cylinder crankshaft. This is with negligible damping.

19 I have later had time to repeat these
20 calculations using larger values of damping and this brings
21 some of the resonant peaks down slightly, but it does not in
22 any way alter my conclusions.

23 Q Thank you, Dr. Sarsten.

24 Are there any further corrections from either of
25 you?

WRBeb

1 A No.

2 A (Witness Henriksen) No.

3 Q Fine.

4 MR. GODDARD: As corrected, the NRC Staff moves
5 that the testimony be bound into the record as though read,
6 accompanied by Exhibits 1 through 4.

7 JUDGE BRENNER: The testimony of course was
8 previously bound in on September 20th and appears in that
9 transcript.

10 We will now admit the portion identified as being
11 sponsored by these witnesses on the subject of crankshafts
12 into evidence.

13 We will also admit into evidence Staff Diesel
14 Exhibits 1 through 4, and they may be identified for the
15 index by the same titles used on the Staff's Diesel Exhibit
16 List.

17 I guess they are not very thick. We can bind
18 them into the transcript, in addition, for convenience and
19 we will do at this point. But there will also be three
20 copies for the official exhibit record.

21 (Whereupon, the documents
22 referred to were marked as
23 Staff Diesel Exhibit 1 - 4
24 for identification.)

25 (The documents follow:)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)
LONG ISLAND LIGHTING COMPANY) Docket No. 50-322-0L
(Shoreham Nuclear Power Station,)
Unit 1))

EXHIBITS
for

JOINT TESTIMONY
of

CARL H. BERLINGER, SPENCER H. BUSH,
ADAM J. HENRIKSEN, WALTER W. LAITY, AND PROFESSOR ARTHUR SARSTEN

on
CONTENTIONS CONCERNING TDI EMERGENCY DIESEL GENERATORS
at the
SHOREHAM NUCLEAR POWER STATION

VOLUME 2

EXHIBIT 1

LILCO CRANKSHAFTS

A ABS Requirements: (Par 34.17.1 dia. of pins & journals)

$$d = c \sqrt[3]{\frac{M + (M^2 + 4T^2)^{1/2}}{f}}$$

where:

d = crankpin diameter, in

c = 1.0 (for more than 6-cyl. engines)

D = cyl. bore, 17 in

p = max. firing pressure

a) 1700 psi @ 4890 bhp

b) 1900 psi @ 5380 bhp

L = span between bearings (inner edge to inner edge of main bearings), 17.93 in

H = horsepower at rated speed

a) 4890 bhp (100%)

b) 5380 bhp (110%)

R = rated speed, 450 rpm

f = grade 4 forging, 2,310

and: $M = 0.131 PD^2L$

$$T = 63,000 H/R$$

Required crankpin diameter :-

a) 100% load or 4890 bhp: $d = 10.84''$

b) 110% load or 5380 bhp: $d = 11.103''$

The 12" crankshaft is acceptable both at 100% & 110% load, as far as crankpin diameter is concerned.

B Paragraph 34.17.4 Solid Crankshaft Webs

$$wt^2 \geq 0.35 d^3$$

where w = effective width of web, 21"

* t = thickness of web 4.965"

* Note: Proportions are such that pins & journals overlap. Furthermore, the pin fillet is undercut with a re-entry into the web. Interpreting the correct method to determine t for such a case, Woytowich of ABS replies to a question concerning this on p 129, line 21 to p 130, line 6 of their testimony:

" I believe that our normal practice would be to measure that dimension from the boundary of the actual crankshaft material, at one fillet to that

at its opposite fillet, rather than constructing the arbitrary lines of a face of the web and going between them.

Essentially it makes sense to count only the metal that is actually there "

Employing this interpretation, a figure of 4.965" has been determined (See full scale drawing)

$$\therefore wt^2 \geq .35 d^3$$

a) 100% load; $d \geq 10.84$ in

$$wt^2 \geq .35 \cdot 10.84^3$$

$$21 \times 4.965^2 \geq .35 \times 10.84^3$$

$$518 \geq 445.81 \quad \underline{\text{Satisfied at diameter required for 100\% load}}$$

b) 110% load; $d \geq 11.03$ in

$$wt^2 \geq .35 \cdot 11.03^3$$

$$21 \times 4.965^2 \geq .35 \cdot 11.03^3$$

$$518 \geq 479.02 \quad \underline{\text{Satisfied at diameter required for 110\% load}}$$

At the limit $wt^2 = .35 d^3 \Rightarrow d = 11.39$ "

The crankshaft will meet ABS requirements up to a

$d = 11.39$ ", given by formula in section 34.17.1.

i.e. for power and firing pressures in excess of 110% load.

Arthur Sauter

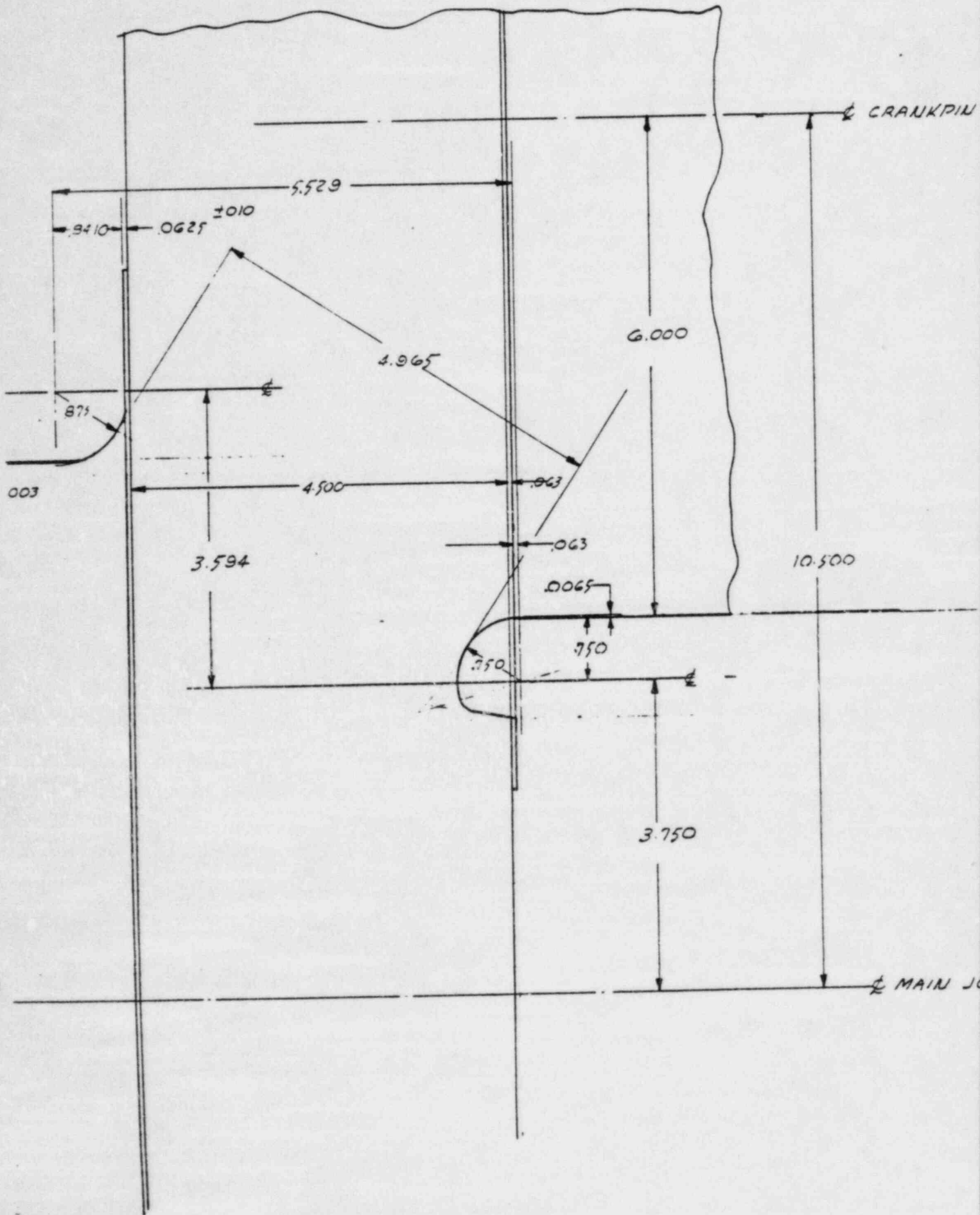


EXHIBIT 2

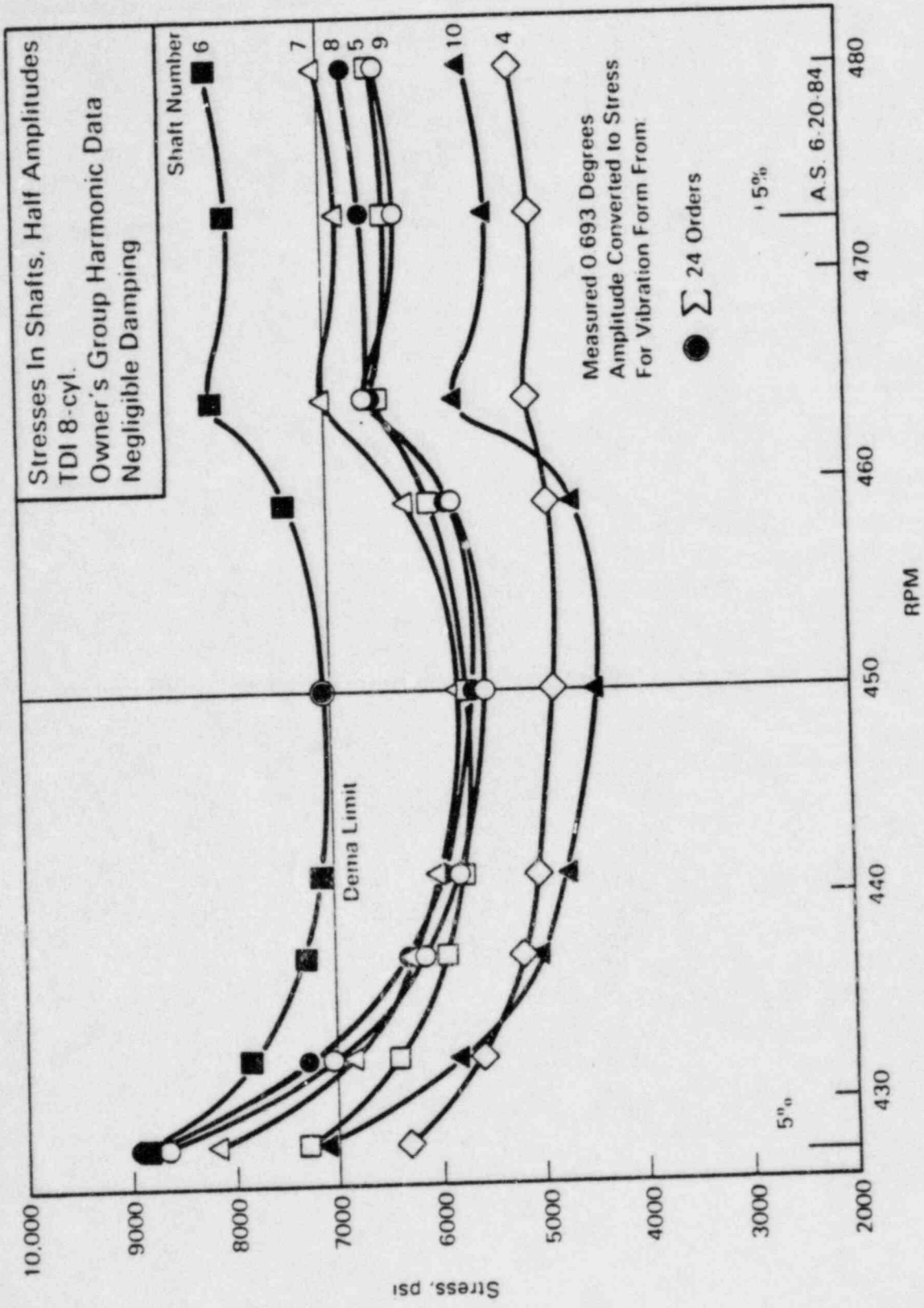


EXHIBIT 3

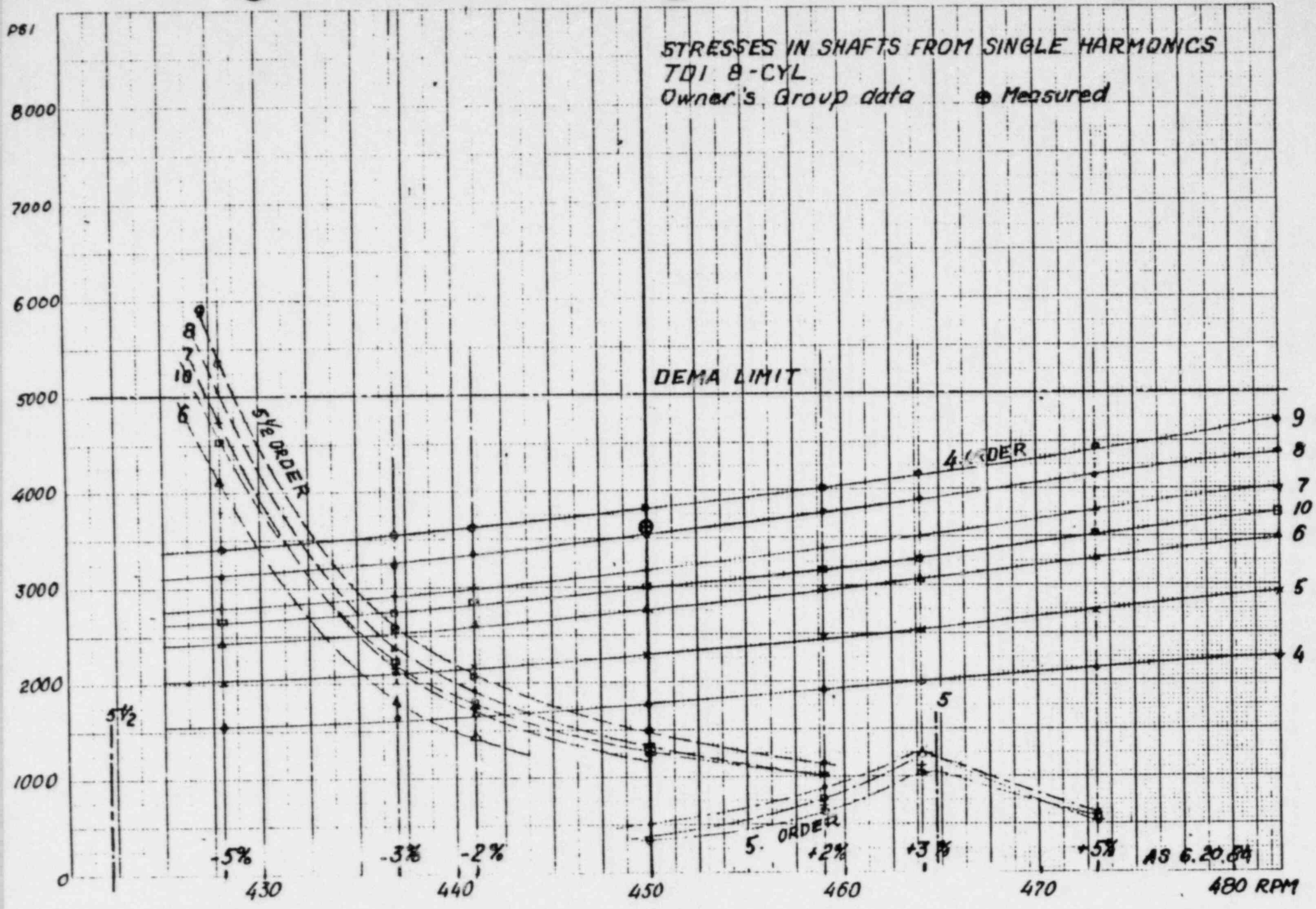


EXHIBIT 4

304

American Bureau of Shipping

Sixty-five Broadway

New York, N.Y. 10016

3 May 1984

Handwritten: RTW:ml

File No.: T8-3

Transamerica Delaval DSR-48 Diesel Engine/Generator
for Long Island Lighting Company Shoreham Plant
Report on Crankshaft Torsional Stresses.

Transamerica Delaval Inc.
Engine & Compressor Division
550 85th Avenue
P. O. Box 2161
Oakland, CA 94621

Attention: Mr. Roland T. M. Yang
Manager Applied Mechanics.

Gentlemen:

We have your letter of 3 April 1984 submitting copies of the above subject report for our review, and with regard thereto have to advise as follows:

We note from the submitted report that the torsional vibration stress in the crankshaft for the first mode $5\frac{1}{2}$ order critical speed (422 RPM) was expected to approach or exceed that permitted by the Rules for the submitted crankshaft material.

We further note from the submitted report that tests were conducted to determine the actual stresses in the crankshaft, and that these tests indicated a substantial margin of safety against fatigue failure due to torsional vibration.

Based on the submitted test data, and on submitted service experience with similar engines having similar torsional critical speed arrangements, we advise that we would have no objection to the submitted torsional critical speed arrangement for use on diesel generator sets on an ocean going vessel, insofar as our classification requirements for marine service are concerned.

Three (3) copies of the subject report, stamped to indicate our review, are being returned.

Very truly yours,

AMERICAN BUREAU OF SHIPPING

W. M. HANNAN
Vice President

by: *Robert A. Giuffre*
Robert A. Giuffre
Principal Surveyor - Machinery

G. E. T. A. R. F. M. H. L.
S. O. R. T. Y. C. R. C.

RECEIVED

TICKLER MAY 07 1984 UPDATE

ENGINEERING

CIRC. FORWARD COPY

TO FILE: _____; SEE ME

cc: LILCO. (E. Montgomery)
Accounting Dept. w/enclosure
Legal Dept. (M. Adams)
Subject File 460

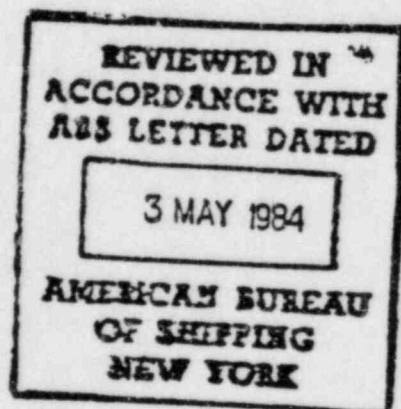
REPORT
ON
CRANKSHAFT TORSIONAL STRESSES

TRANSAMERICA DELAVAL MODEL DSR-48

Serial No. 74010/12

for

LONG ISLAND LIGHTING COMPANY



Roland Yang.
April 4, 1984
Transamerica Delaval
Oakland, CA.

TABLE OF CONTENTS

	Introduction	Pages i & ii
Section One	Torsional Analysis	Pages 1 to 17
Section Two	Torsiograph Tests	" 18 to 21
Section Three	Strain Gauge Tests (FaAA)	" to
Section Four	Operating Hours Logged	" to

ALLOWABLE TORSIONAL STRESS CALCULATION.

Based on Para. 34.47 of 1984 ABS Rules.

$$S = \left(\frac{U + 23180}{18} \right) C_k C_d C_r$$

where U = Minimum Tensile Strength of Shaft Material 100000 PSI

C_k is .55 for propeller shafts and crankshafts

C_d is size factor, $.35 + 0.487 / \sqrt[5]{12} = .6463$

C_r is speed ratio factor, 1.38 for 90% to 105% rated RPM.

$$S = \left(\frac{100000 + 23180}{18} \right) (.55) (.6463) (1.38)$$

= 3357 PSI due to single order

Total Allowable Stress = 150% of 3357 = 5035 PSI

ALLOWABLE TORSIONAL STRESS CALCULATION.

Based on Table 34.3 of 1982 ABS Rules.

<u>Engine Speed</u>	$\frac{3}{4} \times 450 \text{ RPM}$	$\frac{8}{10} \times 450 \text{ RPM}$	$\frac{.95 \text{ to } 1.0}{450 \text{ RPM}} \times$	$\frac{1.05 \times}{450 \text{ RPM}}$
	= 135 RPM	= 360 RPM	427.5 to 450	472.5 RPM

Grade 2, 60000 psi 5689 psi 3556 psi 2134 psi 3556 psi

Grade 4, 100000 psi 8217 psi 5136 psi 3082 psi 5136 psi

$$\text{Stress limit multiplier} = \frac{2}{3} \left(\frac{100000 - 60000}{60000} \right) + 1 = 1.4444$$

for adjustment from 60000 psi
to 100000 psi material.

WRBeb

1 MR. GODDARD: Judge Brenner, for the convenience
2 of the parties when working with these transcripts, would
3 the Board object to binding in pages 9 through 18 again at
4 this point in the transcript?

5 JUDGE BRENNER: It doesn't seem necessary.

6 MR. GODDARD: It is not necessary but it might be
7 convenient for the parties.

8 JUDGE BRENNER: I would rather not.

9 MR. GODDARD: Thank you.

10 JUDGE BRENNER: I think it leads to too much
11 complication where you're citing pages following certain
12 transcripts.

13 MR. GODDARD: Thank you, Judge Brenner.

14 The panel is tendered for cross-examination.

15 JUDGE BRENNER: Mr. Ellis.

16 MR. ELLIS: Thank you, Judge Brenner.

17 CROSS-EXAMINATION

18 BY MR. ELLIS:

19 Q Professor Sarsten, I am going to direct a number
20 of questions to you to begin with.

21 Good morning.

22 A (Witness Sarsten) Good morning.

23 Q I would like to have your answers on these if I
24 may without consultation.

25 Professor Sarsten, with respect to the DEMA standard

WRBeb 1 for crankshaft torsional stresses that you've referred to in
2 your testimony, did you participate in the development or
3 formulation of that standard in any way?

4 A I did not.

5 Q Do you know when the DEMA standard was developed?

6 A I only know the latest edition, 1972. I believe
7 it goes back much further than that to the late '50s at
8 least.

9 Q Do you know when the 5,000 and 7,000 psi limits
10 were inserted into the DEMA standard for torsional stresses?

11 A I do not know that, no.

12 Q Given that you indicated that you were aware that
13 the last revision was in 1972, Professor Sarten, did you
14 participate prior to that time in any way in the development
15 of the methodology DEMA intended to be used in connection
16 with calculations relating to that standard for crankshaft
17 torsional stresses?

18 A There is nothing in the DEMA standards about the
19 methodology intended to be used.

20 Q My question though was did you participate in any
21 way in the development, prior to 1972, of any methodology
22 intended to be used by DEMA in connection with calculations
23 using its standard?

24 MR. GODDARD: Objection. I believe the question
25 has been asked and answered. It is subsumed by the first

WRBeb 1 question Dr. Ellis asked Dr. Sarsten.

2 JUDGE BRENNER: No, we will permit him to probe a
3 little more particularly for this fact.

4 The objection is overruled.

5 WITNESS SARSTEN: Could you come back with the
6 question? I'm not quite sure what you're referring to by
7 "methodology."

8 BY MR. ELLIS:

9 Q What do you understand me to mean by
10 "methodology"?

11 A (Witness Sarsten) By "methodology" I would
12 understand the mathematical calculation of the torsional
13 vibratory stresses or the programs used in this context.

14 Q All right.

15 Professor Sarsten, with that as the definition
16 for "methodology," did you, prior to 1972, participate in
17 the development of the methodology DEMA intended to be used
18 in connection with its calculations -- with calculations
19 relating to the DEMA standard for crankshaft torsional
20 stresses?

21 A I have no way of knowing which methodology DEMA
22 intended to be used.

23 I did, prior to 1972, of course participate in
24 the development of methodology for calculation of torsional
25 vibration. I assume that is what DEMA intended to be used

WRBeb 1 as a general available methodology for calculation of
2 vibrations.

3 Q But you do not know, as you just testified, what
4 DEMA intended to be used in connection with calculation of
5 its torsional stress standard?

6 A I don't know if anyone really knows what DEMA
7 intended. All we have there is their wording.

8 Q My question is do you know--

9 JUDGE BRENNER: Let him finish the answer. If
10 you are going to ask the proverbial one question too many,
11 he's entitled to give the answer to it.

12 MR. ELLIS: I appreciate the lesson,
13 Judge Brenner.

14 JUDGE BRENNER: Professor Sarsten, I don't think
15 you had completed your answer.

16 WITNESS SARSTEN: I think I completed my answer.

17 BY MR. ELLIS:

18 Q But you do not know what DEMA intended to be
19 used, do you?

20 A (Witness Sarsten) I know what I read out of
21 their standards. That's all anyone can do. No one can read
22 the mind of the members of the Board in 1972. All we have
23 is their written word and the standards.

24 Q Do you know what the DEMA Technical Committee is,
25 and what its role is in connection with the DEMA standard

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1 for torsional stresses in crankshafts?

2 A I have not served on that Technical Committee. I
3 would assume their role would be the same as any technical
4 committee, to review and revise the standards at given
5 intervals of time.

6 Q Well, do you have any knowledge of the role of
7 the Technical Committee with respect to the development of
8 the DEMA standard for crankshaft torsional stresses?

9 A As I have not served on the Committee I would not
10 know, no.

11 Q Do you know who the members of DEMA are?

12 A The manufacturers who are the members of the
13 Diesel Engine Manufacturers Association are listed on the
14 first pages. They are, among others,-- They were given in
15 the testimony previously. ALCO, where I worked once, was
16 one of the members then.

17 Q Is that the only one you can name?

18 A No, there are several members. American. I
19 believe Cooper-Bessemer probably is a member.

20 I would assume that Trans-America, now DeLaval,
21 would be a member.

22 Fairbanks Morse I would assume would still be, or
23 at least was a member when this was printed in 1972.

24 I don't know if there are any new or revised
25 printings of the DEMA standards.

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1 Q Well, when you say you "assume," is that based on
2 your memory or is that just based on your knowledge that
3 these are diesel engine manufacturers?

4 A That was my memory of the testimony presented
5 here last week. As I recall, there were about six member
6 firms listed.

7 Q So your testimony then is based on the testimony
8 of the LILCO panel last week?

9 A Yes, it is based on that.

10 I also read the members when I have read through the
11 DEMA standard practices, but that was longer ago. The
12 freshest recollection is from the panel here, yes.

13 Q And when you read through the DEMA standard in
14 connection -- that was in connection with preparation for
15 this case?

16 A Yes, it was.

17 Q Dr. Sarsten, you mentioned Cooper-Bessemer. Do
18 you know whether Cooper-Bessemer, in the design of their
19 crankshafts for their medium-speed diesel engines, used the
20 DEMA crankshaft standard for torsional stresses?

21 A No, I would not know that.

22 Q Do you know whether-- You mentioned ALCO, for
23 whom you worked. I believe you worked for ALCO for two
24 years. Is that correct?

25 A The time span was longer than that, but I worked

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1 full-time with ALCO only two years. I worked part time also
2 with them in summer vacations while I was at RPI, studying
3 for my doctorate.

4 Q Did ALCO use the DEMA standard in connection with
5 torsional stresses for their crankshafts, if you know?

6 A I would not know that. That was Porter's, the
7 torsional vibration expert's, domain. I would not know
8 that.

9 I do know, however, that they have worked with
10 some of these classifications societies when their engines
11 have been sold for shipboard use.

12 Q But you are not familiar with their use or lack
13 of use of the DEMA standard for crankshafts?

14 A No.

15 Q By "no" I take it you mean yes, I am correct in
16 my assertion?

17 A Yes, you are correct.

18 Q Thank you.

19 Professor Sarsten, you also mentioned TDI or
20 DeLaval. Do you know whether DeLaval uses the DEMA standard
21 in connection with the design of crankshafts?

22 A Well, in this specific case they evidently have.

23 Q But your knowledge then is limited to what you
24 have learned in connection with this case?

25 A It is in connection with this case and with the

WRBeb 1 other engines they have sold for nuclear standby service,
2 the 12-, the 16- and the 20-cylinder engines.

3 Q And your knowledge with respect to the 12-, 16-
4 and 24-cylinder engines, all of that knowledge was obtained
5 in connection with this case, was it not?

6 A Yes, that is true.

7 Q Let me mention some other names to you.

8 MR. ELLIS: It might be easier, Judge Brenner, I
9 have some excerpts from DEMA which I can hand out to the
10 Board and the parties now. I don't intend to introduce it
11 as an exhibit, but I think it would be convenient for the
12 witnesses and the parties.

13 JUDGE BRENNER: What do you want them to do?
14 Look at the names of the members of DEMA?

15 MR. ELLIS: Yes, sir. I can suggest them to him.

16 JUDGE BRENNER: This is going to be material for
17 some finding later as to whether he can read the rates
18 correctly?

19 MR. ELLIS: No, sir, not as to whether he can
20 read the names correctly. I just thought it would be
21 simpler, rather than my suggesting who the members might be,
22 to have that in front of him.

23 JUDGE BRENNER: You've got testimony through your
24 witness that has not been contradicted, to the best of my
25 knowledge. Do you know that?

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1 MR. ELLIS: That's correct. I don't know if it
2 is every member, though.

3 JUDGE BRENNER: I don't know if it is either. I
4 don't know if I care, though.

5 MR. ELLIS: Well, I care.

6 JUDGE BRENNER: All right. Go ahead. I will
7 look with interest for the finding that that is related to
8 later.

9 MR. ELLIS: Well, I know I have disappointed you
10 in the past but....

11 JUDGE BRENNER: I was kidding by that remark. If
12 as the case develops you don't feel compelled to include a
13 finding on it, I will understand that that's a result of
14 your evaluation of the entire case later.

15 We won't make it an exhibit for now. As
16 suggested, we will see what you do with it first.

17 MR. ELLIS: Thank you, Judge.

18 BY MR. ELLIS:

19 Q Professor Sarsten, I have handed you a xeroxed
20 copy of some excerpts from the Standard Practices for Low
21 and Medium Speed Stationary Diesel and Gas Engines by the
22 Diesel Engine Manufacturers Association, or DEMA, and I
23 would like for you to turn to the second page which lists
24 the members.

25 JUDGE BRENNER: You did note the date of this,

WRBeb 1 didn't you, Mr. Ellis?

2 MR. ELLIS: I did not, but I will. It is
3 copyright 1972, Judge Brenner.

4 BY MR. GODDARD:

5 Q Professor Sarsten, I have asked you about ALCO,
6 Cooper-Bessemer and DeLaval. Let me now ask you about
7 Chicago Pneumatic Tool Company.

8 Do you know whether the Chicago Pneumatic Tool
9 Company uses the DEMA crankshaft standard for torsional
10 stresses?

11 A (Witness Sarsten) No, I do not.

12 Q Would it be fair to say that you do not know
13 whether any of the members listed on the second page of the
14 excerpt I have handed you from DEMA use the DEMA crankshaft
15 standard for torsional stresses?

16 A Except the DeLaval, what is called here the
17 DeLaval Turbine Incorporated, which I referred to a couple
18 of questions ago.

19 Q Yes, sir.

20 And your knowledge, as you indicated there, is
21 based on this case. Is that correct?

22 A That's correct.

23 Q So it would be fair to conclude, wouldn't it,
24 Professor Sarsten, that with respect to the members of the
25 Diesel Engine Manufacturers Association, the companies that

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1 I've asked you about, that you would not know how many
2 orders these companies sum in the event that they do use the
3 DEMA standard for crankshaft torsional stresses?

4 A That is correct. I base all my witness on how I
5 interpret the DEMA standards.

6 Q Are you aware of any other diesel engine
7 manufacturers of medium speed diesels that are not listed on
8 page 2 of the excerpt I handed you? And I'm talking about
9 in the United States.

10 A Well, it would depend upon how you define "medium
11 speed," but I think most people would consider the larger
12 engines as medium speed engines. No, I am not aware of any
13 in that context.

14 Q Professor Sarsten, would you agree that you are
15 -- do not consider yourself an expert on the interpretation
16 and application of DEMA with respect to its use in the
17 United States?

18 A All I have to base my interpretation is the rules
19 themselves. I would say that the rule as much is quite
20 clear.

21 What you are perhaps asking is do I have
22 knowledge how other firms in the United States would like to
23 interpret the rules. That I do not have; that's true.

24 Q Well, let me repeat the question then.

25 Would it be fair to say then that you are not an

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1 expert on the interpretation and application of the DEMA
2 standard in the United States with respect to how many
3 orders are summed in the application of that standard?

4 A I would not agree to that formulation. I would
5 say that the DEMA rules there, in my opinion at least, are
6 quite clear, and with my background in torsional vibrations,
7 I would say that I think I have a fair understanding of how
8 these rules should be interpreted.

9 Others may like to interpret them differently.
10 That's another matter.

11 Q You said that the rules are quite clear. Do you
12 mean that the rules tell the user how many orders should be
13 summed?

14 A No, they do not tell how many orders should be
15 summed.

16 Q So would you agree that in determining how many
17 orders should be summed, there is a matter of
18 interpretation?

19 A There's the matter of perhaps determining how
20 many orders are significant.

21 Q Well, is that the term that DEMA uses,
22 "significant" orders?

23 A No, it is not.

24 Q All right. Well, let me ask you my question
25 again.

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1 Given that DEMA does not specify the number of
2 orders to be summed, would you agree that it has to be
3 interpreted or construed by the user in order to arrive at a
4 number of orders to be summed?

5 A I would say the user has to follow standard
6 engineering practice in this regard, yes.

7 Q And you would agree that that would be standard
8 engineering practice in the United States, wouldn't you?

9 A I do not see why the standard practice here
10 deviates significantly from other countries in the world in
11 this respect.

12 Q Well, you say you do not see that it does, but
13 isn't it true that you do not have any knowledge of what the
14 practice is with regard to how many orders are summed by
15 manufacturers in the United States using DEMA?

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WRBpp 1 A I do not have -- I have to think back now.

2 No, I do not have knowledge of how many orders
3 are summed by individual firms in the United States when
4 they use DEMA.

5 JUDGE BRENNER: Mr. Ellis, excuse me.

6 Professor Sarsten, in your answer prior to the
7 last answer you referred to your belief that you saw no
8 reason why the practices in the United States should differ
9 significantly from those elsewhere in the world. What you
10 left unstated, at least expressly, is what the practice is
11 elsewhere. Could you tell me what that is?

12 DR. SARSTEN: Yes. The standard practice
13 elsewhere in the world is to some 24 orders for a forestroke
14 engine. That is, orders from one-half to 12. That is, for
15 example, as specifically stated in the proposal for the new
16 CIMAC rules for torsional vibration where, in 1979 they
17 mention 24 orders as standard. That's the first 12 for
18 four-stroke engine.

19 BY MR. ELLIS:

20 Q Professor Sarsten, you say the practice
21 elsewhere, am I to understand that that is -- that these
22 manufacturers you're talking about are in Europe?

23 A (Witness Sarsten) This would hold for the world
24 in general. This was for the main classification
societies. They are combining to see if they can arrive at

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1 a common set of rules that also includes the ABS, the
2 American Bureau of Shipping.

3 JUDGE BRENNER: It does not include DEMA does it?

4 A DEMA is not a classification society. It would
5 not be included, no.

6 Q You refer to the CIMAC rules. That is not DEMA
7 either, is it?

8 A No. The CIMAC rules are also the proposed rules
9 from the Association of Classification Societies. Both
10 names are sometimes used.

11 Q And you refer to those rules. Isn't it true that
12 those rules are in draft form?

13 A Those rules are in draft form and they probably
14 will be in draft form for a number of years yet, that's
15 true.

16 Q So that the practice that you refer to of summing
17 24 orders, to your knowledge, does not involve DEMA and is
18 -- strike that.

19 The practice of summing 24 orders then, does not
20 involved DEMA, does it?

21 A I would say it does involve DEMA. Because if
22 you're going to apply the DEMA rules, you would have to
23 include the significant orders. I would include 24 orders.
24 That is standard practice elsewhere in the world.

25 Q When you say elsewhere in the world, you've

WRBpp 1 already testified you don't know what they do in the United
2 States. That's correct, isn't it?

3 A I do not know what they do in the United States.
4 I know what they do in the rest of the world.

5 Q On page 12 -- well, you would agree with me then
6 wouldn't you, Professor Sarsten, that you are not an expert
7 on the application of the DEMA standard as that standard is
8 used by American manufacturers of medium speed diesels?

9 A I can only read the DEMA standards. I know how I
10 would apply it. I do not know how all the engine
11 manufacturers in the United States, many for that matter, do
12 apply it.

13 Q Professor Sarsten, on page 10 of your direct
14 testimony you indicate, and I will paraphrase a little here,
15 that the rules -- I'm reading now, four lines down -- "The
16 rules are often subject to or often require interpretation
17 discussion with the classification society." You were
18 referring to DEMA in this instance, weren't you?

19 A I was not referring to DEMA in that instance. I
20 was referring to the classification societies. DEMA is not
21 a classification society.

22 Q Would you agree, though, that that statement
23 would also apply with respect to DEMA?

24 A I think the rules are quite clear for DEMA for my
25 part.

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1 Q Well, are they clear on the summation of how many
2 orders should be summed. If so, could you point out to me
3 where it says that?

4 A It does not specifically state the number of
5 orders.

6 Q So it's not clear on that point, is it?

7 A I would say that you must follow standard
8 practice. Which is, today, 24 orders. Which are
9 significant. To more than that, they taper off and did not
10 influence the results very much.

11 Q Why do you say, then, that the rules are often
12 subject to or often require interpretation or discussion
13 with the classification society?

14 A I was then referring to the classification
15 society's rules. They do often require interpretation.

16 Q In your opinion, DEMA requires no interpretation
17 at all?

18 A I would say that DEMA, at least if you follow
19 standard practice, this would not require interpretation in
20 this respect. You're referring now to the number of
21 orders. I would say you must use the number of orders
22 commonly used, which is 24.

23 Q And you've already testified that 24 is the
24 number of orders used in the rest of the world, other than
25 the United States?

WRBpp 1 A I did not testify that it was not used in the
2 United States.

3 Q You don't know whether it was used in the United
4 States or not?

5 A We have performed calculations for ALCO
6 products. I believe then we used the standard number of
7 orders.

8 Q Was that for DEMA?

9 A That was not for DEMA. That was for a specific
10 calculation some years ago.

11 Q Have you had any conversations or discussions
12 with DEMA concerning how many orders they deem appropriate
13 should be summed for the application of the torsional stress
14 standard?

15 A No, I have not.

16 Q Has anyone on the Staff had such conversations?

17 A That you would have to ask the rest of the staff.

18 Q To your knowledge, have they?

19 A To my knowledge, no.

20 Q Dr. Henriksen, do you have any knowledge of that?

21 A (Witness Henriksen) Correction. I am not a
22 doctor.

23 Q Neither am I. So we're together on that.

24 A Will you repeat your question, please?

25 Q Yes. Do you have any knowledge of whether the

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1 Staff has contacted DEMA to discuss the interpretation of
2 that standard?

3 A I do not. I do know that the Staff has contacted
4 DEMA members, but not DEMA as an organization, no.

5 Q Do you know who was contacted?

6 A I did.

7 Q I beg pardon?

8 A I d'd.

9 Q I'm sorry. I didn't hear.

10 A I contacted DEMA members.

11 Q Which DEMA members did you contact?

12 A ALCO, Waukesha Motors -- those are the two
13 members I contacted.

14 Q Professor Sarsten, let me come back to you.
15 On page 12 of your direct testimony -- strike
16 that.

17 Professor Sarsten, have you ever used the DEMA
18 standard for crankshaft torsional stresses in connection
19 with crankshaft evaluation or design before you were
20 retained by the NRC in connection with this case?

21 A (Witness Sarsten) No, I have not.

22 MR. ELLIS: Judge Brenner, at this time we would
23 move to strike Professor Sarsten's testimony relating to the
24 application of the DEMA standard on the ground that, as he
25 has clearly and very forthrightly testified, that he has no

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1 experience with respect to what DEMA uses, how the standard
2 was developed, the methodology, or what the American
3 manufacturers in this country do in the application of the
4 DEMA standard. And he has not, before this case, used the
5 DEMA standard for crankshaft torsional stresses. I think,
6 under the circumstances, I do not think even a liberal
7 standard would be met to permit a conclusion. And he is an
8 expert in the application of the DEMA standard.

9 JUDGE BRENNER: Could I get Mr. Ellis' last
10 question read back, please?

11 (Whereupon the reporter read the record as
12 requested.)

13 JUDGE BRENNER: Well, we'll certainly hear a
14 response from the Staff and then from the County if it
15 wishes to make on. If the Staff would prefer to ask
16 Professor Sarsten some questions in the nature of redirect
17 or voir dire prior to making a response, we'll give it
18 leeway to do that also.

19 MR. GODDARD: Fine.

20 JUDGE BRENNER: Do you want to do that now?

21 MR. GODDARD: Yes, I would.

22 VOIR DIRE EXAMINATION

23 BY MR. GODDARD:

24 Q Dr. Sarsten, it is your testimony that based upon
25 your professional engineering judgment, the DEMA rules are

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1 not susceptible to significant interpretation. And you feel
2 that you are capable to interpret them, is that correct?

3 MR. ELLIS: I object to that question. It's
4 leading in the most obvious way.

5 JUDGE BRENNER: I will grant the objection
6 because I don't like overly leading questions either. And I
7 want all counsel to remember that and this is a good time to
8 make my point. Mr. Goddard, don't feel as though you'll be
9 the sole recipient of it. But this way those making the
10 objection as well as those receiving the objection will
11 remember it for the rest of the hearing.

12 MR. ELLIS: I hope I am permitted to do it,
13 though, on cross examination.

14 JUDGE BRENNER: On cross examination, you are.
15 One of your co-counsel thought that shouldn't be permitted
16 either, but he lost.

17 Go ahead, Mr. Goddard. Try again.

18 You don't need to repeat the testimony. I did
19 not mean to imply that you had to ask Professor Sarsten
20 questions. I just thought that maybe you had something in
21 mind that you knew that has not yet been brought to light.
22 You certainly should have an opportunity.

23 MR. GODDARD: Certainly.

24 BY MR. GODDARD:

25 Q Dr. Sarsten, in your evaluation of these

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1 crankshafts under the DEMA rules, you work with other
2 members of the PNL staff and consultants?

3 A (Witness Sarsten) I did speak with Mr. Henriksen
4 concerning this and I also believe I had some conversations
5 with Paul Louzecky.

6 Q Did you include information obtained from those
7 persons in formulating your answers to the questions
8 regarding the applicability of DEMA standards?

9 A Of course. Their information was also included
10 in my answer.

11 Q And in fact, Mr. Henrickson was employed --
12 MR. ELLIS: I think we have another leading
13 question coming here.

14 MR. GODDARD: Why don't you wait till you hear
15 it, Mr. Ellis?

16 Excuse me, Judge Brenner. That was a spontaneous
17 remark by the Staff.

18 JUDGE BRENNER: Your remark was correct,
19 nevertheless.

20 BY MR. GODDARD:

21 Q Dr. Sarsten, do you know whether either
22 Mr. Louzecky or Mr. Henriksen has, in fact, been employed by
23 members of DEMA?

24 A (Witness Sarsten) I do know that both have been
25 employed by members of DEMA.

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1 Q And who were those members?

2 A Nordberg Manufacturing Company.

3 Q In your opinion, do the DEMA rules require
4 significant interpretation prior to their application to the
5 evaluation of a crankshaft for torsional vibratory stress?

6 JUDGE BRENNER: That has been asked several
7 times by Mr. Ellis almost to the point of where I was
8 tempted to jump in before. Although he got slightly
9 different answers each time, so I hesitated.

10 Professor Sarsten, in the course of an answer
11 discussing your prior employment with ALCO to one of
12 Mr. Ellis' questions, you referred to others at ALCO who
13 perform the torsional vibration analyses, is that correct?

14 WITNESS SARSTEN: Other firms than ALCO?

15 JUDGE BRENNER: No. Other persons at ALCO other
16 than yourself?

17 WITNESS SARSTEN: Oh, yes, yes.

18 JUDGE BRENNER: I inferred from that that you did
19 not perform torsional vibrational analyses in your
20 employment at ALCO, am I correct?

21 WITNESS SARSTEN: That is correct. I had close
22 contact with these people on other calculations, but the
23 torsional vibration calculations themselves were performed
24 by Mr. Fred Porter.

25 JUDGE BRENNER: Putting DEMA aside for the

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1 moment, can you tell me what your prior experience is in
2 performing torsional vibration analyses of either
3 crankshafts or of objects that you would think would be
4 similar to crankshafts?

5 WITNESS SARSTEN: My first torsional vibration
6 calculation, I believe, was made in 1957 for an engine firm
7 in Norway. I have since developed numerous programs for
8 calculation of torsional vibrations. The first one was in
9 1962, I believe it was. I have performed numerous torsional
10 vibration calculations after that time. We have sold the
11 programs, also sold calculation services to numerous firms,
12 among them, ALCO Products at Auburn, New York.

13 JUDGE BRENNER: Could you give me some examples
14 of the torsional vibration analyses that you performed?
15 That is, what were they performed for, and also some
16 examples of the application of the program you developed
17 used by consumers of the program.

18 WITNESS SARSTEN: The programs -- there are
19 several of them -- have been sold, among others, to what was
20 previously Montreal Locomotive Works. They've been used for
21 their calculation of the ALCO engines, when used outside
22 locomotive service.

23 JUDGE BRENNER: These are -- are these for
24 calculations of crankshafts in the engines?

25 WITNESS SARSTEN: They are for the calculation of

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1 torsional vibration.

2 JUDGE BRENNER: Of what?

3 WITNESS SARSTEN: Of the crankshafts in the
4 four-stroke engines.

5 JUDGE BRENNER: I interrupted you. I'm
6 sorry. You were going to give me a few more examples.

7 WITNESS SARSTEN: Well, we have, of course, made
8 numerous calculations of various engines up through the
9 years, and the University also has consultants. Our main
10 activity, however, has been in the development of programs
11 and sales, or lending of these to various firms.

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1 JUDGE BRENNER: In developing these programs,
2 what experience do you have in actual application of the
3 programs and/or feedback of results of applications of the
4 programs to experience?

5 WITNESS SARSTEN: Well of course we make trial
6 calculations for the customers, I have made numerous
7 calculations for both the Norwegian engine manufacturers,
8 Wichmann Motorfabrikk and Bergen Diesel. At times, as study
9 projects for the students get actual cases in farm industry,
10 which we calculate if they are interesting enough -- the run
11 of the mill stuff, of course, is done by the engine firms
12 themselves.

13 JUDGE BRENNER: Have you participated in or
14 otherwise become aware of any tests used to validate any of
15 the programs that you have prepared for torsional vibration?

16 WITNESS SARSTEN: Yes, of course. We have tested
17 them against other programs where they are available -- and
18 it's very easy with a little ingenuity to construct very
19 large vibratory systems which can test the accuracy of the
20 program.

21 If this is done, you can use the analytical
22 results for the torsion vibration of a bar and, for
23 example, check your natural frequencies which would come out
24 as pi, three pi, five pi with a large number of significant
25 digits.

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1 Secondly, you have analytical solutions for
2 single mass and two mass systems which may be put
3 back-to-back and added on and a 60 mass or 100 mass system
4 made whereby you can check the accuracy of the -- well of
5 the natural frequencies, of course -- and mainly the
6 amplitudes of vibrations and the stresses in these large
7 systems.

8 You will find that they usually have four or five
9 significant digits which are accurate, even in a large 60
10 mass system.

11 JUDGE BRENNER: You stated at the first part of
12 your answer that it was fairly easy to put together, I think
13 you said, a vibrational field; I may have the term wrong.

14 Can you first correct me on the term and, second,
15 tell me whether that's been done for your programs either by
16 you or by other....

17 WITNESS SARSTEN: Of course. It's a standard way
18 for us to check the accuracy of the programs. They're, of
19 course, also checked against other existing programs using
20 other codes and other languages; instead of FORTRAN, the
21 earliest versions of some of the programs were programmed in
22 ALGOL.

23 By comparing these programs for typical cases, we
24 find that the discrepancies or the differences creep up
25 first in the fifth significant figure. So we have very good

WRBagb 1 verification of the accuracy of such computer programs

2 JUDGE BRENNER: Incidentally, as long as I have
3 interrupted this much, previously in talking about ALCO,
4 with which you have had prior experience, I believe you
5 stated that it was a member of DEMA when you were there, am
6 I correct or did I get that wrong?

7 WITNESS SARSTEN: Let me see. I think ALCO then
8 -- this was in the -- around 1960, was a member of DEMA.
9 I'm not quite sure of this.

10 They are now, I think, listed a the White Motor
11 Corporation.

12 JUDGE BRENNER: All right. That was my next
13 question. Thank you.

14 WITNESS SARSTEN: Here we have them: White
15 Superior Division. They are now a part of White Motor
16 Corporation of Springfield, Ohio and, as such, they should
17 still be members.

18 MR. ELLIS: Judge Brenner, I may not have been as
19 clear as I should have been.

20 JUDGE BRENNER: Do you want to strike him because
21 he doesn't know anything about DEMA?

22 MR. ELLIS: It's his interpretation of DEMA that
23 I --

24 JUDGE BRENNER: I understand. I want to see what
25 else he knows to see if that may be pertinent. You're not

WRBagb 1 challenging him as an expert in the performance or analyses
2 of torsional vibration, are you?

3 MR. ELLIS: No, sir.

4 JUDGE BRENNER: But you didn't ask him about what
5 he knew, so I thought I was ask that part and then put it
6 together with what he said he didn't know.

7 MR. ELLIS: Yes, sir, I understand.

8 JUDGE BRENNER: And in addition, if we were to
9 grant your motion, you have not yet gotten to Mr. Henriksen,
10 who is the co-author of much of the same answers, and you
11 would have to work your way through him, even if we granted
12 the motion.

13 MR. ELLIS: No, sir, because the answers that I
14 would have stricken do not have Mr. Henriksen on them.

15 JUDGE BRENNER: All right. That would take care
16 of that problem if we get to that point.

17 I suppose it would help you to know now, so we
18 can take a moment.

19 Does the County have anything to add, either by
20 way of argument or questions to Professor Sarsten?

21 I'll get back to you for your argument,
22 Mr. Goddard, I wanted to hear from the County.

23 MR. ELLIS: Judge Brenner, while you're waiting,
24 would you like me to give you some of the questions and
25 answers that I have in mind?

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2 JUDGE BRENNER: No, I can probably figure them
3 out if I went through them also.

4 MR. SCHEIDT: Judge Brenner, I think it is clear
5 that Professor Sarsten is an expert on torsional vibration
6 calculations, that he understands DEMA and thus far there
7 has been no showing that DEMA is anything other than what
8 Professor Sarsten has stated it is and what the rest of the
9 world has interpreted the number of orders to be summed in
10 making those calculations. And I don't believe there is any
11 basis for striking his testimony, as Mr. Ellis has
12 asserted.

13 JUDGE BRENNER: Mr. Goddard.

14 Do you have any more questions?

15 MR. GODDARD: No, Judge Brenner, I have more than
16 covered the ground.

17 The Staff would only submit that based upon
18 Dr. Sarsten's expertise in the area of torsional vibration
19 and his experience with the rules of other worldwide
20 classification societies, he should be able to -- in the
21 opinion of the Staff -- interpret the DEMA rules which he
22 testified are susceptible to minimal interpretation, they
23 are quite clear on their face. And that if any weight be
24 given to Mr. Ellis' position, it should go to the question
25 of the weight and not the admissibility of Dr. Sarsten's
testimony.

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JUDGE BRENNER: Mr. Ellis, you wanted to add something?

MR. ELLIS: May I be heard further?

JUDGE BRENNER: Yes.

MR. ELLIS: Judge Brenner, I think central to what we're talking about is the interpretation and application of DEMA. DEMA is there for the Board to read and the Board has heard the witness' testimony on that. But it seems to me that if one is going to be an expert on whether something meets DEMA and that is the brunt -- the thrust of the testimony, then one has to have some experience in the application of that standard. And if the record is clear on anything, I certainly agree that Professor Sarsten is an experienced torsional stress analyst but he is not experienced at all in the application of DEMA to crankshafts and his view of how many orders to be summed is certainly an important issue in this case and he is not an expert on the application of DEMA in that respect.

And therefore we don't see any way that it can go to weight, it is either -- it would be no different from asking anybody else who knows a good deal about torsional stress analysis and they had never heard of DEMA, well how many orders would you sum. That isn't the standard. If you're going to be an expert before this Board, it seems to me that you must come to this Board with some substantial

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1 experience in the interpretation and application of DEMA.
2 That does not mean that his other testimony on ABS or other
3 matters is similarly inform. But I certainly think this
4 one is. He does not bring to the Board the kind of
5 expertise with DEMA that I think is plainly required by even
6 the most liberal standard.

7 JUDGE BRENNER: Maybe I should accept your
8 invitation to give us the particular answers that you would
9 strike if your motion were granted.

10 MR. ELLIS: Yes, sir.

11 On page 12, we would strike the portion of the
12 answer at the top of the page relating to testimony that 24
13 orders are now normally used. There is no basis for that
14 with respect to DEMA.

15 We would also strike his portion of the testimony
16 on page 13 relating to the DEMA standard, the second
17 paragraph of that answer in the middle of the page and also
18 the next question and answer and the following question
19 involving the computer program, it follows the question:
20 "How do your results compare with those by FaAA," that would
21 also go out.

22 To the extent that his answer on page 17, he is
23 there both with Mr. Henriksen, his answer should not be
24 accepted with respect to DEMA.

25 There was one other one I think as well, Judge

WRBagb 1 Brenner.

2 JUDGE BRENNER: All right. Well you've given
3 us the picture and if we need to we'll come back with
4 specificity on anything you might have left out.

5 MR. ELLIS: Thank you.

6 JUDGE BRENNER: In fact we would need more
7 specificity on some of the ones you ran through, if we need
8 to.... Why don't you give us a moment and we'll see if we
9 can give you a ruling before the lunch break.

10 MR. SCHEIDT: Your Honor, could I make one point?

11 There has been no evidence in the record that
12 DEMA deviates in any way from the standard practices in the
13 rest of the world.

14 JUDGE BRENNER: Well I don't think that is an
15 accurate statement. There may be evidence that you disagree
16 with.

17 MR. SCHEIDT: I'm sorry?

18 JUDGE BRENNER: I don't think that's an accurate
19 statement on your part, you said there is no evidence in the
20 record. That's a strong statement.

21 MR. SCHEIDT: I don't believe there is, Judge
22 Brenner.

23 JUDGE BRENNER: I have a recollection -- I don't
24 think it's going to matter for our ruling, but I have a
25 recollection that Dr. Chen offered some testimony in that

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1 regard as to what he believed was the appropriate procedure
2 in terms of the number of orders to meet DEMA and he talked
3 about his experience with what has been done over the years
4 to his knowledge. So to say there is no evidence -- that's
5 why I said your statement was a strong one.

6 MR. SCHEIDT: Well --

7 JUDGE BRENNER: You may not agree with it or you
8 may later show in findings that he was speaking in
9 generalities and then when he was attempted to be pinned
10 down by cross-examination could not support it in the detail
11 necessary to believe the statement, but that's different
12 than saying there is no evidence in the record.

13 And I would add that it's solely based on my memory.
14 That would certainly be the kind of thing I would want to
15 search for in the transcript before making a ruling on it,
16 but I don't have to make a ruling on that point now.

17 (The Board conferring.)

18 JUDGE BRENNER: We are going to deny the motion.
19 Professor Sarsten, as everybody can see, is clearly an
20 expert in the performance of analysis of torsional vibration
21 that is sufficient to give the testimony he is giving.

22 He has also testified and has sufficient
23 expertise to be permitted to give the testimony on what he
24 thinks our proper standard practices should be. He has
25 explained candidly as to how he is applying what he has

WRBagb 1 done to DEMA.

2 Later we will evaluate the weight of whether or
3 not this is the way it should be done under DEMA. But that
4 would be the weight and not the admissibility.

5 Our starting point is -- One of our points is the
6 obvious one that LILCO surely is not moving to strike all
7 testimony that refers to DEMA as some sort of benchmark by
8 witnesses who analyses employ 24 orders or orders greater
9 than six because otherwise some of FaAA's testimony would
10 fall for that reason, so clearly that is not what LILCO has
11 intended by the motion.

12 When we evaluate Professor Sarsten's testimony,
13 it is very similar in certain regards to FaAA's, that is, a
14 presentation of the approach to how the calculations are
15 made by the witness and then the matching up of those
16 results with certain guidelines or benchmarks, including
17 DEMA's, and then different opinions as to whether or not
18 that's an appropriate matchup to be sure. But that is
19 something we will evaluate in terms of the evidence.

20 MR. ELLIS: I understand the Board's ruling. It
21 does seem to me, however, that there is a distinction
22 between an expert on the calculation of torsional stress or
23 torsional stress analysis of the crankshaft and a person who
24 indicates that he is an expert on the interpretation and
25 application of DEMA. That is not the -- the interpretation

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1 and application of DEMA was not, I don't think, an FaAA --
2 it was Dr. Chen who was the interpreter and the applier of
3 DEMA. And to the extent that Professor Sarsten would put
4 himself in the same category, we do not believe he has met
5 that standard.

6 JUDGE BRENNER: Well you have our ruling. He has
7 explained what he knows and what he doesn't know about DEMA
8 and why he has taken the approach he has taken to using the
9 24 orders and we'll put it together with the weight.

10 Incidentally, even if we were to accept the fact
11 that there was some subset known as an expert on DEMA under
12 which we should strike testimony, just using by example the
13 testimony you pointed to as falling under that motion,
14 Mr. Ellis, it's overly broad because much of that testimony
15 does what FaAA did: it performs the calculations, shows
16 what the results are and then points out something which we
17 could do for ourselves as to whether or not it's over
18 the 5000 and 7000 psi limits of DEMA.

19 MR. ELLIS: Yes, I understand.

20 The reason that I gave that testimony --

21 JUDGE BRENNER: Let's end it right here. We have
22 our ruling.

23 MR. ELLIS: The reason that I gave that testimony

24 --

25 JUDGE BRENNER: I think we have enough on it.

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MR. ELLIS: -- was as a predicate for the conclusion that it did not meet DEMA.

JUDGE BRENNER: You have some other questions in your cross plan which are similar to questions we have in our mind as to pursuing the point of is it proper to take this approach given DEMA and what was known back when DEMA was promulgated and so on? And we expect you to pursue those and we have some testimony from other witnesses for LILCO already in the record in that regard.

MR. ELLIS: Yes, sir, I do want to follow up on some of these.

JUDGE BRENNER: All right. Right after lunch. We're going to break for lunch at this point and we'll come back at 2:00.

(Whereupon, at 12:26 p.m., the hearing in the above-entitled matter was recessed, to reconvene at 2:00 p.m., this same day.)

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AFTERNOON SESSION

2

(2:00 p.m.)

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JUDGE BRENNER: Good afternoon.

4

Whereupon,

5

ARTHUR SARSTEN

6

and

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ADAM HENRIKSEN

8

resumed the stand and, having been previously duly sworn,

9

were examined and testified further as follows:

10

JUDGE BRENNER: We have discussed the matter of scheduling for the discovery and possible preparation of supplemental testimony by the County and Staff on cylinder blocks. In our own mind we believe it a close question as to whether the hiatus of one week is sufficient, or whether two weeks is in fact needed.

16

Since it is a close question, if it is determined -- and I will get to the timeframe for such a determination in a moment. If it is determined that two weeks are in fact needed we will permit it, our reason being that to a reasonably large extent, LILCO is in control of the schedule with respect to the further testing and imparting of the knowledge to the County of that further testing, and steps could have been taken to impart a good deal of that knowledge earlier than it was. Even three or four days earlier could have made a difference in our mind in

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WRBeb 1 choosing between one week and two weeks.

2 Furthermore, the fact that the tests were
3 conducted when they were as opposed to an earlier time is
4 also in LILCO's control. We certainly don't know whether it
5 could reasonably have been done sooner or not, but
6 nevertheless LILCO was in control of its own testing and
7 examination.

8 We infer from the discussion this morning that
9 the present state of affairs of the County's plans are that
10 the County has not yet determined that supplemental
11 testimony by its witnesses will in fact be necessary but
12 wants time to consider that.

13 Am I correct?

14 MR. SCHEIDT: That's correct, Judge Brenner.

15 JUDGE BRENNER: All right.

16 We also recall from this morning -- and let me
17 check with the Staff to make sure we recall correctly --
18 that if the Staff decides to submit supplemental testimony
19 on the new information, it can do so by late in the week of
20 October 8th.

21 MR. GODDARD: That's correct, Judge Brenner. And
22 I have spoken with my witness and we do intend to present
23 supplemental testimony based on LILCO's.

24 JUDGE BRENNER: All right. So the Staff would be
25 prepared to file its supplemental testimony by a received

WRBeb 1 date of Friday, October 12th. Is that right?

2 MR. GODDARD: That's correct, Judge Brenner.

3 JUDGE BRENNER: All right.

4 Our order is that discovery on the new
5 information begin at once, such discovery to involve any and
6 all means of expedited discovery other than interrogatories.

7 I also do not mean to preclude the simple
8 obtaining of data such that further discovery would be made
9 more efficient such as where certain things are located,
10 what documents exist, what people perform certain things,
11 and so on, and preclude interrogatories. We do not preclude
12 simple identification-type questions which should and could
13 be done informally.

14 The discovery should be concluded just as soon as
15 possible and certainly some time before the end of the week
16 of Friday, October 8th. I don't want to set a more precise
17 date than that. Well, maybe I should say no later than
18 October 12th, so the parties don't end up in a dispute, but
19 we would expect that it could be completed earlier than the
20 12th by at least a day or two.

21 As soon as possible from the County's point of
22 view next week we would like to hear whether the County
23 plans on submitting supplemental testimony and if so,
24 whether it is going to be brief enough such that the County,
25 too, could file its supplemental testimony on October 12th,

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1 and we certainly need to hear that from the County on the
2 record of this hearing by the morning of October 4th. To
3 the extent the County can tell us earlier, we would
4 appreciate that earlier advice.

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

10 We expect good faith on the part of the County in
11 terms of giving us its serious and considered opinion that
12 if it can indeed accomplish the task by Friday, October
13 12th, we can avoid taking a lengthier break in this hearing
14 than the Board would like to see for reasons of our own
15 prearranged schedules.

16 Let me add that if the County's problem is that
17 October 12th is too tight but it can make it the day or two
18 or three after that, such as October 15th, we could probably
19 come up with some accommodation for that that would avoid
20 the need to take a full two-week break. If it gets much
21 beyond that, we will probably have to take the full two
22 weeks.

23 So that's where the matter will stand until we
24 revisit it as soon as the County is ready to revisit it next
25 week no later than the morning of October 4th.

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Mr. Ellis.

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MR. ELLIS: Judge Brenner, does the Board

contemplate that in this period of time during which there is discovery, if the County has new opinions or changes of views on the basis of that LILCO, too, and the Staff will have an opportunity to take their depositions to know what their views are?

JUDGE BRENNER: No, we did not contemplate that.

MR. ELLIS: Well, I guess I'm asking you to contemplate that because I think it would be appropriate.

JUDGE BRENNER: You are not going to make it in a week if you discover them at the same time they are trying to discover you and decide whether they want to prepare testimony. We certainly contemplate that you will have any supplemental testimony that they are going to file at least a few days before you have to cross-examine it.

If you want to conduct discovery of them, I might as well make it two weeks.

MR. ELLIS: If we could keep it the way it is, I suppose we wouldn't. If it does go to two weeks because the Board for some reason decides that it is appropriate, then we would.

JUDGE BRENNER: All right. We will consider that point again when we get to October 3rd or October 4th.

MR. ELLIS: Judge Brenner, does that mean the

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1 block testimony will then begin with the LILCO panel on
2 October 15th?

3 JUDGE BRENNER: Not necessarily. We will find
4 out on October 3rd or October 4th whether we are going to
5 take a week break or a two-week break.

6 MR. ELLIS: I see. With a week break it would be
7 October 15th, and with a two-week break it would be the
8 22nd?

9 JUDGE BRENNER: Except that we are going to
10 finish up the County's panel on crankshafts and pistons
11 before we go back to blocks.

12 MR. ELLIS: Yes, sir.

13 JUDGE BRENNER: And I indicated in passing that
14 an adjustment of a day or two might be accommodated without
15 having to lose a whole week. And that's why I purposefully
16 did not give particular dates for particular events. We
17 will have to go back to this on the 3rd or the 4th of next
18 week.

19 In short, the County has prevailed in the
20 timeframe that it believes it needs. However, we do not
21 want to assume at this time and do not believe the County
22 has to assume at this time that it will need that full
23 timeframe. And we want to try to save some time and hope we
24 can do that when we discuss the subject again on October 3rd
25 and October 4th, based on greater information which the

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1 County will rapidly and efficiently be able to obtain from
2 LILCO.

3 MR. ELLIS: Judge Brenner, where does the Board
4 contemplate we do after these witnesses are completed?

5 JUDGE BRENNER: These two witnesses?

6 MR. ELLIS: Yes, sir.

7 JUDGE BRENNER: I thought the Staff has agreed we
8 could go to its witnesses on pistons.

9 Am I correct, Mr. Goddard?

10 MR. ELLIS: I think the Staff said that but I
11 think the Board had indicated that would be one of the
12 things it would consider.

13 JUDGE BRENNER: I'm sorry, I meant to say that
14 that was very good news to us because we did not want to
15 require the County's witnesses to be here this week for a
16 number of reasons, the inconvenience to the County's
17 witnesses due to lack of notice that some of them would have
18 to be here this week, and more importantly, the fact that
19 they are going to be efficiently engaging in discovery this
20 week, and that could be one of the reasons why we won't need
21 a full two-week break.

22 And we know we are not going to hear about any
23 discovery disputes unless they are absolutely, positively
24 matters of the utmost importance and privilege.

25 MR. ELLIS: I hope not, Judge, but I hope that is

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1 also not an invitation to the kind of blanket request that
2 sometimes comes. I am sure that both sides can be
3 reasonable, but I hope the Board's views are not taken as an
4 invitation to those kinds of requests.

5 JUDGE BRENNER: They won't be, and if they are,
6 we will deal with it. And your point is well-taken.

7 We are at the point of very specific information
8 based on very specific things that have occurred in the
9 uncertain timeframe subsequent to August 14th. Of course
10 they are going to have to find out better what occurred from
11 LILCO.

12 We can proceed. Continue with your
13 cross-examination now, Mr. Ellis.

14 MR. ELLIS: Thank you, Judge Brenner.

15 CROSS-EXAMINATION (Resumed)

16 BY MR. ELLIS:

17 Q Professor Sarsten, let's continue along a line
18 that--

19 JUDGE BRENNER: Mr. Goddard, did you want to say
20 something?

21 MR. GODDARD: No, I just turned my microphone on,
22 anticipating Mr. Ellis' first question, Judge.

23 (Laughter.)

24 JUDGE BRENNER: All right.

25 I'm sorry, Mr. Ellis. Proceed.

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1 BY MR. ELLIS:

2 Q Returning to the subject that we were discussing
3 before, Professor Sarsten, namely the summing up orders,
4 look at page 12 of your direct testimony.

5 You say there, and I'm paraphrasing, that
6 Dr. Chen summed 12 orders and that that accounted for only
7 half, as you put it, of the 24 orders now normally used.

8 How many orders were formerly used?

9 A (Witness Sarsten) Before the advent of the
10 digital computer and hand-calculations were made, it was
11 customary to only look at one order. The vectorial
12 summation is a very laborious process if not done by a
13 digital computer.

14 JUDGE BRENNER: Off the record.

15 (Discussion off the record.)

16 JUDGE BRENNER: Back on the record.

17 BY MR. ELLIS:

18 Q Professor Sarsten, you said or I believe you said
19 that prior to the digital computer and hand-calculator, only
20 one order was used. What period of time was this?

21 A (Witness Sarsten) We made our first computer
22 program for forced torsional vibration and summation of a
23 number of orders in 1965.

24 I also believe that Det Norske Veritas made their
25 first computer program for summation of forced torsional

WRBeb 1 vibration orders also in 1965.

2 It, however, took some time before the majority
3 of the engine manufacturers started to use digital computers
4 to sum their orders, and I believe that at least in Europe,
5 it has been standard practice since around, oh, '72, '73,
6 for all of them.

7 Some of the engine manufacturers used it previous
8 to that date.

9 Q Now that is summing of orders in Europe. Is that
10 correct?

11 A That's correct.

12 I must also add we have performed calculations
13 for American engine manufacturers. We have there also used
14 our program and summed 24 programs.

15 Q But the summing of 24 orders was not with respect
16 to DEMA, was it? It was just summing of orders? It is not
17 the application of DEMA?

18 A This was for the calculation of a specific
19 application which was critical. I do not know the use this
20 American firm made of our computer results.

21 Q So your answer is you don't know whether it was
22 for DEMA or not?

23 A No, I do not know.

24 Q What was the name of that firm?

25 A The name of that firm was ALCO Products,

WRBeb 1 Incorporated. They were then, I believe, already associated
2 with White Motor Company in Auburn, New York, at the time.

3 Q So is it your testimony then that until
4 approximately 1972, the number of orders normally used by
5 manufacturers in Europe was one rather than 24?

6 A No, that was not my testimony. My testimony was
7 that it was not universal for the computer calculations
8 submitted to the major classification societies -- I am now
9 speaking actually of one, Det Norske Veritas -- to include
10 force vibration. Before roughly 1972, it was not
11 universal.

12 When you make forced calculations you will
13 include normally a large number of orders, now usually 24,
14 because if we are in a loop it doesn't make any difference
15 really how many orders you include as long as you have the
16 data available.

17 Q Well, then as I understand your testimony, it was
18 prior '65 and prior to use just one order in connection with
19 torsional stress analysis.

20 A For force vibrations, yes.

21 I seem to recollect that Porter had summed some
22 orders but it is very laborious and will not be done by hand
23 unless in very special cases and then only a few orders.

24 Q I take it you would agree with me that when a
25 classification society or an organization like DEMA sets a

WRBeb 1 stress limit which has 7,000 psi for summation of orders
2 that it has in mind certain calculational techniques that
3 exist at that time. Wouldn't you agree with that?

4 A No. I do not know that I would phrase it in that
5 manner.

6 Q How would you phrase it?

7 A When they say that they refer to a sum of major
8 orders, I would say that is to include as many orders as is
9 significant for the accuracy of the result.

10 Q All right.

11 Will you agree with me that there are in theory
12 anyway an infinite number of orders?

13 A There is an infinite number of orders, granted.

14 Q All right.

15 You indicate in your testimony that 12 orders
16 include the most significant ones. Did you do any of your
17 calculations summing 12 orders, as you term them, the most
18 significant ones, on page 12?

19 A No, it is standard practice to use 24 orders. I
20 would never use as few as 12. I would use more, but never
21 fewer.

22 Q May we have an understanding that when you use
23 the term "standard practice" you are referring to the
24 testimony you have given about the European manufacturers?
25 Is that correct?

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1 A Also the other classification society, I would
2 assume, would use 24 orders as a standard practice. The
3 proposed rules -- I would call them CIMAC, or International
4 Association of Classification Societies' proposals includes
5 the Japanese society and the American society, ABS. They
6 specifically refer to the use of 24 orders.

7 Q Okay, that's interesting.

8 You say first of all--

9 MR. ELLIS: Let me have the answer read back,
10 please. I think you said you assumed something.

11 (Whereupon, the Reporter read from the record
12 as requested.)

13 JUDGE BRENNER: Excuse me. Off the record.

14 (Discussion off the record.)

15 JUDGE BRENNER: Back on the record.

16 BY MR. ELLIS:

17 Q You said that you assumed that the other
18 classification societies would use 24 orders.

19 Do you, as a matter of fact, know what ABS -- how
20 many orders ABS sums?

21 A ABS does not sum any orders. It only moves on
22 the calculations submitted to it. There is nothing specific
23 in their rules, I believe, which requires 24 orders.

24 Q I see.

25 So that's an instance where you would agree that

WRBeb 1 since there is nothing specific in the classification
2 society's rules that it is a matter of interpretation and
3 you have to consult with the society. Is that right?

4 A You would have to consult with the society, and
5 if they did not agree that the number of orders you
6 submitted were suitable, or if your torsional or vibratory
7 stresses lie close to the allowable limit, they would ask
8 you to refine your calculations. They would ask you perhaps
9 to make measurements.

10 Q Well, then, do you know how many orders ABS
11 accepts as adequate for being summed?

12 A That is something ABS would have to rule upon.
13 I do not know that.

14 Q Well, have you reviewed the testimony given by
15 ABS witnesses in this proceeding in depositions, together
16 with the exhibits?

17 A Yes, I have.

18 Q Well, do you know from having reviewed that
19 testimony how many orders they accept as adequate for
20 summing for torsional stresses of crankshafts?

21 A I cannot recollect. I read it through but it was
22 some time ago.

23 If you could point to a specific page I would be
24 grateful.

25 Q Well, it is fair to say then that you do not

WRBeb 1 know what number of orders ABS will accept as being adequate
2 for summing for their torsional stress analysis?

3 A No. That would be something they would have to
4 rule upon.

5 Q You are aware, however, that they have ruled upon
6 that in connection with the 13 by 12 inch crankshaft figures
7 submitted to them by TDI?

8 A I'm aware that they have ruled upon that
9 crankshaft, yes.

10 Q Necessarily wouldn't they have to rule on whether
11 the number of orders summed there was adequate for them?

12 MR. SCHEIDT: Objection.

13 WITNESS SARSTEN: Necessarily--

14 JUDGE BRENNER: There's an objection. You have
15 to stop.

16 MR. SCHEIDT: The question clearly calls for the
17 witness to speculate as to what ABS might have done or might
18 do, and on that basis, the question is objectionable and
19 improper.

20 JUDGE BRENNER: I will allow the answer. I will
21 allow the witness to answer, but the weight which it will be
22 accorded may be minimum, depending upon what else the
23 witness knows and what the basis for the answer is. And I
24 will recall for Counsel some words with respect to our view
25 of ABS and our ruling on the motion to strike some of the

WRBeb 1 County's testimony filed by LILCO, so we are already on our
2 own very wary about this area.

3 It depends in part on how controversial some of
4 the information is among the parties, but we will allow the
5 answer because at this point I don't know what
6 Professor Sarsten knows as to the bases for it. If he is
7 just repeating things ABS said, we will evaluate things in
8 that light, along with how complex some of the things are
9 that he is repeating.

10 Do you need the question back after all that?

11 WITNESS SARSTEN: Yes, please.

12 MR. ELLIS: I will give it to him.

13 BY MR. ELLIS:

14 Q You are aware, Professor Sarsten, that the ABS
15 has ruled with respect to the present 13 by 12 crankshaft.
16 Does that not mean that necessarily ABS has ruled on what
17 the appropriate or adequate number of orders for summing
18 would be as applied to the case of the new crankshaft for
19 the Shoreham emergency diesel generators?

20 A (Witness Sarsten) I would say not. You can
21 submit additional evidence, and I believe in this case the
22 Applicant submitted evidence on a number of other plants
23 which they stated had similar torsional vibratory
24 characteristics.

25 I must also point to the fact that the torsional

WRBeb 1 stress levels submitted by the Applicant actually lay over
2 the permissible ABS rules, in my opinion.

3 Q Professor Sarsten, you indicated that you did not
4 know how many orders were summed by TDI in its submission to
5 ABS. Did you review that calculation?

6 A I reviewed the calculation. TDI, as I recall,
7 did not sum orders at all. They only submitted the
8 individual resonance peaks in their calculation.

9 Q Did you also review the ABS calculations relating
10 to the TDI submission for the 13 by 12 inch crankshaft?

11 A Which page are you referring to now?

12 Q I'm not referring to any specific page. I'm
13 asking you whether you reviewed the calculations made by ABS
14 with respect to any calculation made by ABS with respect to
15 the 13-inch by 12-inch crankshaft of TDI?

16 A As I recollect, ABS did not make their own
17 individual check of the calculations. They have, however,
18 accepted the crankshaft dimensions as being satisfactory.

19 Q Did you review the exhibits to the depositions of
20 the ABS witnesses as well as the transcripts?

21 A I reviewed the transcript. I did not recollect
22 having seen-- I'm not sure, but I don't recollect having
23 seen any exhibits to the ABS transcript.

24 The crankshaft itself, the crankshaft drawing is
25 not available, but it's stated that it has been approved.

WRBeb 1 Q Well, suffice it to say, Professor Sarsten, if
2 ABS summed any orders in calculations of its own, you are
3 not aware of them?

4 A I can't recollect right now, no.

5 Q Now you indicated-- Strike that.

6 Was there a period in connection with your
7 experience in the European sphere when it became customary
8 to sum six or 12 orders, or some number other than one or
9 24?

10 A In my experience the jump was made from hand
11 calculation to computer calculations, and when you first did
12 that, you went to the number of orders for which you had
13 data available.

14 I specifically know that in 1964 when I was at
15 Sulzer, they had the first 10 orders printed on sheets and
16 added on in pencil, I think, up to the 12th order.

17 I also know that for certain applications,
18 computer programs have been sold which sum less than 24
19 orders. This is due to the minicomputer capabilities. But
20 with a little knowledge and more rational programming you
21 can get 24 or 36 orders easily on what would be termed a
22 minicomputer.

23 We did it, around 1974 or '75, for the students.
24 They used a minicomputer program which sums 24 orders.

25 Q These calculations for Sulzer, what code were

WRBeb 1 they for compliance with?

2 A The Sulzer calculations were for compliance with
3 the code which the engine purchaser specified. They were
4 for compliance with Det Norske Veritas, with Lloyd's of
5 London, Germanischer Lloyd, and so forth, depending upon the
6 specific engine.

7 I worked in their torsional vibration balancing
8 computer -- I'm sorry, torsional vibration and balancing
9 computation department for some months while I was in
10 Switzerland.

11 Q On page 12 you indicate that although the 12
12 orders, referring to the 12 orders that Dr. Chen summed,
13 include the most significant ones, the remaining 12
14 contributed to the accuracy of the analysis and should be
15 considered.

16 Wouldn't an additional 24, 36 or 48 orders also
17 contribute to the accuracy of the analysis?

18 A Yes, they would, but insignificantly.

19 I must here add that as the order number
20 increase, the effect on the computational accuracy
21 decreases, and for sake of computer time, it is standard
22 practice to cut them off at 24.

23 I have at times used up to 36 orders in order to
24 calculate the accuracy of the calculations when compared to
25 a formal integration of the equations of motion. The

WRBeb

1 higher orders do not appear above -- that is, above 24, do
2 not appear to add anything significant to the results.
3 However, there is a slight ripple on top of the calculations
4 which will continue to be there even if you have 48 orders
5 or more.

6 This small ripple on top of the results is, in
7 everyone's opinion, very insignificant and is neglected in
8 practice.

9 Q Is the program you used or have capable of
10 summing 12 orders, or is it only capable of summing 24 or
11 greater?

12 A It is capable of summing any practical number of
13 orders you wish. I believe the present program has a cutoff
14 at 48 orders but if you wished to use more you can use added
15 excitations, so called, and finagle the program into
16 accepting 48 plus two times 24 orders. But this is never
17 used. It is wholly impractical and only used for purely
18 theoretical work.

19 Q Did you make any calculations using just 12
20 orders?

21 A No, I did not.

22 Q Do you know what contribution the second 12
23 orders -- that is, from 12 to 24, make in terms of
24 percentage?

25 A No, I do not. I would have to do it, do the

WRBeb 1 calculation to ascertain that.

2 Q You reached the conclusion I think that a
3 summation of 24 orders led you to the result of 7,096 psi.

4 A That's correct.

5 Q The 96 or 97 psi, would that be about 1.5 percent
6 of the total?

7 A Roughly, yes.

8 Q And you cannot tell me how many orders contribute
9 to that 1.5 percent, can you?

10 A Not without making a digital calculation.

11 Q Well, would it be fair to say that we are only
12 talking about one or two or three orders that make up 96
13 psi, or are we talking about the 12 additional orders that
14 make up the 96 or 97 psi needed to meet DEMA?

15 A It depends also on the phasing of the harmonics.
16 It is hard to say without calculating. I would assume that
17 there were several orders needed to-- Well, again it
18 depends on the phasing. That is not to say anything off the
19 top of my head.

20 Q It depends on what? I'm sorry.

21 A I was going to say it depends on the phasing of
22 the order, the phase angle, but I would not like to guess.
23 I would like to calculate it to see in this specific
24 instance.

25 Q Well, is it fair to say that as an engineering

WRBeb

1 rule of thumb that orders that contribute 10 percent or less
2 to the result are not significant ones?

3 A No, I would not say that. Far from it.

4 Q All right.

5 From 10 percent, what would you say down from
6 that would you say ceases to be a major order in terms of
7 contribution?

8 A I can here only abide by the standard practice in
9 industry which is to take the 24. I would have to look at
10 the difference between the 23rd and the 24th to say that.

11 It is not based upon a variable number, depending
12 upon a magnitude. It is a fixed number of orders that is
13 commonly used.

14 Q Do you know how DEMA defines the orders to be
15 summed?

16 A If we had the rules. But it's the major orders
17 which, if my memory is correct, come into phase
18 simultaneously, or something of that order.

19 Q Prior to the lunchhour, I handed Professor
20 Sarsten -- I gave you excerpts of DEMA, and I might just
21 help you by asking you to turn to--

22 JUDGE BRENNER: Mr. Ellis, some of the DEMA
23 rules are already an exhibit. If you can refer to a portion
24 already in evidence, that might help. Don't ask me which
25 ones.

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MR. ELLIS: We'll find that, Judge.

JUDGE BRENNER: LILCO Diesel Exhibit 14 perhaps..

MR. ELLIS: It is C-14, Judge Brenner. And for purposes of the question-- I haven't asked you a question yet, Professor Sarsten, but did you want to say something?

WITNESS SARSTEN: I wanted to correct my memory. I said "simultaneously" but it says coming to phase "periodically" here.

BY MR. ELLIS:

Q It's a big difference, isn't it?

A No, it's just a matter of semantics.

Q All right.

Look if you would, please, and I'm referring to Exhibit C-14 -- it's page 53.

How does that define the orders to be summed under DEMA?

A (Witness Sarsten) I'm sorry, this is C-14. Would that be the same as page 55 on the handout you have just given us?

Q Yes, it is.

JUDGE BRENNER: You said 53. Did you mean--

MR. ELLIS: I was incorrect. I meant 55.

JUDGE BRENNER: All right.

WITNESS SARSTEN: I'm sorry, are you waiting for an answer?

WRBeb

1 MR. ELLIS: Yes, I am.

2 BY MR. ELLIS:

3 Q I asked you how does that define the orders to be
4 summed for DEMA purposes?

5 A (Witness Sarsten) All right. Here is says:

6 "....or a superimposed stress of less
7 than 7,000 psi created by the summation of the
8 major orders of vibration which might come into
9 phase periodically."

10 Q Is there any definition in DEMA as to how many
11 are the major orders?

12 A There is not.

13 Q Well, then this requires some interpretation,
14 doesn't it?

15 A I would not say it does. An engineer, looking at
16 this, would say that it is-- Let me first add that the
17 series of orders of course goes to infinity. An engineer,
18 looking at this, would read it, or at least I did, that this
19 is all the orders of vibration which are significant for the
20 accuracy of the result.

21 They cannot say summation of the all the major
22 orders because that would be an impossibility. There is an
23 infinite number of them.

24 Otherwise, if one is to choose a lower number of
25 orders than that which is commonly used, this DEMA standard,

WRBeb

1 which is supposed to be standard, would then allow the user
2 to choose from a menu of different orders and choose those
3 which he, to his own mind, would define as major orders
4 which would allow him, when summed, to bring the stress down
5 below 7,000 psi.

6 I do not believe that this is the right way to
7 construct a standard practice. It will allow the user all
8 the leeway he wanted to bring the stress level down to a,
9 for him, acceptable level.

10 Q I think you testified this morning that you did
11 not know when this standard was set, but if it was
12 established as I believe testified to by Dr. Chen in the
13 1958 time period, you would agree with me, wouldn't you,
14 that you could not sum 24 orders in that period of time for
15 purposes of DEMA?

16 A No, it would be quite a laborious exercise;
17 granted.

18 Q And indeed you have already testified that at
19 least until 1972 or '73, it did not become universal, even
20 in Europe, to use 24 summed orders, so that if there were--
21 Strike that.

22 JUDGE BRENNER: Are you going to ask him a
23 question about that, or are you going to testify yourself?

24 MR. ELLIS: I was using it for a leading
25 question.

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1 I'll withdraw that.

2 JUDGE BRENNER: It's okay to lead in cross-
3 examine, but the problem is if you have double assumptions
4 and don't give the witness the chance to answer as to --

5 MR. ELLIS: I agree.

6 BY MR. ELLIS:

7 Q Professor Sarsten, are all orders in the first 24
8 considered major?

9 A (Witness Sarsten) There are two definitions of
10 major orders. One is the major critical orders. The second
11 is major, which as used here, in the sense that they
12 contribute to the accuracy of the answer. Of course, all
13 the 24 orders do not contribute the same amount to the final
14 result, obviously.

15 Q How much does the third order contribute in terms
16 of percentage, if you know?

17 A I do not know. I would have to look that up. I
18 have made these calculations. A third is, as I remember, a
19 relatively large order. It is also a large order as regards
20 the effect of the oscillating mass. The third order
21 employed is the difference between the gas forces order and
22 the result of the oscillating inertia forces.

23 Q You don't know whether the third order, then, is
24 a large or small one in its contribution to the torsional
25 stress summations?

WRBpp

1 A Well, I've been sitting all evenings punching
2 these in. I have them in the computer printout. The third
3 order is a relatively large order.

4 Q All right. Would you look, please, at the
5 Exhibit C-17, page 3-14, Professor Sarsten?

6 MR. ELLIS: For the Board's convenience, that's
7 the crankshaft report.

8 WITNESS SARSTEN: Which page?

9 BY MR. ELLIS:

10 Q 3-14, Professor Sarsten.

11 Do you have that before you?

12 A (Witness Sarsten) I do.

13 Q Let me direct your attention to the stress for
14 the third order. It says, "The amplitude and displacement
15 for the third order," -- it says, ".001." Do you see that,
16 sir?

17 A I do.

18 Q That's very small in relative contribution, isn't
19 it?

20 A I thought you were asking about the magnitude of
21 the harmonic excitation. The others would depend upon the
22 specific example cited. It may be large, it may be small.
23 Depending upon the vibratory system being considered.

24 Q Well, is the third order, then, a fairly minor
25 contributor to the summation process that you go through?

WRBpp

1 A Referring to this specific case, we're not now
2 speaking of the magnitude of the harmonics. Then the third
3 order is a minor.

4 Q It's a minor one, isn't it?

5 A It's a minor contribution. But it is a major
6 order. I would say any of the 12 are major -- the first
7 24, then, are major orders. Some of them contribute more.
8 Some contribute less.

9 But I distinctly do not want to accept a method
10 of calculation which allows the user to sit and choose among
11 a menu of contributions to suit his own needs.

12 JUDGE BRENNER: Professor Sarsten, I'm a little
13 confused. Could you explain to me your distinction between
14 the contribution to the magnitude of the harmonics of an
15 order in this example, the third order, from the
16 contribution to the total and the summation of all the 24
17 orders processed?

18 WITNESS SARSTEN: I would like to try. What I
19 referred to originally in my answer was the harmonic
20 excitation of the third order. However, that excitation
21 may, for a specific system, not result in a large amplitude
22 of vibration of that order. The 0.001 here is the result.
23 It depends upon the number of cylinders and the phasing and
24 so on.

25 Now this will, in this case, not contribute

WRBpp

1 very much to the vector summation if they are in phase. In
2 can, at the most, contribute only one-thousandth to the
3 vector summation given at the bottom of the page.

4 JUDGE BRENNER: While I'm at it, if you will
5 forgive me, Mr. Ellis, I have one or two other things I was
6 confused on with regard to Professor Sarsten's use of these
7 orders.

8 MR. ELLIS: Yes, sir.

9 JUDGE BRENNER: Maybe I can clear it up in my
10 mind.

11 Looking at your Exhibit 3, Professor Sarsten, --
12 let me check. Yes, your Exhibit 3, which is your graphic
13 representation of the single orders.

14 WITNESS SARSTEN: That's correct. It shows a
15 fourth order and, to the left, the five and a half order,
16 which is here nearing resonance and increasing in magnitude
17 as we go toward the left towards lower revolutions of the
18 engine.

19 JUDGE BRENNER: Are those the only two orders
20 shown?

21 WITNESS SARSTEN: There is also at the bottom
22 shown the fifth order, which is a very insignificant
23 contribution. But it has a slight peak at its natural
24 frequency. The line is shown as five.

25 JUDGE BRENNER: What do the numbers in the right

WRBpp 1 vertical scale mean, four, five, six; then seven, eight,
2 nine?

3 WITNESS SARSTEN: Those are the various shafts.
4 There are different stresses in each of the various shafts
5 along the engine.

6 JUDGE BRENNER: Thank you.

7 Mr. Ellis?

8 BY MR. ELLIS:

9 Q Professor Sarsten, getting back now to the third
10 order with respect to the Shoreham 13 x 12-inch
11 crankshafts. Am I correct that I heard you say that that
12 would contribute no more than .001 to the summation of
13 stresses to meet the 7,000 PSI DEMA standard?

14 A (Witness Sarsten) That would be the maximum,
15 yes, if it were phased correctly.

16 Q So that would be less than 1 percent of the 7,000
17 allowable?

18 A I'm not good at mental arithmetic, but it would
19 be less than 1 percent of the allowable.

20 Q Would you agree with me, then, that this is not a
21 major order in terms of summing stresses for the DEMA
22 allowable?

23 A No, I would not. In this specific case, it turns
24 out that this order has a low value. It may not in other
25 cases.

WRBpp

1 Q Do you know whether Dr. Chen used number three in
2 his summation of 12 orders?

3 A No, I do not.

4 Q Professor Sarsten, you referred to a graph in
5 which you showed the fourth order and the fifth and a half
6 order. Are those the two orders that contribute the most to
7 the allowable limit of 7,000 psi?

8 A It would depend upon their phasing.

9 Q But I'm referring now to the Shoreham 13 x
10 12-inch crankshaft?

11 A I am too. It would depend upon the phase. You
12 have to take these two individual orders and run them for
13 the phase angles that are relevant. I've not done that.

14 Q You've not calculated the phase angles?

15 A The phase angles are given as input, of course.

16 Q So you've made no assumption about phase angles,
17 then.

18 A I think we're speaking on different wave
19 lengths.

20 The input to the computer program has, among
21 other things, a list of 24 amplitudes of harmonic
22 excitation. There is also a list of 24 phase angles of
23 harmonic excitation. I've had to have all these, of course,
24 in order to calculate the results.

25 Q Well, when you depicted on your graph, the fifth

WRBpp

1 and a half and fourth order, why did you select those two
2 for depiction on your graph?

3 A Because those were the orders which, in the speed
4 range we were considering, the rate of speed plus/minus 5
5 percent, had significant stress levels and some of them were
6 near resonance, so therefore, the magnitude of stresses
7 caused by the single orders were largest.

8 JUDGE BRENNER: Mr. Ellis, while you've paused, I
9 wonder if I could ask a question about that also?

10 MR. ELLIS: Yes, sir.

11 JUDGE BRENNER: Professor Sarsten, in giving your
12 results for the largest single order at 450 rpm at the
13 bottom of page 13, you report that -- this is in the very
14 last line of that page -- you report that as approximately
15 3800 psi. Whereas -- do you have that?

16 WITNESS SARSTEN: Yes.

17 JUDGE BRENNER: Whereas, on page 15 in the next
18 to the last line of the first answer, you report that as
19 being 3608 psi. Why is that figure different? Am I missing
20 something?

21 WITNESS SARSTEN: Yes. The one figure is the
22 results as they came out of the computer. The second figure
23 are the results corrected or refined to take into account
24 the measured values of the front end amplitude of the
25 engine.

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JUDGE BRENNER: Which is the refined one?

WITNESS SARSTEN: The 3608 calculated value of 3 -- where was it -- 3300 psi came out of the computer. This was based on the fourth order harmonic amplitude given by the owner's group data and, I believe, calculated by Failure Analysis Associates.

On page 15, the figure 3608 psi is the same figure diminished, or scaled down slightly, to agree with the measured front end amplitude due to the fourth order.

JUDGE BRENNER: I'm still confused, I'm sorry. Because when I look at your Exhibit 3, which is the graph, the measured value bowing at, what looks like it might be the 3608 point -- it's thought to be precise from that exhibit -- but a little above 3500, falls on the eighth position of the shaft. Whereas you still have a higher value which looks like about 3800 falling on the ninth position of the shaft. So aren't they two different values for two different shaft positions?

WITNESS SARSTEN: Actually the figure given is for the most highly stressed shaft, which is the ninth shaft, in this case. We have only one measured value at 450 rpm.

JUDGE BRENNER: And the measured value is for the ninth position?

WITNESS SARSTEN: Right. Perhaps I should have

WRBpp 1 noted that.

2 JUDGE BRENNER: All right.

3 Yes, again comparing two different portions of
4 your testimony, you apparently made no adjustment for your
5 sum or the 24 orders, in that you report that figure both
6 times as 7,096 psi, correct?

7 WITNESS SARSTEN: That figure has also been
8 adjusted. The calculated figure was 7,060-something. But I
9 calculate that to agree with the measured front end
10 amplitude of .693 degrees. It was a very, very minor
11 adjustment there because the calculated front end amplitude
12 agreed so well with the measured value.

13 JUDGE BRENNER: All right. But your testimony
14 only reports the adjusted value, then, in both places?

15 WITNESS SARSTEN: Correct, correct.

16 JUDGE BRENNER: I'm sorry, Mr. Ellis. I
17 interrupted because I wanted to try to get straightened out
18 before your cross-examination zeroed in on these specific
19 numbers.

20 MR. ELLIS: Yes, sir. And I have the same
21 question in mind.

22 BY MR. ELLIS:

23 Q Professor Sarsten, which then is the corrected
24 number for taking into account the measured front end
25 amplitude, the 7,096 or the 7,060?

WRBpp

1 A (Witness Sarsten) The 7,096.

2 If you'll look, the difference between them is
3 the ratio of 693, which is the measured value, to .690,
4 roughly, which was the calculated front end displacement.

5 Q Professor Sarsten, you say on page 12 that the 12
6 orders that Dr. Chen summed include the most significant
7 ones. How did you make that determination?

8 A I did not look at the orders individually. I
9 would assume that -- an assumption again -- that Dr. Chen
10 would take the most significant orders if he had only 12
11 available orders on his computer program. He would, of
12 course, choose the most significant ones.

13 Q What do you mean by the most significant ones,
14 the largest?

15 A I would assume he chose the largest orders, yes.
16 I do not know that. It's purely an assumption.

17 Q Were you here when Dr. Chen testified and
18 identified the orders which he summed?

19 A I heard his testimony. I perhaps would have to
20 have that re-read if I were to try to identify his orders.
21 But again, it would be purely an assumption.

22 Q Did you make any calculations of the third 12
23 orders. In other words, you computed the first 24, did you
24 make any calculations for 36?

25 A Not in this case. I have done, in previous

WRBpp

1 cases, just to test the accuracy of the computer program.

2 Q Do you know to what extent the second 12 --
3 strike that.

4 Can you name for me today the first 12, in terms
5 of contribution, for the Shoreham 13 x 12-inch crankshaft.
6 In other words, the 12 largest.

7 A You would have to define this. I can looking at
8 my computer program printout, find those which give the 12
9 -- the largest stresses in a certain shaft. But however,
10 when you add these vectorially, you do not know if these 12
11 will, indeed, give a larger vector summation and another
12 choice from the menu of 24 orders.

13 Q Well, my point is, can you tell me today, which
14 one -- which of the 24, which 12 of the first 24, would give
15 you the greatest contribution vectorially to the 7,000
16 allowable?

17 A Not without performing a large number of
18 calculations to make that choice.

19 Q And, I take it it follows that you cannot tell me
20 what contribution is made by the second 12, in terms of the
21 magnitude of vectorial contribution to the allowable?

22 A Not without calculating.

23 Q So when you say that the 24 orders are necessary
24 for the accuracy of the analysis, you cannot tell me today
25 whether the contribution of the second 12, in terms of

WRBpp 1 of vector magnitude amount to 1 percent, 2 percent, 3
2 percent, or any percent, can you? And I'm referring to the
3 Shoreham 13 x 12-inch crankshaft.

4 A My answer would be purely a guess without making
5 the calculation.

6 Q So your answer would be, no, you cannot tell me?

7 A Not exactly, no. I would guess, without knowing,
8 that it would be less than 10 percent. That's just a guess.
9 That's just off the top of my head, if that's what you want.
10 I don't think anyone can say that without calculating.

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JUDGE BRENNER: We are going to deny the motion. Professor Sarsten, as everybody can see, is clearly an expert in the performance of analyses of torsional vibration that is sufficient to give the testimony he is giving. He has also testified and has sufficient expertise to be permitted to give the testimony on what he thinks proper standard practices should be. He has explained candidly as to how he is applying what he's done to DEMA

WRBagb

1 Q Professor Sarsten, would you agree with me that
2 the standards such as DEMA are established on the basis of
3 the methodologies that exist at the time the standards are
4 adopted?

5 A I have not sat on the panel. It would be pure
6 conjecture on my part.

7 Q You mentioned the CIMAC standard. That -- I
8 think you testified today that is still a draft, is that
9 correct?

10 A That's still a draft and probably liable to be
11 for the next several years.

12 Q I take it that is because agreement has not been
13 reached among various manufacturers and suppliers and users,
14 is that right?

15 A Agreement has not been reached, but the agreement
16 is between the classification societies. The manufacturers
17 and users enter only indirectly into this consultation
18 through their respective classification societies.

19 Q Does the CIMAC that you mentioned, does that
20 refer to "major orders," or does it specify the specific
21 number of orders to be summed?

22 A As the rules are not finished yet, we do not know
23 what they will specify. But in a 1979 overview of the
24 proposed draft rules, they specifically mentioned 24 orders
25 as the standard used to achieve the accuracy they supposed

WRBagb 1 when using the rules.

2 Q Do you know whether -- Do you know what terms the
3 ABS standard uses to define the number or category of orders
4 for ABS purposes?

5 A I have read their rules but I do not remember
6 them specifically, no.

7 MR. ELLIS: Judge Brenner, in the interest of
8 saving time -- I may come back to that but I have to Xerox
9 something to make it easier for the parties.

10 JUDGE BRENNER: Did you want to add something,
11 Professor Sarsten?

12 WITNESS SARSTEN: No, I did not.

13 BY MR. ELLIS:

14 Q On page 10 of your testimony, your direct
15 testimony, Professor Sarsten, you indicated the rules of a
16 society may change with time as new design techniques,
17 materials and fabrication methods are developed.

18 Can you give me some examples of what you mean by
19 new design techniques?

20 A (Witness Sarsten) One thing that has come into
21 use sometimes, of course, is the finite element method which
22 has given a means of closer calculating the stresses in a
23 crankshaft.

24 Q Finite element analysis then has become generally
25 accepted as providing an accurate analytical means of stress

WRBagb 1 analysis, is that correct?

2 A There are finite element calculations and finite
3 element calculations. It depends upon the depth of the
4 analysis.

5 In the case of crankshafts, it requires a very
6 complex model with very, very many node points to achieve
7 sufficient accuracy.

8 Q Well have you -- Are you familiar with a book
9 written by Dr. Johnston on finite element analysis?

10 A No, not Dr. Johnston's book, no. I usually use
11 Zienkiewicz.

12 Q Is that a European author?

13 A That's a European author. He's in the University
14 of Swonsea, Wales.

15 Q When I said Dr. Johnston, did you know that I
16 intended Dr. Paul Johnston of FaAA at Stamford?

17 Did you know who I meant?

18 A No, there are two Johnstons.

19 JUDGE BRENNER: There is at least one other
20 Dr. Johnston but I guess he doesn't count.

21 MR. ELLIS: The only one I had ever heard before
22 was Sam Johnston and he wisely kept out of all this kind of
23 stuff.

24 JUDGE BRENNER: Yes, but I know you're fond of
25 quoting him so I mentioned him.

WRBagb 1

BY MR. ELLIS:

2 Q I meant Dr. Paul Johnston, who is sitting to my
3 right here.

4 Are you familiar with his book?

5 A (Witness Sarsten) No, I'm not familiar with his
6 book.

7 Q Did you familiarize yourself with the finite
8 element analysis that FaAA conducted in this case with
9 respect to the crankshaft?

10 A I have read through it, yes.

11 Q Well have you made an analysis of it or an
12 evaluation of it?

13 A It was given only as an outline. I formed my
14 opinions, perhaps, if that's what you're looking for.

15 Q You have not stated your opinions in your
16 testimony, have you?

17 A No.

18 Q Professor Sarsten, would a new design technique
19 -- as you have used that term of page 10 of your testimony
20 -- also include the ability to sum 24 orders rather than one
21 order or two orders or three orders?

22 A No, the rules.... No, that would not be what I
23 was thinking of.

24 Q Well is the ability to sum all orders and to
25 write these programs nonetheless a new technique to use in

WRBagb 1 connection with assessing the torsional stress of a
2 crankshaft?

3 A I don't know if you want to call it a new
4 technique. It has been around quite a while. I was not
5 referring to that when I made the statement.

6 Q Professor Sarsten, did you do any calculations on
7 the old 13 by 11 inch crankshafts?

8 A I did not.

9 Q On pages 16 and 17 of your testimony you state in
10 the bottom answer there that you would prefer to assess the
11 adequacy of the crankshaft based upon the large amount of
12 data represented by the appropriate classification
13 societies' rule and their experience in the interpretation
14 of these rules.

15 What are your reasons for thinking that a
16 classification society -- societies' experience in the
17 interpretation of its own rules is important?

18 A Because they have a very, very large basis of
19 data base with failed crankshafts and a very large amount of
20 information. It is not easy -- in fact it is sometimes
21 almost impossible for an engine manufacturer to read the
22 rules on his own. Some interpretation is usually required
23 from the classification society at hand.

24 The rules are different. Some classification
25 societies' rules are rather regular and straightforward.

WRBagb 1 Some depend upon the interpretation by the classification
2 society in order to be able to use them.

3 Q If the classification society does not tell you
4 the number of orders to be summed specifically in their
5 rules, that's a matter of interpretation, isn't it?

6 A The classification society only -- for example,
7 Det Norske Veritas, referring to that, for the crankshafts
8 which are the matter of contention here.

9 Q Why don't you talk about ABS, which is one of the
10 ones that's in issue here --

11 A All right.

12 Q -- and not the other.

13 A I have not had.... Wait, that might not be true.

14 I may have way back reviewed some crankshafts for
15 ABS, but I did not remember using their rules and I cannot
16 -- at least I have not used their present rules and I do not
17 know how they would interpret the data submitted to them as
18 regards torsional vibration calculations, for example, or
19 crankshafts.

20 Maybe we're on different wavelengths.

21 MR. GODDARD: Mr. Ellis asked a question which
22 dealt with classification societies in general and I believe
23 Dr. Sarsten was going to answer that question in light of
24 the rules of Det Norske Veritas, a Norwegian classification
25 society with whose rules he is very familiar and I would

WRBagb 1 like to hear him be allowed to provide that answer.

2 JUDGE BRENNER: All right. We'll allow it.

3 Did you want to go back to the answer you had
4 started with respect to Det Norske Veritas?

5 WITNESS SARSTEN: All right.

6 MR. ELLIS: May I hear as well his answer
7 that he gave with regard to ABS before it gets too far off
8 the record?

9 JUDGE BRENNER: You want the whole answer again?

10 MR. ELLIS: Yes, sir, that's the one I'm
11 interested in.

12 JUDGE BRENNER: Let me give you the gist of it
13 and then he can tell you if it's right or not, because he
14 repeated himself a lot of times while thinking out loud and
15 I don't think we have to hear it all, unless you really
16 think it's crucial at this point.

17 MR. ELLIS: Well I'm certainly going to ask him
18 further questions about the ABS.

19 JUDGE BRENNER: He doesn't remember if he ever
20 evaluated a crankshaft for the ABS using their rules and, in
21 any event, has no present recollection to offer as to how it
22 would be done under ABS.

23 Am I right, Professor Sarsten?

24 WITNESS SARSTEN: That's correct.

25 JUDGE BRENNER: He said some other things but

WRBagb 1 that's the gist of it. If you want it all, I will allow it
2 reread back.

3 MR. ELLIS: No, that's fine, Judge Brenner.

4 JUDGE BRENNER: Okay. I did not want to prevent
5 you from getting something you thought you needed

6 MR. ELLIS: No, I'm going to pursue that in a
7 minute, if I may.

8 May I do that now?

9 JUDGE BRENNER: No, let him back up to the answer
10 you interrupted, which is the cause of all this problem now.

11 WITNESS SARSTEN: We were speaking, I think,
12 about classification societies' rules and I mentioned Det
13 Norske Veritas. I have now either forgotten which tack I
14 was on when this interruption was made. Could I get the
15 question back which I was trying to answer?

16 MR. ELLIS: I will withdraw the question.

17 JUDGE BRENNER: No, because you have an objection
18 from the witness' counsel. He wants the witness to be
19 allowed to give the answer and in that light you have
20 withdrawn it after acceptance, if you will.

21 MR. ELLIS: All right. He can also ask him on
22 redirect. But I don't remember -- I think I was keying off
23 his general testimony on page 17 involving -- 16 and 17
24 involving the experience and interpretation of the rules by
25 the societies.

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JUDGE BRENNER: Why don't we go back to Mr. Ellis' question? Can you do that?

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

JUDGE BRENNER: Back on the record.

Do you recall what you started to say before you were interrupted with respect to Det Norske Veritas?

WITNESS SARSTEN: Yes. I said with respect to Det Norske Veritas the torsional vibration level for the crankshaft is not specified as such, however it does enter into the rules for the crankshaft together with the bending stresses.

The classification society, if they found the stress levels to be very high, would presumably check into the amount, the number of orders used and may, if they were below 24, request the submission of a full 24 orders of calculation.

Speaking about Det Norske Veritas, in this case I have submitted a crankshaft to them and had their views on this matter. And they find --

MR. ELLIS: Your Honor, I object to this. This goes well beyond any question I asked. He is now giving an opinion about what Det Norske Veritas may have opined and I think the Board has already ruled on that.

JUDGE BRENNER: That objection is sustained.

WRBagb 1

BY MR. ELLIS:

2 Q Professor Sarsten, with respect to ABS, do you
3 know whether ABS -- or have you checked with ABS to
4 ascertain how many orders ABS would consider adequate for
5 summation of the orders for the ABS allowable?

6 A (Witness Sarsten) I have not checked with ABS on
7 this matter, no.

8 Q And do you know what the ABS allowable is?

9 A For summing the orders?

10 Q Yes.

11 A I have the figure somewhere. I think in this
12 specific case the figure was four thousand six hundred and
13 something. It is in the testimony.

14 Q I refer you to page 15.

15 A Yes.

16 Yes, I'm sorry, it's 5035 psi.

17 Q And in those ABS rules, as I think I recall your
18 testimony, you do not know whether those rules -- how those
19 rules define how many orders are to be summed for that
20 allowable, do you?

21 A No, I have not had the rules interpreted.

22 Q You have not had the rules interpreted and you
23 testified you don't know how many they accept for being
24 summed.

25 How then, Professor Sarsten, do you reach the

WRBagb 1 that and close that issue out.

2 JUDGE BRENNER: All right. Fine. Let's break
3 now and come back at 3:40 using that clock.

4 (Recess.)

5 JUDGE BRENNER: Back on the record.

6 Mr. Ellis, do you have a time estimate as to
7 how much more you have?

8 MR. ELLIS: Yes, sir, I do. I think that I will
9 have approximately three more hours. No more than that.
10 That's an extravagant estimate. That's for both
11 Mr. Henriksen, whom I had not counted on, and Dr. Sarsten.

12 JUDGE BRENNER: It's certainly a lot different
13 than the estimate this morning when I suggested I thought
14 all parties could complete their examination of the Staff's
15 witnesses on crankshafts and I heard no dissent.

16 MR. ELLIS: Well it's the old story of finding
17 more than -- but I will do my utmost to expedite it and I
18 may be incorrect but I would rather give you an estimate
19 that is too long rather than one that was too short.

20 JUDGE BRENNER: Right. You're not going to
21 exceed three more hours, that's what you're telling me.

22 MR. ELLIS: Yes, sir. I'm pretty clear that I
23 can finish in three hours.

24 JUDGE BRENNER: All right.

25 MR. ELLIS: I say that without having -- I

WRBagb 1 focused chiefly on Professor Sarsten, but I --

2 JUDGE BRENNER: I think it may be inefficient to
3 have done that and I was going to ask you -- and this is as
4 good a time -- when are you going to open up these questions
5 to the entire panel?

6 MR. ELLIS: In the not too distant future. It
7 may be inefficient but I think it is more effective.

8 JUDGE BRENNER: Okay. Maybe you're right. Why
9 don't you proceed?

10 BY MR. ELLIS:

11 Q Professor Sarsten, does it refresh your
12 recollection with regard to the ABS standard if I tell you
13 that the ABS standard refers to significant non-resonant
14 harmonics that are to be summed. They use the word
15 "significant." Does that refresh your recollection?

16 A (Witness Sarsten) Yes.

17 Q All right.

18 With respect then to the use of the term
19 "significant," would you say that the third order which
20 contributes less than 1 percent, is that a significant
21 non-resonant harmonic or an insignificant one?

22 A In this specific case, the contribution would not
23 be significant. But without going through all the orders
24 and all the contributions, I don't think anyone can a priori
25 determine which orders are significant or not.

WRBagb

1 Q All right. Let's assume that you go through and
2 you calculate all 24 orders.

3 What is the benchmark or at what level would you
4 say that the orders are significant and below which they are
5 insignificant in terms of contribution?

6 A If I first have all the 24, I would add them in.
7 Why speculate on which is more important than the other?
8 There's no point in that. You go through all the 24 orders
9 when you first have your program.

10 Q Well accept the assumption, Professor Sarsten:

11 You calculate 24 orders, you are now going to sum
12 them vectorially. And I want to know from you at what point
13 or at what level in terms of percentage contribution does an
14 order become significant?

15 A If we have 24 orders and we are close or above
16 the limit, I would not exclude any order as being
17 insignificant. Because even a small contribution can bring
18 the vector summation over the top. We do not know how it
19 will phase in -- phase-in, phase-out, I was about to say --
20 and add or subtract from the total. We're playing games
21 here, really, and making an exercise which one would never
22 do in practice.

23 Q When you testified just now that one would never
24 do this in practice, you in fact do not know what was done
25 in practice in connection with the American Diesel Engine

WRBagb 1 Manufacturers' Association, do you?

2 A If you are speaking of specific calculations
3 submitted, I would have no way of knowing what the
4 individual manufacturers were doing. But I hope that the
5 individual manufacturer would not sit down and choose and
6 wheedle and remove certain orders in order to get a desired
7 result. The most efficient, as far as time and effort goes
8 and also the most straightforward method would be to include
9 all the orders once you have a computer program that is
10 capable of doing this.

11 Q Well my question to you was that at what point
12 does an order, when summed vectorially, become insignificant
13 in terms of its contribution?

14 MR. GODDARD: Objection. I believe this has been
15 asked and answered repeatedly.

16 MR. ELLIS: I don't believe he's ever answered
17 that question, Judge.

18 JUDGE BRENNER: I'm going to give Mr. Ellis
19 leeway on cross-examination. I won't know until the answer
20 if it has been answered repeatedly. It certainly has been
21 asked a number of different ways and there has been some
22 confusion in language between the questions and the answers
23 and that's another reason to give Mr. Ellis leeway on
24 cross. So the objection is overruled for those reasons.

25 WITNESS SARSTEN: I would not like to consider

WRBagb 1 any order insignificant. If we are -- well strike that.

2 In general I would not like to consider any order
3 insignificant because we do not a priori know if it will add
4 or subtract to a perhaps already large number and we do not
5 know a priori perhaps if the sum of these orders will lie
6 exactly on or just below or just above the limiting value.
7 That's about all I can say, I'm sorry.

8 BY MR. ELLIS:

9 Q Well Professor Sarsten, I don't think you. Let
10 me try again.

11 I think you've testified that you agree that the
12 fourth order does not make a significant contribution.

13 A (Witness Sarsten) Third order.

14 Q Third order, I'm sorry.

15 Now you've also testified that the third order
16 contributes less than 1 percent.

17 Now what I'm asking you is at what percentage
18 contribution level does an order cease to make a significant
19 -- an insignificant contribution and begin to make a
20 significant one?

21 A Personally I would not like to weed out any
22 orders. And again it depends upon where the sum, the vector
23 sum lies. A very small value can be the straw that breaks
24 the camel's back, so to speak, when you're at the limit.

25 Q So is it your testimony then that no matter how

WRBagb 1 small the contribution of any order, you would require that
2 it be summed?

3 A No. If you do that you would go beyond the 24 to
4 infinity of orders. We have to set a limit to the number of
5 orders somewhere. Below 24 I would add them all, no matter
6 how large or how small they would be.

7 Q But you have already testified that less than 1
8 percent contribution is not significant.

9 What percentage contribution is significant?

10 A Less than 1 percent. Are we speaking of 70,000
11 psi? There may be some misunderstanding here.

12 That would be 70 psi. That could make or break
13 the sum of orders if you are close to the limit.

14 Q Where did you get the figure 70,000?

15 A 7,000, I'm sorry, psi.

16 Q All right.

17 Now didn't you tell me earlier that the third
18 order contribution is less -- substantially less than 1
19 percent?

20 A To the front end amplitude, yes.

21 Q All right.

22 So when you get ready to sum its contribution to
23 determine 7,000, you're going to get a very small number,
24 isn't that right?

25 A The number will be small, but I would not

WRBagb 1 neglect it.

2 Q Well would you neglect the contribution of 1 psi
3 to the 7,000 allowable?

4 A All right. That does not amount to much. But
5 I'm speaking of more than 10 psi. It really contributes to
6 the answer.

7 Q Well going up from 1 psi, at what point would you
8 say it becomes significant?

9 A Remember we are summing a large number of orders
10 and even though the individual contribution may be small,
11 the sum of a number of small contributions, when in phase,
12 can add up to a figure which is not negligible. So it is
13 difficult to give a fixed value. It must be less than 1
14 percent at least.

15 Q Is that only when you are at a point that is
16 close to the allowable?

17 A The same rule should apply no matter what, no
18 matter where we are. We don't know beforehand where we will
19 wind up.

20 Q Professor Sarsten, let me -- I think I asked you
21 earlier and you testified that you do not know whether ABS
22 summed any order of its own and, if so, how many orders.

23 Based on your testimony concerning classification
24 societies, you will agree with me, won't you, that the
25 number of orders that ABS summed, if they summed orders,

WRBagb 1 would be significant in terms of the interpretation and
2 application of the ABS standard?

3 A According to the ABS standards they can approve
4 the crankshaft also on other premises than the torsional
5 vibration levels.

6 Q Yes, but that wasn't my question, Professor
7 Sarston. Do you want me to repeat it or have it repeated
8 again?

9 A Yes, please do.

10 MR. ELLIS: Repeat the question, please.

11 (Whereupon, the Reporter read from the record
12 as requested.)

13 WITNESS SARSTEN: There are many if's and but's
14 in that long question. It's a little perhaps hard to answer
15 it.

16 Could you rephrase it and break it down into
17 simpler parts which I can retain in my somewhat porous
18 memory?

19 MR. ELLIS: Sure, Professor Sarsten, I would be
20 glad to.

21 BY MR. ELLIS:

22 Q Professor Sarsten, on pages 16 and 17 you said
23 you already testified that ABS "...was among the societies
24 that you had in mind when you gave that testimony and
25 there you said that you prefer to assess the adequacy of

WRBagb 1 the crankshaft based upon the large amount of data
2 represented by the appropriate classification
3 societies' rules and their experience in the
4 interpretation of these rules."

5 ABS' experience in the interpretation of its
6 rules is important, isn't it?

7 A Yes. But I was not referring to the ABS
8 specifically here because the ABS has not perhaps the widest
9 experience in diesel engine crankshafts that some of the
10 other major classification societies have. Their rules are
11 not very -- their rules do not take into consideration the
12 torsional vibratory stresses when dimensioning the
13 crankshafts, for example.

14 Q Is it your testimony that the American Bureau of
15 Shipping is not content to issue standards relating to
16 torsional stresses for crankshafts for medium-speed diesels
17 such as the one at Shoreham?

18 A No. I only said that the torsional vibratory
19 stresses do not enter specifically into their scantling
20 rules or dimensioning rules for the crankshaft.

21 Q But they do take into account the dimensions in
22 approving a crankshaft, don't they?

23 I'm sorry. They do take into account the
24 torsional vibratory stresses in deciding whether to approve
25 a crankshaft or not?

WRBagb

1 A Deciding whether to approve it, yes, but not as
2 far as the approving the dimensions of the crankshaft goes,
3 the horsepower rating enters but not the vibratory torsional
4 stresses.

5 Q Professor Sarston, look if you would, please, at
6 Exhibit -- County Exhibit 43.

7 MR. ELLIS: Judge Brenner, this is the one I
8 thought I would have to Xerox but the tendency of all to put
9 in all seems to have taken care of that.

10 BY MR. ELLIS:

11 Q Do you have that in front of you?

12 A (Witness Sarsten) No, I do not.

13 Q Maybe your Counsel can furnish you with it.

14 (Document handed to witness panel.)

15 JUDGE BRENNER: I guess I only heard half of your
16 last comment about the tendency... Were you criticizing the
17 County for including something you want to use?

18 MR. ELLIS: No, I said all the parties.

19 JUDGE BRENNER: I have already given you my
20 somewhat veiled and perhaps uncharacteristically subtle
21 opinion that the parties have not met their responsibilities
22 in screening which portions of these exhibits are
23 appropriate for evidence and in the discussion we had last
24 week with the Staff's Exhibits 7 and 8 on a minor scale
25 reinforced that point and I still heard nothing further from

WRBagb 1 the parties in that regard.

2 MR. ELLIS: I understand, Judge Brenner.

3 BY MR. ELLIS:

4 Q Exhibit 43 is the deposition of three witnesses
5 from the American Bureau of Shipping. This is a transcript
6 I think you testified you had reviewed, is that right,
7 Professor Sarsten?

8 A (Witness Sarsten) That's correct.

9 Q You see attached are the exhibits to that
10 deposition transcript. Do you see that, Professor Sarsten?

11 A Yes.

12 Q Okay. And you see the calculations that are
13 attached to that?

14 A The computer printouts here?

15 Q No, the calculations that are attached to it,
16 handwritten calculations.

17 A Yes.

18 Q Okay.

19 Do you recall the reference to those when you
20 reviewed the transcript as being the calculations of ABS?

21 A I have seen the transcript. I have not seen
22 these calculations.

23 JUDGE BRENNER: At least one page is almost
24 totally illegible, obliterated is more to the point. That
25 is, it's blank in my copy.

WRBagb 1

MR. ELLIS: Yes, I have the same problem.

2 If you will find that page, that's a good
3 benchmark since they are not numbered; it's the one just
4 prior to that. I think in fact what that is, Judge Brenner,
5 is it is not a blank page but I think it is merely the
6 remainder -- if you look at the right-hand side and I'm
7 speaking not for one of my own exhibits but only for -- in
8 the hope that I might clarify, I think that second page is
9 nothing more than the remainder of what was cut off from the
10 page right before it.

11 Do you see what I mean?

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1 MR. SCHEIDT: This is the way it was provided to
2 the parties by the ABS when it was copied at the time of the
3 deposition. And the second page to which Mr. Ellis is
4 referring is the runoff or the extra section of the
5 righthand margin of the page that precedes it.

6 JUDGE BRENNER: Particularly since we are dealing
7 with numbers, I'm not going to speculate on whether there
8 are any digits missing in between the two pages.

9 MR. ELLIS: Well, let me just ask a short
10 question and may end this.

11 BY MR. ELLIS:

12 Q Professor Sarsten, can you tell how many orders
13 summed from looking at the page that I referred you to,
14 which is the page immediately prior to the one that is
15 largely blank?

16 A (Witness Sarsten) I have not seen this before so
17 it's a little difficult. My testimony ends on page 173. I
18 have not seen this before.

19 Q I understand you haven't seen -- you have seen
20 the transcript before?

21 A The main transcript, not the attachments.

22 Q Right.

23 Now, can you tell, from looking at that
24 calculation how many orders were summed?

25 A I would have to go through it in detail, the

WRBpp 1 specific page you're referring to here?

2 Q That's right -- well --

3 Look at the handwritten calculations. Do you see
4 those?

5 A Yes.

6 Q Okay. Let me direct you to the fifth page, do
7 you see those?

8 A What's at the top of the page, just as a check?

9 Q Critical speed for five and a half order.

10 A Correct. I have that page here.

11 Q Can you determine, from that page, how many
12 orders were summed?

13 A I would not like to do so without going through
14 all the calculations and finding what's going on.

15 Q I beg your pardon?

16 A I would not like to guess here without going
17 through all the pre-calculations and seeing what's going
18 on. But being a handwritten calculation, I would be
19 surprised if it were more than one order. That's all I can
20 say.

21 Q Can't you tell where you see the square root of
22 $25/37$ ths squared plus the square root of $35\ 39/58$ ths
23 squared?

24 A It looks like two figures are being summed.
25 That's all I can say. What they are, I don't know here.

WRBpp

1 JUDGE BRENNER: Presumably, by the square root,
2 the sum of the squares method?

3 BY MR. ELLIS:

4 Q Professor Sarsten, on page 17 of your testimony,
5 you conclude that, in your opinion, the 13 x 12-inch
6 crankshafts do not meet the ABS requirements regarding
7 torsional vibration stresses. In light of your testimony
8 that you do not know how many orders ABS sums, or accepts as
9 being adequate or summing, and in light of the fact that
10 you have not contacted ABS concerning the interpretation of
11 their rules or reviewed their calculations, is it unfair to
12 say that you don't have a basis for reaching a firm
13 conclusion that the ABS requirements are not met?

14 A (Witness Sarsten) The figure set forth here of a
15 little over 5,000 psi is way below the calculated figure.

16 Q What figure are you referring to?

17 A If we are now speaking of the sum of the orders.

18 Q I thought you couldn't tell what that figure was?

19 A I, again, was speaking on different --

20 Q Oh, I see. You're talking about the 5,035 on
21 pages 15 of your testimony?

22 A That is correct.

23 Q And you arrived at that by summing 24 orders, is
24 that correct?

25 A No. I arrived at that from the calculations

WRBpp 1 submitted to ABS. That is not a calculation of mine. That
2 is the ABS limit, and the TDI calculations submitted to
3 ABS. If we're speaking of the same thing, now.

4 Q Did you compare the 7,096 to 5,035?

5 A I'll have to get the figures correct. There's
6 5,000-something, yes, I'm sorry. 5,035, you say. That
7 sounds, a little over 5,000, that sounds correct.

8 JUDGE BRENNER: Look at page 15 of your
9 testimony, Professor Sarsten.

10 WITNESS SARSTEN: Yes.

11 JUDGE BRENNER: We don't need to think out loud.

12 WITNESS SARSTEN: Here we are, 5,035. That is
13 TDI's figure for allowable vibratory stresses.

14 JUDGE BRENNER: Okay, now, ask your question.

15 WITNESS SARSTEN: -- as they interpret the ABS
16 rules.

17 JUDGE BRENNER: Now, ask your question again,
18 Mr. Ellis.

19 BY MR. ELLIS:

20 Q Didn't you just take the sum of 24 orders as
21 7,096 and compare it to the 5,035 psi ABS figure?

22 A (Witness Sarsten) I did. That would be
23 standard practice, in such cases.

24 Q You don't think it is at all significant what ABS
25 itself did in this case, in light of your testimony that the

WRBpp

1 ABS's interpretation of its own rules is important?

2 A The ABS's interpretation of its own rules is, of
3 course, important. And, of course, they're the only ones
4 who can move upon this if the crankshaft meets the rules
5 or not. I can only say that the stress I have calculated is
6 above that which the rules allow using 24 orders. It's
7 clear that ABS can accept any stress level they want to, do
8 it in any fashion they wish to. They can approve the
9 crankshaft on any other basis than torsional vibration if
10 they so wish. I've only stated the calculated stresses, and
11 the allowable stress levels.

12 Q And your testimony, then, is based on the use of
13 24 orders which, you say, is standard practice in Europe
14 these days to some orders to torsional stress?

15 A That is true. I'm here also that ABS is one of
16 the classification societies sponsoring the so-called CIMAC
17 rules. The matter of 24 orders is not under contention as
18 far as, you understand, an accepted practice for all these
19 classification societies.

20 Q Do you know why ABS did not use 24 orders in the
21 promulgation of its standard that sets 5,035 as the
22 allowable?

23 A Did not use 24 orders in the -- could you --

24 Q Why didn't ABS specify 24 orders when it
25 established its allowable for summation at 5,035 psi.

WRBpp

1 MR. SCHEIDT: Objection. There's no foundation
2 that ABS did, in fact, do as Mr. Ellis states.

3 JUDGE BRENNER: The objection is sustained. It
4 anticipates a question I wanted to interrupt and ask.
5 Because, Professor Sarsten, and I'm going to ask the
6 question now: In passing, you refer to the 5,035 psi
7 figure as the ABS allowed figure. Did I hear you correctly?

8 WITNESS SARSTEN: That's correct. That's taking
9 from the TDI calculation submitted to ABS.

10 JUDGE BRENNER: You don't know what ABS's allowed
11 figure is according to ABS, do you?

12 WITNESS SARSTEN: No, they would have to move
13 upon that. They would have to judge that for themselves, of
14 course.

15 JUDGE BRENNER: In other words, ABS, if I'm
16 understanding your testimony in the first answer on page 15
17 correctly, doesn't have a precise figure. Rather, they have
18 a means -- well, let me ask you:

19 How does one arrive at the allowable figure for
20 total vibratory stresses under the ABS?

21 WITNESS SARSTEN: It's in the ABS rules and this
22 figure was increased to take the added ultimate tensile
23 strength of the crankshaft into consideration. And that was
24 submitted by TDI to ABS.

25 JUDGE BRENNER: Well, what's in the ABS rules?

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1 The figure?

2 WITNESS SARSTEN: The ABS rules has a certain
3 figure for a certain grade of steel. If you have a higher
4 grade of steel you're allowed to escalate that limiting
5 value according to the steel grade.

6 JUDGE BRENNER: Well then, why do you need a TDI
7 calculation of the values that would be allowed by ABS if
8 it's as simple as going to the ABS rules with some
9 adjustments in getting the allowable figure from the rules?

10 WITNESS SARSTEN: Because it had been done
11 there.

12 JUDGE BRENNER: I'm sorry. What had been done
13 where?

14 WITNESS SARSTEN: I'm sorry. Because these
15 calculations had already been performed by TDI.

16 It is our purpose, I have understood, to review
17 the calculation, not to repeat and re-do all calculations on
18 our own. I've only performed calculations in cases where
19 the accuracy, perhaps, of stress or where the figures were
20 very critical. I've not repeated all calculations in all
21 things I have reviewed.

22 JUDGE BRENNER: Well, that doesn't clarify very
23 much for me. But I'm going to bow out and allow you to have
24 your up to three hours to the extent that I can and if
25 somebody does some clearing up before it gets back to me,

WRBpp

1 I'll try again.

2 Go ahead.

3 MR. ELLIS: Judge, I think I'm doing my best. I
4 hope I'm moving it along as quickly as I can.

5 JUDGE BRENNER: I was criticizing myself for
6 interrupting you and not you.

7 Go ahead.

8 BY MR. ELLIS:

9 Q Professor Sarsten, turn to Exhibit 2, to your
10 direct testimony, if you would, please?

11 A (Witness Sarsten) I have it.

12 Q This exhibit shows stresses at 450 rpm and then
13 at higher and lower rpm's as well, for a number of orders,
14 is that correct?

15 A That is correct. But it refers to a number of
16 different shafts. Shaft 6 is the most critical shaft.

17 Q Thank you.

18 The point in the middle at 450 rpm is the point
19 at the continuous speed of the engine isn't it?

20 A That's correct.

21 Q And that's the point that appears on 7,096, is
22 that correct?

23 A That was plotted at the -- let me see -- that is
24 plotted at the calculated value of almost 7,100 -- 7,096,
25 yes, I think that was the figure.

WRBpp

1 Q All right.

2 Then you calculated other stresses at over speed
3 and under speed conditions. Are those steadystate or
4 transient conditions?

5 A Those are steady state conditions.

6 Q What do you mean by steady state conditions?

7 A I mean a steady state condition is such that when
8 you start the calculation at, for example, top dead center
9 of crankshaft one, everyone of the masses after 7720 degrees
10 of rotation will have the identical amplitude and identical
11 velocity.

12 May I add identical to the initial value that was
13 implied. The values will be identical to the start values.
14 When you start the calculations that is termed as a steady
15 state solution.

16 Q Do you know what the governor response of the
17 Shoreham engines is for underspeed and overspeed conditions?

18 A It has been stated at roughly 2 to 3 percent, I
19 believe. Somewhere in the transcript.

20 Q Okay.

21 Let me refer you to Exhibit C-17, page 2-5.

22 A I will need some help here.

23 We have it.

24 Q All right.

25 You will see referred there, that the largest

WRBpp

1 variations in speed were minus 3 percent, 2 plus 2 percent,
2 do you see that?

3 A I see that.

4 Q And that the time lag associated with the unit's
5 ability to return the 450 rpm was likewise found to be less
6 than 3 seconds?

7 A I see that.

8 Q Given that, wouldn't you agree that it is not
9 unrealistic to accept that there will be under speeds and
10 over speeds stresses of any significance actually
11 experienced by the engine?

12 A I would not because those are requested by the
13 DEMA standard practices which are invoked in this case. But
14 the range covered by the governor is not addressed here. Or
15 it's only addressed in the DEMA standards.

16 Q So you're saying that a rigid application of the
17 DEMA standard required you to make those calculations?

18 A Rigid or not. That's not the question. The
19 application of them, I would delete the word, rigid.

20 Q Just the application?

21 A Yes.

22 Q Then stated 105 percent and 95 percent?

23 A It's stated plus or minus 5 percent, which is the
24 same as 95 to 105.

25 Q There is no ambiguity there as there was with

WRBpp

1 respect to the summation of major orders, is that right?

2 MR. GODDARD: I object to the form of the
3 question.

4 MR. SCHEIDT: I object.

5 JUDGE BRENNER: I'm going to allow it if he's
6 asking it as a serious question. A cross examiner is
7 entitled to probe. I think it arguably redundant, but let's
8 see what happens.

9 WITNESS SARSTEN: Again, there were two
10 simultaneous objections which drowned out the question.
11 Could you repeat it?

12 MR. ELLIS: Yes. I'll repeat it, Professor
13 Sarsten.

14 BY MR. ELLIS:

15 Q I would say there was no ambiguity with respect
16 to the under speed and over speed situations contrary to the
17 ambiguity that exists on the summation of major orders,
18 isn't that right?

19 MR. SCHEIDT: Objection.

20 JUDGE BRENNER: I overrule the same objection.
21 You can't object twice on two different times to the same
22 question. It's overruled.

23 WITNESS SARSTEN: I personally do not consider
24 there is much ambiguity in the other case, either. But here
25 it is not even a matter for discussion.

WRBpp

1 BY MR. ELLIS:

2 Q In the other case, it's a matter for some
3 discussion.

4 A (Witness Sarsten) Well, you can -- I've heard
5 Professor Chen has had other views on this matter in his
6 testimony.

7 Q Are you also saying that you realistically, as an
8 engineer, expect that with the response times given for this
9 engine as they are, that the underspeed and overspeed
10 conditions reflect something realistic that the engine will
11 experience?

12 A It is not for me to decide. I only have to look
13 in the DEMA regulations. Secondly, I must remind you that,
14 under recent applications, one of the Shoreham engines
15 indeed did exceed these limits for a considerable period of
16 time under load.

17 JUDGE BRENNER: Is that the so-called excursion
18 of the 103 engine, Professor Sarsten, that you have in mind?

19 WITNESS SARSTEN: Exactly.

20 JUDGE BRENNER: Do you know how far over 100
21 percent that engine operated at?

22 WITNESS SARSTEN: I heard that it went below 390
23 rpm. And enormous excursion in terms of rpm.

24 JUDGE BRENNER: Do you know, though?

25 WITNESS SARSTEN: Beg pardon?

WRBpp

1 JUDGE BRENNER: I did not measure one myself. I
2 read some testimony to that effect. I'm sure we will hear
3 more about that in at least one other context.

4 MR. ELLIS: Judge Brenner, I would move to strike
5 that, since he doesn't have any basis for that testimony as
6 to how low it went, 300 and whatever it was rpm.j

7 JUDGE BRENNER: I'll tell you what. I won't rely
8 on his figure for it and you remind me to ask somebody that
9 you think knows on behalf of LILCO at the appropriate point.

10 MR. ELLIS: Yes, sir. I think we can do that.
11 That panel has already testified, I believe. But --

12 JUDGE BRENNER: Well, somebody who knows a bit
13 about blocks might know about it.

14 MR. ELLIS: They do. Mr. Youngling will know,
15 Judge Brenner.

16 JUDGE BRENNER: That's one of the major reasons
17 ascribed for why there are problems with the 103 cylinder
18 block, is that correct?

19 MR. ELLIS: That's right. I'm just telling you
20 who would know, Youngling.

21 BY MR. ELLIS:

22 Q Dr. Sarsten, another question about ABS. I take
23 is it fair to say since you have not reviewed the ABS
24 calculations, and don't know how many orders they use in
25 summing, that you have no opinion regarding the adequacy or

WRBpp

1 the accuracy of the ABS calculation and evaluation of the
2 Shoreham crankshafts?

3 A (Witness Sarsten) Are you referring to the
4 attachment to the testimony, the handwritten calculations?

5 Q Yes.

6 A I have no opinion, of course, not having seen
7 them before or reviewed them.

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1 Q Dr. Sarsten, is DEMA applicable to a specific
2 design and manufacturer of crankshafts or to a range of
3 crankshafts?

4 A DEMA is an engine manufacturer organization. I
5 would like to believe that it is applicable to a range of
6 low- and medium-speed stationary diesels engines, the range
7 we refer to.

8 MR. ELLIS: Judge Brenner, I am on page 5, Roman
9 III-A and B, in that area.

10 BY MR. ELLIS:

11 Q Professor Sarsten, so the 5,000 psi for a single
12 order and the 7,000 psi for a summation of the major orders
13 are general figures meant to apply to a range of
14 crankshafts. Isn't that right?

15 A (Witness Sarsten) If by "range" you mean a
16 certain number of makes and rotational speeds, yes.

17 Q And also different materials, different
18 geometries for fillets?

19 A None of this is mentioned in the DEMA standards,
20 so I would assume that it is applicable to also these
21 different crankshaft configurations.

22 Q Do you know how DEMA defines the range of
23 crankshafts to which it is applicable?

24 A They name low- and medium-speed engines for
25 stationary purposes. They also have another recommendation

WRBeb 1 for marine applications which covers a larger speed range.

2 Q Well, do they make any assumptions or statements
3 about the kinds of materials that crankshafts should be made
4 of to fall within the application of the DEMA standard of
5 5,000 and 7,000 psi?

6 A Yes, they mention on page 53 shafting information
7 such as physical characteristics and materials, lengths,
8 diameters, et cetera, and they have a number of other data.

9 Q This is page 53 of the handout that I gave you
10 earlier today?

11 A Correct.

12 JUDGE BRENNER: C-14.

13 MR. ELLIS: C-14.

14 BY MR. ELLIS:

15 Q My question though was does DEMA say anything
16 about the kind of materials, the kind of steel that the
17 crankshaft should be made of in order to fall within the
18 scope of the DEMA standard?

19 A (Witness Sarsten) I would have to read it again
20 and check that. I cannot remember any specific reference to
21 steel.

22 Q Would it refresh your recollection if I tell you
23 that DEMA refers to "conventional materials"?

24 A All right.

25 Q Well, "all right." If it does refresh your

WRBeb 1 recollection you can tell me it does. And if it doesn't--

2 A It does, yes.

3 Q Okay. I see.

4 What does "conventional materials" mean?

5 A Well, that is a rather broad phrase. It can mean
6 really a lot of things. It is not very specific.

7 Q Well, do you know what assumptions, if any,
8 Professor Sarsten, are made by DEMA with respect to ultimate
9 tensile strength or forging process, surface finish,
10 clearance limits, or matters of that sort?

11 A No. They may have a reference to conventional
12 manufacturing procedures. I do not know.

13 Q Do you know what material the original
14 crankshafts at Shoreham were made of?

15 A Yes. I think it had-- At least one of the
16 shafts had a UTS of 93,000, and it varied somewhat.

17 I have also seen a test figure of 88,000 for
18 another of the shafts.

19 JUDGE BRENNER: I didn't get the first figure. I
20 don't know if the Reporter did.

21 WITNESS SARSTEN: 93,000 psi.

22 JUDGE BRENNER: Ultimate tensile strength?

23 WITNESS SARSTEN: Correct.

24 BY MR. ELLIS:

25 Q Do you know what the figures are for the new

WRBeb 1 13 by 12 inch crankshafts?

2 A (Witness Sarsten) They are somewhat higher,
3 roughly 100,000 psi. I remember a figure of one hundred
4 thousand, seven hundred, and I think it was seventy-seven
5 psi for the lowest of these.

6 Q Do you know what range DEMA assumes as being
7 pertinent for their 5000 and 7000 allowable limits for
8 torsional stresses?

9 A DEMA does not refer to any steel specification,
10 as far as I'm aware, except that the material be as stated
11 earlier.

12 Q It would be relevant, though, wouldn't it,
13 Professor Sarsten--

14 Did I interrupt you? I'm sorry.

15 A No; you're correct. Go ahead.

16 Q It would be relevant, though, wouldn't it,
17 Professor Sarsten, to an assessment of whether a crankshaft
18 was adequate?

19 A The material specifications of course would be
20 relevant to an assessment of the adequacy of the crankshaft
21 if it were done under a classification society rule. But,
22 however, the DEMA rules do not take the material into
23 consideration whatsoever anyway.

24 Q Except insofar as, I think, you have conceded
25 that I refreshed your recollection that it calls for

WRBeb 1 conventional materials.

2 A Right.

3 Q But in terms of assessing whether the crankshaft
4 is adequate or not, you would agree with me that if the
5 tensile strength were very high, then if the summation of
6 the orders were close to the allowable, that would be less
7 significant than if the tensile strength were substantially
8 lower?

9 A As there is nothing in the DEMA rules about this,
10 we cannot speculate on what we would like to do. The rules
11 are straightforward. As far as I am concerned, there is a
12 limit of 7,000 psi for the summation of the orders,
13 irrespective of the material employed.

14 Q Well, let me just give you a hypothetical.

15 If the steel used in the crankshaft in issue had
16 an ultimate tensile strength of -- instead of 100 or 102
17 ksi, if it had 100,000 ksi, would you be concerned that the
18 summation of the orders then was 7096?

19 A It is not my prerogative to be concerned or not.
20 It is to judge if the vibratory torsional stresses are above
21 or below this limit.

22 I concede, if we were looking at the adequacy of
23 the crankshaft in another context, that would be something
24 we could discuss, but not here.

25 Q What do you mean by the "adequacy of the

WRBeb

1 crankshaft in another context"?

2 A If we were looking at the adequacy of a
3 crankshaft with very high tensile strength, it would of
4 course influence the results we came to if we reviewed that
5 crankshaft under Lloyd's rules or Veritas rules or
6 whatever. But here we are looking at just a limit on the
7 torsional vibratory stresses in which the material does not
8 enter into the picture, the way the rules are formulated
9 today.

10 Q But the rules assume some range of materials,
11 don't they?

12 A The rules only assume that the materials must be
13 as good or better than the conventional.

14 Q The quality of materials you say has improved,
15 Professor Sarsten, since the late '50s to today for use in
16 crankshafts.

17 A The quality of materials has, in the cases where
18 I have been more intimately concerned, improved over the
19 years. This is due to the intense competition, the rise in
20 break mean effective pressures, and maximum firing
21 pressures, and the wish to remain competitive without
22 building enormous engines and crankshafts which would be too
23 costly. Yes.

24 Q You said that the materials for DEMA had to be --
25 I think you said conventional or better. Can you show me

WRBeb 1 anywhere in DEMA where it says conventional or better?

2 A No. You asked me perhaps to interpret the
3 rules. We can get the reading exactly from the DEMA
4 standards if we can find the page.

5 Q In the interests of time I will point you to the
6 place --

7 A Please do.

8 Q -- at the next opportunity. Let me go on now in
9 the interests of time.

10 You testified that the tensile strength of the
11 replacement shafts was better than the original shafts. Do
12 you know whether the surface finish on the replacement
13 shafts is better than in the original shafts?

14 A I do not know that, no.

15 Q Well, based on your testimony that you are aware
16 that the tensile strength, the ultimate tensile strength of
17 the replacement shafts is better, would you then conclude
18 that the replacement crankshafts are of better material than
19 the conventional -- or that the material used in the
20 original crankshafts?

21 A Yes. I know also that they have been thoroughly
22 inspected for flaws which might arise as a result of the
23 slab forging process. Assuming that there are no hidden
24 flaws, I would say that the material was better, yes.

25 Q Well, you will agree with me, won't you, that the

WRBeb

1 surface finish in the fillet regions is a significant
2 factors in crankshaft performance?

3 A Yes.

4 Q And DEMA also encompasses, I think you testified,
5 Professor Sarsten, a range of crankshafts. Would that
6 include a range of journal pin web configuration and fillet
7 geometries?

8 A Yes.

9 Q Do you know how wide or how this range would be
10 defined, how broad it is?

11 A No. You would have to make an extensive survey
12 of the various engines. I have not done that.

13 Q Well, will you agree with me then that the DEMA
14 standard for the single order and the summation of major
15 orders is a general or rough predictive tool that is not as
16 accurate as actual experimental data?

17 A We are speaking of two different things now, a
18 limit on torsional stress levels allowable, and the second
19 is measured values, if I understood the question correctly.

20 Q What is the answer to my question?

21 A Could you please rephrase or repeat it?

22 JUDGE MORRIS: I think it would be better,
23 Mr. Ellis, if you would rephrase it. I didn't understand
24 the question myself.

25 MR. ELLIS: I was afraid you would say that.

WRBeb

1 I will, Judge.

2 BY MR. ELLIS:

3 Q Given that DEMA assumes a range of crankshafts
4 which you have indicated includes a range of materials,
5 fillet geometries, journal pin web configurations, it
6 really is a general predictive tool, isn't it, that is not
7 as accurate as making actual empirical measurements of the
8 stresses in the high stress areas of the crankshaft?

9 A (Witness Sarsten) We are speaking of two
10 things. One is a torsional vibration calculation that gives
11 a certain value.

12 Another is the measured stress values on the
13 crankshaft. They are two different things. They both have
14 their uses and their limitations. It is very hard to
15 compare them.

16 Q Let me add to my question:

17 I understand your answer with regard to assessing
18 the adequacy of the crankshaft. Isn't it fair to say that
19 if you had actual torsional stresses in the areas of known
20 high stress, you had the actual strength of the material,
21 that that is a more adequate measure or assessment of the
22 adequacy of a crankshaft than plugging figures into the DEMA
23 calculation?

24 A As I said before, these are two different things,
25 but I personally perhaps would be more happy with a more

WRBeb 1 refined approach. But on the other hand, the DEMA
2 requirements are there and they have to be met, so let's
3 wait.

4 Q I don't think you answered my question, Professor
5 Sarsten. Maybe it is still unclear.

6 MR. ELLIS: May I have it read back? I am trying
7 to get it clear, but perhaps I haven't succeeded yet.

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

10 WITNESS SARSTEN: All right.

11 Having heard it again I think that I can say I
12 presently would perhaps be more happy with such an approach.

13 BY MR. ELLIS:

14 Q Which is the "such an approach"?

15 A (Witness Sarsten) "Such an approach" using the
16 measured values.

17 Q Professor Sarsten, did you make any calculations
18 at load levels of 3300 or 3200 or some level below 3500?

19 A I did make some very rough approximate
20 calculations at these load levels, yes.

21 Q What damping factor did you use in connection
22 with those calculations?

23 A I used a magnification factor of 40, referred to
24 the fourth order.

25 Q How did you arrive at that damping factor?

WRBeb 1 A I arrived at that damping factor through
2 experience with such torsional vibration calculations
3 previously, and I know specifically that that is the range
4 used by Det Norske Veritas.

5 I know it is a rather high damping relative to the
6 recent results from another diesel engine manufacturer in
7 Norway. I would assume this value to be, as damping goes,
8 slightly on the high side.

9 Q Is that different from the damping factor that
10 you used in connection with your calculations that are
11 reflected on Exhibit 2 of your testimony?

12 A Yes, it is. The figure there was one of a number
13 of calculations I made when reviewing the 8, the 12, the 16
14 and the 20 cylinder crankshafts. I then employed a damping
15 value which happened to be in the data. This is a slightly
16 lower value of damping than I subsequently used.

17 However, the values referred to at 450 rpm have
18 been corrected to the larger damping value.

19 Q What then would be the new stresses that you
20 calculated using the new damping at the underspeed and
21 overspeed conditions?

22 A The stress levels using this rather large damping
23 changes the value slightly near resonance. At the lower end
24 of the speed range I used 428 rpm. The value turned out to
25 be 7,051 psi. At the upper end of the speed range, 473 rpm,
the value was 7,851 psi.

WRBagb 1 Q And what was the value then at 450 rpm?

2 A That is the value that's given in the report. I
3 had time to perform one calculation before writing the
4 testimony and the correct values are given there. There is
5 a very slight difference at these values, because the
6 damping does not make too much of a difference.

7 Q Were the figures you just gave at 3500 Kw?

8 A They were at 3500 Kw, yes, or, to be more
9 specific at 225 psi. The psi was assumed constant over the
10 speed range.

11 Q So then by using this different damping factor on
12 your calculations, you went from about 9,000 on your Exhibit
13 2 down to about 7,021 at the underspeed condition, is that
14 correct?

15 A 7,051.

16 Q 7,051.

17 A Correct.

18 I also indicated in the testimony that the
19 damping was negligible, that the figures were preliminary
20 and that the stress values at the lower end of the speed
21 range would go down dependent upon the damping.

22 Q You would consider, wouldn't you, this 30 percent
23 reduction to be fairly significant, wouldn't you?

24 A Yes, but they still do not meet the DEMA
25 requirements or alter my conclusions at all. They were

WRBagb 1 expected.

2 Q Well is it your testimony that in the application
3 of DEMA there is no room for any engineering judgment?

4 A I have only the rules to go by. So that is my
5 testimony.

6 Q Is it true that you do not use an engineering
7 judgment in the application of any standards?

8 Let's take ABS, do you use engineering judgment
9 in the application of ABS standards?

10 A The standards are specific. We are not allowed
11 to use engineering judgment. If so, it must be the
12 classification society itself who waives the rules or uses
13 some engineering judgment.

14 Q Did you use that new damping factor in connection
15 with your calculations for 3300 Kw?

16 A Yes, I did.

17 Q Were the values then -- What were the values that
18 you received or that you obtained then for your stresses?

19 A They were somewhat lower, of course.

20 If you will give me a little time, I can try to
21 give you approximate values.

22 I'm sorry, this may take a little time, if you
23 wish the actual values now.

24 Q Why don't we do it overnight then and I will pick
25 it up in the morning and go on, if that's all right with

WRBagb 1 the Board.

2 JUDGE BRENNER: It's all right with us.

3 Are you going to ask him about 3200 also?

4 MR. ELLIS: If he has done them. I wasn't sure
5 that he had done them at 32.

6 WITNESS SARSTEN: I have done them at 32 and Det
7 Norske Veritas has done them at 3150.

8 MR. ELLIS: I'm only interested in what you've
9 done.

10 BY MR. ELLIS:

11 Q Professor Sarsten, let me show you a book
12 entitled "Rules for Building and Classing Steel Vessels,
13 1983, American Bureau of Shipping."

14 MR. ELLIS: I only have one of these, Judge. I
15 didn't anticipate this was coming up. Shall I hold this as
16 well?

17 JUDGE BRENNER: You can proceed. I don't know
18 where we'll go.

19 MR. ELLIS: It's just a short point.

20 JUDGE BRENNER: I assume you'll ask him some
21 preliminary question about it.

22 (Document handed to the witness.)

23 BY MR. ELLIS:

24 Q Are you familiar with that volume, Professor
25 Sarsten?

WRBagb 1 A (Witness Sarsten) If the rules, as applied to
2 diesel engine crankshafts are here, I'm familiar with that.
3 Otherwise not.

4 Q Have you ever seen that book before?

5 A This book I have not seen before, no.

6 MR. ELLIS: That was shorter than I thought.

7 BY MR. ELLIS:

8 Q Well Mr. Henriksen, have you seen it before?

9 A (Witness Henriksen) Not that edition. I have
10 seen earlier editions.

11 JUDGE BRENNEK: Once I hear the questions, I will
12 know whether -- in my own mind whether or not it is
13 reasonable for you not to have expected this to come up.

14 And also if it focuses in on a particular point
15 the rest of us will have overnight to catch up, so that's
16 another reason for proceeding now a little bit.

17 MR. ELLIS: Yes, sir. I plan to be very short.
18 I did not anticipate it. That doesn't mean that I shouldn't
19 have.

20 JUDGE BRENNER: All right.

21 MR. ELLIS: You may conclude that I should have.

22 JUDGE BRENNER: I may.

23 MR. ELLIS: I would just ask that you be
24 charitable.

25 JUDGE BRENNER: We may need copies overnight.

WRBagb 1 Let's see where it goes. We may not.

2 MR. ELLIS: Yes, sir.

3 BY MR. ELLIS:

4 Q Mr. Henriksen, those are the ABS rules -- that
5 includes the ABS rules that we've been talking about today,
6 don't they?

7 A (Witness Henriksen) Yes.

8 Q Is it also your testimony, as well as Professor
9 Sarsten's, that the application of ABS standards excludes
10 the exercise of engineering judgment?

11 MR. SCHEIDT: Objection. I don't believe that
12 was Professor Sarsten's testimony.

13 JUDGE BRENNER: Why don't you rephrase the
14 question and leave out the reference to Professor Sarsten
15 but ask the same question.

16 MR. ELLIS: Yes, sir.

17 BY MR. ELLIS:

18 Q Mr. Henriksen, does the application of the ABS
19 rules exclude the use of engineering judgment?

20 A (Witness Henriksen) I have not made any judgment
21 on the ABS rules. I have only been involved with the
22 torsional as it applies to DEMA.

23 Q You are not then I take it an expert in the
24 application and interpretation of the ABS standard for
25 torsional stresses for crankshafts?

WRBagb 1 A No.

2 Q Thank you.

3 Professor Sarsten, do you recall -- I know you're
4 going to look tonight, but do you recall whether at 32- or
5 3300 Kw there is a demonstration of DEMA compliance or not,
6 both at the synchronous speed and at the overspeed and
7 underspeed conditions?

8 A (Witness Sarsten) As far as I remember, you had
9 to go down to 3200 to get compliance with the DEMA
10 requirements over the whole speed range required by DEMA.

11 Q So that at 3300 Kw it is above 7000 for the
12 summation of 24 orders, is that right?

13 A I would have to refresh my memory but I believe
14 that's right, yes.

15 Q Does the DEMA standard of 7000 have conservatisms
16 built into it, if you know?

17 A The DEMA standard of 7000 is a relatively high
18 torsional stress and far above what is normally allowed, for
19 example, by Lloyd's Register of Shipping, for example.
20 Their rules, I think, allow for this size of shaft something
21 around a little over 4000 psi. I would have to calculate
22 that but it's in the range they would allow.

23 Q So if it were an 11-inch crank pin -- strike
24 that.

25 Do you know what the calculated summation of

WRBagb 1 major orders was by Dr. Chen for the 13 by 11 inch crank pin
2 -- crankshaft?

3 A It's in his testimony. I have not calculated
4 that. I do not remember what it was, no.

5 Q If I tell you that it was in the range of 9000,
6 does that refresh your recollection?

7 A Yes. It was far above the DEMA requirements, at
8 least as I remember, according to his testimony.

9 Q So you would expect certainly a fairly early
10 failure then under those circumstances, wouldn't you?

11 A That would, of course, depend on the crankshaft
12 configuration and material and so on. But under normal
13 conditions, yes, one would expect an early failure.

14 Q Do you know how many hours were on the diesel
15 generator 102 at the time that that crankshaft failed?

16 A The exact number I don't remember, but it was
17 something in the order of 400 hours I believe but full
18 load. It may have run more at lower load levels.

19 Q Look if you would, please, at Exhibit 35 of the
20 County's exhibits. Exhibit 35 is an NRC Technical
21 Evaluation Report by Franklin Research Center.

22 Do you have that, Professor Sarsten?

23 A Yes.

24 Q Have you reviewed that?

25 A It is..... Let me see.

WRBagb 1 May 9, 1984. I do not remember reviewing it.

2 JUDGE BRENNER: I think you may have to turn to
3 the third page of the exhibit to see if you recognize it,
4 Professor Sarsten. The first two pages are just a cover
5 letter.

6 WITNESS SARSTEN: Oh, I'm sorry. April 6, 1984.

7 I have not reviewed it. I may have seen it and
8 glanced briefly through it. I have not reviewed it, no, in
9 detail.

10 BY MR. COLLIS:

11 Q Look at page 15 of that report, if you would.

12 A (Witness Sarsten) I have it.

13 Q Do you see there where it indicates the number of
14 hours on each of the three engines at the time that the
15 diesel generator 102 crankshaft failed?

16 A Yes.

17 Q Do you see diesel generator 102 had 718 hours at
18 the time of the failure?

19 A Correct.

20 Q That's almost ten to the seven, isn't it?

21 A It is, but it depends on how many of these hours
22 were at the load, the rated load. It is not shown here.

23 Q Do you know how many hours of the 718 were at the
24 rated load or higher?

25 A No.

WRBagb 1 Q Do you know whether the Franklin Research
2 Institute concluded that the 13 by 12 inch crankshafts met
3 the DEMA standard or not?

4 A No.

5 Q Look if you would, please, at page 69 of that
6 Exhibit 35.

7 Does that refresh your recollection on whether
8 Franklin Research Center on behalf of the NRC concluded that
9 the 13 by 12 inch crankshaft, the replacement crankshaft,
10 met the DEMA recommended values for single order excitation
11 and for summation of the orders?

12 A Which part of the page is this on? I'm sorry,
13 I'm not familiar with it.

14 Q Look at about midpoint on the page.

15 A Okay. Right. I see that. I have not read this
16 before.

17 Q Okay.

18 Do you know how many orders they summed?

19 A No.

20 MR. ELLIS: Judge, this might be an appropriate
21 time to break and I will use the time to insure that my
22 estimate was accurate.

23 JUDGE BRENNER: Okay. We will break in a moment.

24 Let me make sure I understand something:

25 This exhibit that you've been examining from on

WRBagb 1 your last question or two which, as of now, is proposed
2 County Exhibit 35, is the Technical Evaluation Report
3 prepared by Franklin Research Center acting as a Staff
4 consultant?

5 MR. ELLIS: That's correct, Judge Brenner.

6 JUDGE BRENNER: Is that right, Mr. Goddard?

7 MR. GODDARD: That's correct.

8 JUDGE BRENNER: And your lead witness on the same
9 subject is not familiar with it, is that right?

10 MR. GODDARD: I am informed this is a report that
11 was used to analyze the old crankshaft, not the 13 by 12
12 crankshaft.

13 JUDGE BRENNER: The same question, though.

14 MR. GODDARD: It also analyzed the shot peening
15 on the 13 by 12 crankshaft.

16 JUDGE BRENNER: Mr. Henriksen, are you familiar
17 with this report?

18 WITNESS HENRIKSEN: I have read it, yes.

19 JUDGE BRENNER: You've read it. That's all
20 you've done, you've read it?

21 WITNESS HENRIKSEN: Yes.

22 JUDGE BRENNER: You have not been involved in any
23 analyses of it or anything of that nature?

24 WITNESS HENRIKSEN: Other than giving my views on
25 it to PNL.

WRBagb

1 JUDGE BRENNER: All right.

2 MR. ELLIS: Judge Brenner, if you will look at
3 the title, I think it does cover the replacement crankshaft.

4 JUDGE BRENNER: Well I don't want to go into it
5 just yet.

6 Keep in mind what I said about the efficiency of
7 directing questions to the entire panel and also what I said
8 about basing findings on reports that are merely buried in
9 exhibits, particularly lengthy reports.

10 MR. ELLIS: Yes, sir.

11 JUDGE BRENNER: All right.

12 We will break at this point and we will resume at
13 9:00 tomorrow morning and we'll try to finish up by the
14 first break which we usually take around 10:30.

15 MR. ELLIS: Yes, sir. I think I will try to
16 pick out the portions of this exhibit so that I am clear
17 about it tonight and perhaps we may offer those as our
18 exhibits in cross-examination tomorrow.

19 JUDGE BRENNER: If you're going to do that you
20 should tell Staff Counsel what portions you are going to use
21 so they can tell their witnesses and be prepared.

22 MR. ELLIS: Yes, we'll do that and would ask that
23 they do the same thing when our witnesses are up. I'm sure
24 they will.

25 JUDGE BRENNER: All right.

WRBagb 1

We'll be back at 9:00 tomorrow morning.

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(Whereupon, at 5:00 p.m., the hearing in the

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above-entitled matter was recessed, to reconvene at 9:00

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a.m., the following day.)

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CERTIFICATE OF OFFICIAL REPORTER

This is to certify that the attached proceedings before the UNITED STATES NUCLEAR REGULATORY COMMISSION in the matter of:

NAME OF PROCEEDING:

LONG ISLAND LIGHTING COMPANY

(Shoreham Nuclear Unit)

DOCKET NO.: 50-322-OL

PLACE: Hapauge, New York

DATE: 24 September 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

(TYPED) William R. Bloom

Official Reporter

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