

ORIGINAL

UNITED STATES
NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:

LONG ISLAND LIGHTING COMPANY
(Shoreham Nuclear Power Station)

DOCKET NO:

50-322-1 (OL)

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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In the matter of: :

LONG ISLAND LIGHTING COMPANY : Docket No. 50-322-1 (OL)

(Shoreham Nuclear Power Station):

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

Tuesday, October 30, 1984.

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

BEFORE:

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

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

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

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APPEARANCES:

On behalf of the Applicant:

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On behalf of the State of New York:

ADRIAN JOHNSON, Esq.

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C O N T E N T S

2	WITNESSES	CROSS	REDIRECT	BOARD
3				
4	LILCO Panel on Cylinder Blocks			
5				
6	Roger Lee McCarthy)			
7	Harry Frank Wachob)			
8	Charles A. Rau)			
9	Clifford H. Wells)			
10	Edward J. Youngling)			
11	Craig K. Seaman)			
12	Duane P. Johnson)			
13	Milford H. Schuster)			
14	By Mr. Goddard	25085		
15	(Continued)			
16	By Judge Brenner			25107
17	By Judge Ferguson			25140
18	By Mr. Goddard	25209		
19	By Judge Brenner			25214
20	By Judge Morris			25214
21	By Judge Brenner			25248
22				
23	Morning Recess -			25129
24	Luncheon Recess -			25168
25	Afternoon Recess -		25206; 25247	

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C O N T E N T S (Continued)

EXHIBITS	FOR ID.	IN EVD.
LILCO Exhibit B-59; B-59-1 through B-59-8: Further Supplemental Testimony of LILCO Cylinder Block Panel	25082	
Board Diesel Exhibit No. 1 Resolution of Suffolk County Diesel Generator Contention re Cylinder Heads, 21 September 1984	25204	
Staff Diesel Exhibit No. 9 Dr. Wells drawing to illustrate potential leak path between block and liner	25208	25213
DOCUMENTS INSERTED:		
Board Diesel Exhibit No. 1: Resolution of Suffolk County Diesel Generator Contention re Cylinder Heads, 21 September 1984		25204
Staff Diesel Exhibit No. 9: Dr. Wells drawing to illustrate potential leak path between block and liner		25213

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P R O C E E D I N G S

JUDGE BRENNER: Good morning.

Whereupon,

- ROGER LEE MC CARTHY,
- HARRY FRANK WACHOB,
- CHARLES A. RAU,
- CLIFFORD H. WELLS,
- EDWARD J. YOUNGLING,
- CRAIG K. SEAMAN,
- DUANE P. JOHNSON,

and

MILFORD H. SCHUSTER

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

JUDGE BRENNER: We are ready with our ruling on LILCO's motion to admit supplemental testimony on Suffolk County Contention Regarding the Cylinder Blocks.

We are going to deny the motion. The reasons are that it is no longer timely to admit further testimony on the new information discovered with respect to the blocks, given the schedule that we established for such further testimony. When I say "no longer timely," I mean no longer timely as of right.

We set a schedule which was, I think it is fair to say, in LILCO's view longer than necessary. LILCO pushed

WRBeb 1 for even a tighter schedule than what we set. We set a
2 schedule of certainly no later than October 18th for further
3 testimony on the new information discovered with respect to
4 the new 103 block. We had preferred a date of October 12th,
5 which actually is a date we set for LILCO. We allowed the
6 County until October 18th, knowing that when we resumed the
7 hearing on October 22nd, the first witnesses up would not be
8 the County's witnesses.

9 So when you consider the fact that the first
10 witnesses scheduled up on October 22nd were to be LILCO's
11 witnesses, the 18th would have even arguably been too late
12 to file timely testimony as of right on that subject. In
13 any event, October 29th is way beyond that time frame.

14 We recognize that some of this information was
15 only available to LILCO, as we understand it, approximately
16 the weekend of October 20th and 21st. However, LILCO in the
17 first instance chose to file nothing on October 12th when we
18 had directed that either testimony or Board notification be
19 filed at that time.

20 Even in the absence of any requirement by us, it
21 would have been appropriate for LILCO, somewhere in that
22 time frame, to indicate that it had learned about A, B and C
23 with respect to the blocks, particularly the existence of
24 cam shaft gallery crack indications on the blocks.

25 We don't have word one in testimony or Board

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1 notification from LILCO as to that. It was for the other
2 parties to give us more of that information in their written
3 testimony, although we did get the preliminary oral report
4 from LILCO's Counsel about that. And LILCO could then have
5 told us that certain things were known and they were still
6 doing further work.

7 Even moving beyond that, we recognize that some
8 of this information, as I started to say, was only available
9 approximately in the time frame of the weekend of the 20th
10 and 21st. But even at that time LILCO had not informed the
11 parties or the Board that it was changing its
12 more-than-once-expressed position that it was not going to
13 file further testimony on the subject.

14 We are in a time frame now where the testimony of
15 this panel certainly will be finished in the next day or
16 two, hopefully today. The entire litigation is going to be
17 finished I expect by the end of next week, as a reasonable
18 estimate, and perhaps even earlier than that, depending on
19 the status of negotiations on the pistons, but in any event
20 with respect to the blocks, the finish of the hearing is
21 imminent.

22 Therefore, it would be appropriate to apply a
23 reopening type criteria to a motion at this late date to
24 receive such testimony. Certainly in applying the criteria
25 we could be cognizant of the fact that the motion comes when

WRBeb

1 we are still in hearing rather than after the hearing in
2 making the appropriate balances, but nevertheless the
3 considerations would be one of significance and likelihood
4 to affect the result.

5 At this point in time we cannot say whether this
6 information on the stress results on the new 103 block cam
7 shaft gallery area -- strain gage readings, I should say,
8 are of the nature that they would be significant enough in
9 terms of the effect on the result. We are in the midst of
10 the hearing. We are not at the point where we can put
11 together the hotly contested information that we have
12 received and expect to receive from the different witnesses
13 for the different parties in this proceeding.

14 Another important factor in our consideration is
15 the fact that this is part of the on-going further work, as
16 reported in LILCO's status report. LILCO chose when it
17 would schedule this work, and it as scheduled it for a point
18 that LILCO does not expect it to be completed until the
19 beginning of December.

20 Even if we thought that this information was
21 significant enough in terms of the reopening criteria to
22 allow it in, there's the problem that there is further work
23 being done, the problem in terms of the hearing schedule.

24 We are not about to delay the proceeding to
25 permit the County what we believe it has a right to do,

WRBeb 1 that is, conduct some further discovery of this further
2 information. We don't necessarily believe hat that a long
3 time for such processes would be appropriate, but certainly
4 some time would be appropriate, and any time would take us
5 beyond the time frame when we expected to complete the
6 hearing, or at least the hearing on this subject.

7 That is compounded, as I started to say, by the
8 further problem that we would initiate processes to allow
9 the introduction of this further evidence and then the next
10 week, some further information comes to light as a result of
11 the testing program.

12 So for all those reasons, we are not admitting
13 the further testimony. This is not to say, however, that
14 when the further work is complete, which LILCO has estimated
15 to be in early December, and the reports are available, one
16 or more parties may then deem it appropriate to move to
17 reopen the record, based on the completed information.

18 And if so, we would consider it at that time, and
19 we will have a better basis against which to weigh such a
20 motion because the information will be presumably complete
21 from the on-going work. We may have a better picture of the
22 state of our record at that time, having had a chance to
23 consider it and begin to sort through and organize and
24 analyze the evidence on our own part.

25 Beyond that, the Board, as we have been doing,

WRBeb

1 will receive the report of those further results and on our
2 own we may see something that causes us to reopen the
3 record, and we have the right and obligation to do that if
4 we think it appropriate.

5 Of course as information may be developed, the
6 parties still have the requirement of Board notifications to
7 us of anything significant. In that way, if anything
8 significant does develop we will be apprised of that in a
9 more immediate time frame than the completion of the entire
10 program.

11 Even if we had been inclined to grant the motion
12 and thereby, as I said, necessarily permit the County some
13 additional time for discovery and to determine what it
14 wished to do in terms of presenting anything through its
15 witnesses, there is the further consideration which we have
16 discussed from time to time in this proceeding that LILCO
17 insists, every time we ask it, that it is proceeding on this
18 record on the premises of the loads for the diesel engines
19 in the event of the occurrence of a loop LOCA as are stated
20 in the present FSAR yet, at the same time, LILCO,
21 inconsistent with that position that it seeks to continue on
22 that premise, conducts tests by which it hopes to
23 demonstrate things, to whom I don't know, presumably the
24 Staff in part, although it may be demonstrating things
25 before the wrong party when that overlaps with contested

WRBeb 1 issues before us, based on the lower loads.

2 And that is the case apparently with these
3 further results that LILCO has sought to put into evidence
4 before us.

5 That isn't the primary reason for denying the
6 motion, but it is a consideration I wanted to point out.
7 And to my mind, we still have not gotten satisfactory
8 answers as to LILCO's apparently drifting, somewhat drifting
9 and inconsistent approach, and I might say the Staff's also,
10 to proceeding on certain premises in the hearing here and
11 then proceeding on apparently inconsistent premises outside
12 of the hearing.

13 We have asked a question involving a footnote to
14 the cylinder head agreement and the answer to that may help
15 us understand the positions better, and we may have further
16 questions depending on the answers there, including certain
17 things in the status report, but I don't have to get into
18 that at this point.

19 One thing that the motion before us now which we
20 are denying does achieve for LILCO is if after all the
21 testing is in, LILCO then deems it appropriate to move to
22 reopen the record, parties cannot argue that the motion is
23 untimely because LILCO could have sought to advance, by an
24 earlier motion to supplement testimony, some of the earlier
25 results from that testing program. So in effect that much

WRBeb 1 has been accomplished.

2 And I want to emphasize, in the event I did not
3 make it clear, that although we said LILCO's motion is too
4 late to consider allowing this testimony in as of right on
5 the schedule that we had established, we are not saying that
6 it is untimely in terms of a motion to reopen. In fact it
7 is not.

8 What we are saying is that we cannot determine
9 that the other criteria for a motion to reopen are met and,
10 in the absence of that, we are not going to stop the
11 proceeding, or delay the proceeding when the end of the
12 proceeding is imminent.

13 All right, that completes that matter.

14 On another subject--

15 MR. FARLEY: Your Honor, may I say something on
16 that subject?

17 JUDGE BRENNER: Probably not, unless it is very
18 brief. I don't want to entertain further argument.

19 MR. FARLEY: At the appropriate time I will move
20 to make an offer of proof.

21 JUDGE BRENNER: Okay, I can do that right now for
22 you. We have the proposed testimony. We will mark it as an
23 exhibit.

24 We have no record of any LILCO B series exhibits
25 beyond the prefiled ones. Is that correct?

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MR. FARLEY: That is.

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JUDGE BRENNER: All right. So it would be LILCO Exhibit B-59 for identification. You will have to supply the Reporter with three copies, Mr. Farley. It is a document bearing the date October 29th, 1984, entitled "Supplemental Testimony." You will probably need to call it "Further Supplemental Testimony" to distinguish it from the previous Supplemental Testimony, which illustrates a problem I believe.

In any event it is entitled-- Let's mark it "Further Supplemental Testimony." Right now it bears the same title as the other document, does it not?

MR. FARLEY: I suggested that in the original draft.

JUDGE BRENNER: I don't know why you are telling me that. Tell whoever overruled you. It sounds like you need to improve your clout in important departments such as how to caption documents.

MR. FARLEY: You are absolutely right.

JUDGE BRENNER: All right. It will be "Further Supplemental Testimony of...." I will just read the witnesses' last names for brevity: McCarthy, Rau, Wells, Wachob, Johnson, Seaman, Youngling and Schuster, on behalf of Long Island Lighting Company on Suffolk County Contention Regarding Cylinder Blocks. And it consists of four numbered

WRBeb 1 pages, and then attachments marked B-59-1 through B-59-8.
2 (Whereupon, LILCO Cylinder Block
3 Panel Further Supplemental
4 Testimony on SC Contention re:
5 Cylinder Blocks was marked as
6 LILCO Exhibits B-59, B-59-1 -
7 B-59-3 for identification.)

8 JUDGE BRENNER: Thank you. I should have offered
9 you that opportunity on my own.

10 Changing subjects, we have received only through
11 the means of copies of routine correspondence rather than
12 any direct filing before us a copy of a letter dated October
13 10, 1984, to a Mr. Clarence Ray, TDI Owners' Group, from the
14 NRC Staff. It is signed by Mr. Berlinger, and the subject
15 is "Request for Additional Information on Figure 3.13, FaAA
16 Report 85-3-16."

17 I am not sure that's a correct report number but,
18 in any event, that is what it says. "Evaluation of
19 Emergency Diesel Generator Crankshafts at Shoreham and Grand
20 Gulf Nuclear Power Stations."

21 The letter consists of a request for information
22 regarding the crankshafts and their question to the Staff,
23 which we are not seeking an answer to right now but I want
24 you to think about the question and then I'll tell you when
25 we want the answer, the question is:

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"Is not the information being sought by this letter outside the record of this proceeding germane to the issues that we are considering in the contested subject of crankshafts in the proceeding?"

A subpart of that is:

"We recall nothing in the Staff's testimony that it had any remaining substantive work being done on the subject of crankshafts in the course of which leading to the Staff's conclusions beyond the confirmatory testing that the Staff was advocating be performed."

So we want an oral report on the answers to our questions and then you should broaden that to explain what all this means in the context of the proceeding.

WRBpp 1 We would appreciate, if possible, an answer
2 tomorrow. If that is not possible we would require an
3 answer by Friday on the record here.

4 MR. GODDARD: We will attempt to provide an
5 answer to those questions tomorrow, Judge Brenner.

6 JUDGE BRENNER: I note the author of the letter
7 is here and that might be helpful to your considerations.

8 MR. GODDARD: It would also be helpful if I saw a
9 copy of that letter.

10 JUDGE BRENNER: I considered that and I'll be
11 happy to lend you my copy. You don't have to return it
12 until the time you're ready to discuss it.

13 MR. DYNNER: Judge Brenner, if I can say me,
14 too. The County has not received a copy of the letter
15 either and did not know of its existence prior to today.

16 JUDGE BRENNER: All right. Let me provide it to
17 you right after the break. I have a little note on it in
18 pencil which I think is harmless. But I'll erase it
19 anyway.

20 Well, actually I'll tell you what my note says
21 because it's consistent with what I said early and then I
22 could just give it to you. It has a question mark and it
23 says crank shafts why sent now. And I can pass that on
24 and perhaps somebody can make copies for all the parties who
25 want it.

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1 I did not check the report but our recollection
2 of the FaAA report being referenced in that letter is that
3 it is a June report and, as I said, that letter is dated
4 October 10 and the hearing has been scheduled for a long
5 time. So you can factor that into your report also,
6 Mr. Goddard.

7 That's all we have. I apologize to the
8 witnesses. I should have indicated earlier that we had some
9 preliminary matters and they did not have to be there right
10 away. I'm sure you found it fascinating, nevertheless.

11 Mr. Goddard, you can continue your cross
12 examination.

13 MR. GODDARD: Thank you, Judge Brenner. I
14 indicated that I would start the questioning on
15 circumferencial cracking this morning. The Staff does have
16 one followup question to yesterday's examination plus a few
17 additional questions which are based on matters which were
18 covered in LILCO's proposed second supplemental testimony
19 which are not going to be phrased so as to elicit any
20 results of that subsequent testing. This is an area I
21 omitted from my cross examination yesterday pending the
22 ruling in the admission of the testimony which would have a
23 bearing upon the answers.

24 CROSS EXAMINATION (Continued)

25 BY MR. GODDARD:

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1 Q Dr. Wachob, I believe that yesterday it was you
2 who testified that a microprobe analysis had been performed
3 on the coating of the cracks from cam gallery number 7 from
4 the original EDG 103 block. Is that correct?

5 A (Witness Wachob) Yes, sir.

6 Q You identified several of the constituents of the
7 oxide or coating which were found in that analysis. Would
8 you please describe on the record all of the substances
9 which were found in the their concentrations?

10 A The microprobe analysis that was performed on
11 the specimen was focused in on looking at the oxygen on the
12 fracture surface, the calcium and sulfur on the fracture
13 surface. Iron is a result, also.

14 Q Did that microprobe analysis reveal the presence
15 of any other trace elements and their concentrations within
16 that layer?

17 A The microprobe analysis did not encompass other
18 elements.

19 Q Thank you.

20 A (Witness Rau) Mr. Goddard, I would just like to
21 add that that particular analysis, the microprobe analysis,
22 was a very focused examination. We had previously done,
23 through the dispersive energy analysis, all our scanning
24 electron microscope analysis of the products on the
25 surface. It was only the probe which was used to determine

WRBpp 1 or not it was, in fact, an oxide as a result of the
2 supplementary testimony from the County's experts indicating
3 some belief it might not be. So we didn't attempt to do an
4 entire analysis of all possible elements but only focused on
5 that one issue which had been raised.

6 Q Thank you, Dr. Rau.

7 Can you identify any other trace elements or
8 substances which were present in your original examination
9 rather than in the microprobe analysis?

10 A (Witness Wachob) I don't have specific
11 recollection as to all the elements that were involved. If
12 you would like, I'd be glad to go back and look at the
13 sheets to refresh my memory.

14 Q Do you have them available with you?

15 A I don't have them in court with me today, no.

16 Q Perhaps you could provide us that information
17 tomorrow morning.

18 A Yes, sir.

19 Q Thank you.

20 JUDGE BRENNER: I don't know if these witnesses
21 are still going to be on the stand tomorrow morning.

22 WITNESS WACHOB: We can do it after lunch or
23 after the break. I'll try to do it then, after lunch, for
24 sure.

25 JUDGE BRENNER: Maybe they'll be here but I

WRBpp

1 didn't want persons to get into that mind set.

2 MR. GODDARD: Noted.

3 Thank you, Dr. Wachob.

4 BY MR. GODDARD:

5 Q Dr. Rau, this question is based upon your
6 testimony at page 8, your response to question 12 of the
7 supplemental testimony filed by LILCO on September 20, 1984.

8 Have you revised the conclusion in FaAA's June
9 1984 report on the cylinder blocks that the cam gallery
10 cracks propagate very slowly?

11 A (Witness Rau) Excuse me, Mr. Goddard, I can't
12 find my testimony. One second.

13 (Pause.)

14 I think I understand your question but could I
15 ask you to repeat it to make sure I get it correct?

16 Q Yes. The reference was your answer originally
17 sponsored by yourself and Mr. Taylor, and Mr. Taylor has
18 been deleted. It's at the top of page 8. Reference, the
19 fracture mechanic's analysis predicting very slow crack
20 propagation of the cam gallery cracks. My question was
21 whether you have revised the conclusion in FaAA's June '84
22 report on the blocks that those cam gallery cracks, in fact,
23 propagate very slowly.

24 A Yes, Mr. Goddard, that has in fact been revised.
25 As indicated in the answer that preliminary report was based

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1 upon two facts both of which have proven to be very
2 conservative. The first was it was based upon the surface
3 strain gages that had been reported by TDI from their strain
4 gage program which has subsequently been shown to be
5 certainly conservative and wrong.

6 Furthermore, it was based upon a conservative
7 assumption that the surface stresses measured at the outside
8 of the cam gallery were uniform or constant throughout the
9 entire thickness of the cam gallery region. That is also
10 extremely conservative.

11 Under those two very conservative assumptions the
12 preliminary analysis had, in fact, predicted some very, very
13 small rates of crack extension.

14 Subsequent to that preliminary work the stress
15 analysis that have been performed have clearly indicated
16 that, in fact, the stresses are always compressive. In
17 addition to that, the analyses have indicated that there are
18 bending components to the stresses. That is, the stresses
19 are higher at the outboard surface of the cam gallery and
20 they decrease with distance towards the inboard wall. For
21 both those reasons, our current predictions indicate no
22 crack extensions whatsoever.

23 Q And are there no conditions to which the EDG's
24 might be exposed in operation at Shoreham under which the
25 stress field in the cam gallery area might become tensile?

WRBpp

1 A That's correct, Mr. Goddard. There are no
2 conditions of operation under which those stress fields
3 may become tensile.

4 A (Witness Wells) If I might add, Mr. Goddard, the
5 conclusion of the final report FaAA report on the blocks
6 will be that we do not predict crack growth under any
7 operating conditions.

8 Q Thank you, Dr. Wells.

9 Turning to the subject of circumferential
10 cracking, would any member of the panel please outline
11 briefly the mechanisms which, in your opinion, cause the
12 circumferential cracks in the cylinder liner counterbore
13 radii.

14 A Let me start, Mr. Goddard, and then I will ask
15 Mr. Rau for amplification.

16 The same basic mechanisms obtained in the
17 circumferential crack location in the liner landing area as
18 in the rest of the block top as we have previously testified
19 these mechanisms involve primarily the low cycle fatigue or
20 thermal expansion stress provided basically as a radial
21 pressure between the liner collar and the circumferential
22 bore of the block top. And the high cycle fatigue loading
23 resulting primarily from pressure stresses under the maximum
24 firing pressure and, in addition, there is a component of
25 stress resulting from the preloading of the cylinder head

WRBpp 1 nuts.

2 In the case of a weak material such as the
3 original EDG 103 block we feel it is possible that the
4 preloading might cause cracking in essentially the
5 application of one cycle of load. Beyond that point cracks
6 would propagate under a combination of the startup-shutdown
7 stresses, the low cycle fatigue and the high cycle fatigue
8 resulting from steady state operation.

9 We don't believe, however, that in good material
10 such as represented by the blocks of the 101 and 102 engines
11 and the new EDG 103 that overload is the primary mechanism.
12 In fact, it is highly unlikely that that preload stress
13 causes cracks to initiate.

14 Q What are the most significant loads which affect
15 the stress field at the corner, which is formed by the
16 cylinder liner counterbore and the cylinder liner landing,
17 Dr. Wells?

18 A The most significant stresses there result from
19 two directions of loading, if you will. First, the radial
20 pressure I just mentioned between the liner collar and the
21 cylindrical surface of the counterbore and also the
22 vertical loading resulting from the preloading of the
23 cylinder head studs on the cylinder head, part of which load
24 is transmitted to the collar and then vertically transmitted
25 to the horizontal liner landing surface. Both of those

WRBpp

1 components of load acting together resulting in a high
2 stress concentration at the corner which is nominally
3 something like 164th of an inch radius between the
4 cylindrical part of the counterbore and the liner landing
5 surface.

6 Q Does the amount of proudness of the cylinder
7 liner -- and by that I'm referring to the height the liner
8 extends above the top surface of the block, so we're clear
9 -- have a significant effect on the stress field?

10 A Yes. In extreme cases, of course, there are
11 situations that you could imagine that the liner proudness
12 might be such that all the load would be carried from the
13 cylinder head stud pre-tensioning through the liner collar
14 and, in other words, 100 percent of the vertical loading
15 would be carried directly on that horizontal surface. At
16 the other limit, of course, if there were no liner proudness
17 at all there would be essentially no vertical force acting
18 over the top of the liner except for the firing pressure
19 which would be applied over the area between the inside
20 diameter of the liner and some average diameter of the gas
21 seal between the cylinder head and the liner top.

22 In our calculations we have assumed,
23 conservatively of course, that 100 percent of that loading
24 is carried by the liner.

25 A (Witness Rau) Let me just amplify a little bit

WRBpp

1 further. As Dr. Wells has indicated, the amount of
2 proudness, that is, the amount with which the liner extends
3 in the cold state above the block top, can affect what
4 fraction of the head load is supported by the liner as
5 opposed to what fraction is supported by the block top. We
6 have done calculations over ranged conditions all the way
7 from the case where all the load is carried by the liner
8 which is to be conservative with regard to circumferential
9 crack. That is, it would produce larger stresses in the
10 sharp fillet between the counterbore and the liner land than
11 would be the case where those are uniformly carried by the
12 block top in the case where there would be no proudness.

13 We have looked at both those extremes and various
14 combinations in between.

15 Q What if any, relationship exists between the
16 amount of cylinder liner proudness and the final crack
17 depth?

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WRBagb 1 A Mr. Goddard, there is no way that I can give you
2 a definitive quantitative answer to that question. There
3 are a lot of factors which would affect the final crack
4 size, one of which of course is proudness. Let me just
5 attempt to give you a qualititative answer which is, I
6 think, the only thing I can do without more details.

7 That is that the differences in the stresses
8 generated in the vicinity of the sharp corner between the
9 counterbore and the liner land decrease rapidly with
10 distance away from that sharp corner. And the differences
11 between the stresses generated at some reasonable distances
12 away from that sharp corner, say for example from a
13 quarter-inch and farther away from that tip, are
14 surprisingly insensitive to the details of how much of the
15 load is on the liner as opposed to what fraction is on the
16 block top. It is not nearly so sensitive as you might
17 think.

18 A (Witness Wells) If I might add, Mr. Goddard, the
19 direct correlation between cracking and the liner proudness
20 that you asked about neglects the fact that another
21 component of the loading results from the radial clearance
22 or gap between the liner collar and the counterbore. But
23 Dr. Rau's conclusions are precisely the same for that
24 component of loading.

25 Q Dr. Wells, how significant are the effects upon

WRBagb 1 the stress field of the amount of radial clearance between
2 the liner and the counterbore that you just referenced?

3 A Mr. Goddard, we haven't really looked at the
4 effect of varying amounts of the radial pressure and
5 vertical loading. Our calculations for the effect of radial
6 gap have considered the actual gap which is present in the
7 Shoreham engines and, as we stated before, assuming that all
8 of the cylinder head preload is exerted on the top of the
9 liner collar.

10 Q Thank you, Dr. Wells.

11 A (Witness Rau) Mr. Goddard, I'm sorry, perhaps I
12 misheard the question. I thought you were asking only about
13 the radial gap and its effect -- is that what you were
14 asking?

15 Q Yes, I was.

16 A Okay.

17 I think I would just for clarity add that again,
18 as Dr. Wells has said, we have not made explicit
19 calculations where we varied that gap. We have in fact
20 analyzed that gap which exists in the 101 and 102 engines.
21 The expanded gap in the replacement 103 engine, which
22 is induced by reducing the liner thickness, would reduce the
23 thermally induced stresses caused by the expansion of the
24 liner during engine operation.

25 In any case, the impact of that change would

WRBagb 1 have, I think, relatively little impact on the stresses
2 driving circumferential cracks because the primary stress
3 developed is a hoop stress around the hoop of the fillet
4 between the counterbore and the liner landing. And of
5 course it is in fact stresses at 90 degrees or perpendicular
6 to that which are the ones which are primarily driving
7 a circumferential crack if it is to initiate.

8 Not that it will have no effect but it will not
9 be a large effect.

10 Q Thank you.

11 My next questions deal with the answers of
12 yourself, Dr. Rau, and Dr. Wachob at page 11 of your
13 testimony if you would like to refer to that at this time.

14 At page 12 of Suffolk County's supplemental
15 testimony Dr. Anderson observed that below the tip of the
16 3/8th inch circumferential crack are "multiple small
17 disconnected cracks branching out into the cast iron
18 material."

19 Did you observe such cracks, Dr. Rau?

20 A No.

21 Q Dr. Wachob, I ask you the same question.

22 A (Witness Wachob) No, sir.

23 JUDGE BRENNER: Mr. Goddard, what page did you
24 quote from Dr. Anderson's testimony?

25 MR. GODDARD: The top of page 12 of the

WRBagb 1 testimony, Judge Brenner.

2 JUDGE BRENNER: Thank you.

3 WITNESS RAU: Mr. Goddard, in examining the cut
4 surfaces on which the circumferential cracks were revealed,
5 Mr. Anderson examined those in an unpolished condition.
6 Basically they were just as sawed, if you like, as cut. And
7 as I described yesterday, some care is required in preparing
8 the surface of cast iron for metallographic examination for
9 the presence of Widmanstaetten graphite or cracks and, quite
10 frankly, on the as-cut surface even conventional or normal
11 gray cast iron will break off or peel out and leave areas
12 where the graphite has been pulled out by the cutting or
13 grinding operation or sawing operation.

14 In the degenerate Widmanstaetten graphite, which
15 is the microstructure of the original 103 on which the
16 circumferential cracks were detected, this particular
17 problem, if you like, difficulty of maintaining the
18 integrity of the surface for preparation and examination, is
19 even more difficult.

20 In other words, it is easier for the
21 Widmanstaetten graphite areas to kind of fall out, break off
22 and leave a shallow hole in the surface. And I believe the
23 indications which Mr. Anderson may be calling cracks are
24 nothing more than artifacts of the general Widmanstaetten
25 graphite structure.

WRBwrb

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MR. GODDARD: Thank you, Dr. Rau.

2

BY MR. GODDARD:

3

Q Do you know whether Dr. Anderson had an

4

opportunity to observe those specimens after they had been

5

polished by FaAA?

6

A (Witness Wachob) His examination was performed on

7

the as-cut surface of the section. It was not

8

metallographically polished.

9

Q Thank you.

10

Dr. Anderson also testified that he found

11

appreciably less Widmanstaetten graphite in a specimen of

12

the liner landing ledge from the original EDG-103 and other

13

portions of that block. Do you concur with that

14

observation?

15

A (Witness Rau) Mr. Goddard, I do not agree with

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Mr. Anderson's comment in that regard.

17

Again, we were present when Mr. Anderson examined

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the liner landing area where the cracks were indicated. The

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parts which he examined were not metallographically

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polished, and, in my opinion, there is no way in which he

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could have assessed whether and what percentages of

22

Widmanstaetten graphite were present in that location.

23

Q Referring now to page 13, the second full

24

paragraph of your supplemental testimony sponsored by

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Drs. McCarthy, Rau, Wells, Wachob and Mr. Youngling, can you

WRBwrb 1 tell me what analytical predictions are referred to there
2 which demonstrate that these circumferential cracks
3 propagate into a decreasing stress field?

4 A (Witness Rau) The analytical predictions
5 referenced there, Mr. Goddard, are the results of finite
6 element stress analyses performed on the block top. They
7 consisted of a combination of both two-dimensional and
8 three-dimensional finite element analyses, the combination
9 of which was intended to compute, or analyze the stresses
10 resulting from the preload, that is, the bolt tightening,
11 the thermal effects, as well as the pressure stresses
12 induced by firing on the stresses in the vicinity of the
13 sharp fillet between the counterbore and the liner land, and
14 also into the material beneath. And the results of those
15 calculations are the basis for that statement.

16 Q Dr. Rau, if you will assume the event that a
17 circumferential crack were to continue to propagate, could
18 it lead to failure of the cylinder liner landing?

19 A Mr. Goddard, I think Dr. Wells may be in a better
20 position to answer that. But, in my opinion, your
21 hypothetical is not complete enough to say. Again, if you
22 make me assume it fails, then it fails. But if you just
23 assume it's going to propagate in the direction in which it
24 would tend to propogate, given the results of my stress
25 analysis, then the answer would have to be-- It depends on

WRBwrb 1 what you mean by "failure."

2 Let me tell you what I'm trying to say here.

3 The stress analysis suggests that the largest
4 stresses driving a circumferential crack are such as to
5 drive the crack at approximately a 45-degree angle, compared
6 to the vertical and the horizontal in the cylinder liner
7 land, the counterbore area. Therefore, if I incorporate
8 that within the hypothetical, then the crack is going to
9 extend roughly in a 45-degree angle. And if you ask me to
10 hypothetically assume it continues on indefinitely, then
11 eventually it will break through.

12 I think the consequences of that event, if in fact
13 it were to occur, I think Dr. Wells is in a better position
14 to discuss.

15 A (Witness Wells) In order to cause failure,
16 Mr. Goddard, you have to consider the fact that at least
17 one-third of the circumference of the liner landing area is
18 comprised of these reinforced stud bosses that provide, of
19 course, the anchor points for the studs that apply the
20 loading to the liner in the first event.

21 In order for any appreciable motion to occur
22 between the liner and the block, it would be necessary for
23 cracks to propagate in shear, and by that I mean vertically,
24 over a large distance; looking at a scale drawing here, on
25 the order of 4 to 5 inches. The likelihood of that

WRBwrp 1 happening, so that the mechanism of load transfer of the
2 vertical forces -- that is, between cylinder head studs and
3 liner -- would be extremely remote, in view of the fact that
4 the threads on the studs continue for some considerable
5 depth below the circumferential cracking.

6 Therefore, my opinion for a circumferential crack
7 to be of any structural consequence, the cracking which
8 starts out approximately at a 45-degree angle would have to
9 deflect downward and continue to propagate for a distance of
10 several inches. And the stress involved in that, in my
11 opinion, is extremely small, and highly unlikely.

12 Q Dr. Rau, did you wish to add something to
13 Dr. Wells' response?

14 A (Witness Rau) I wasn't sure I understood it,
15 Mr. Goodard. I was asking whether or not he had indicated
16 what would happen, if anything, if the 45-degree crack
17 continued all the way over to the stud hole. I don't know
18 whether Dr. Wells wants to comment on that or not. Maybe he
19 did.

20 A (Witness Wells) If I may, just in the hopes of
21 clarifying a complex picture here without showing it to you:
22 if the crack were to continue at approximately at 45-degree
23 angle, and, if it did so, of course, it would intercept the
24 threaded hole, the load would still be transferred from the
25 liner collar through the studs, because below that

WRBwrb 1 particular crack, this 45-degree crack, there are still
2 many, many threads left, and a considerable amount of
3 material still in shear between the liner landing and the
4 threaded portion of the boss.

5 So, in other words, there would have to be almost
6 a complete destruction of that material between the bottom
7 threads of the cylinder head stud and the liner landing
8 itself in order to cause something to appreciably loosen.
9 Therefore, we don't-- In our opinion there is no way that
10 the propagation of a circumferential crack could result in
11 appreciable loosening, or subsequent failure, of any other
12 components, such as the studs themselves, for instance.

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WRBeb

1 Q Dr. Wells, do I correctly interpret your answer
2 to mean that even if such a crack were to propagate at a
3 45-degree angle into the stud hole that there would be no
4 adverse consequences for the operation of the engine?

5 A Yes, Mr. Goddard, that's correct. The reason for
6 that is that the primary purpose of the block in that event
7 is to provide a load path for the cylinder head studs, the
8 liner top, and recall that the liner itself basically only
9 supports the preload, the clamping load in the vertical
10 direction which is applied by the studs in the first place,
11 plus of course the component of gas pressure that acts over
12 the small annular region on the top of the liner.

13 It is much easier I think if you have not had the
14 opportunity to look at a scale drawing to see what the
15 actual configuration is because our schematics in the
16 exhibits, particularly B-9, don't really show the relative
17 dimensions precisely enough to appreciate the amount of
18 material that is involved.

19 I have a sketch here, if it will help at all,
20 which is drawn to scale.

21 But in short it is our testimony that the
22 propagation of a 45-degree crack from that sharp corner into
23 the stud hole would not result in any lack of ability to
24 carry the loads, either the preloads or the dynamic firing
25 loads in the load chain between the studs, cylinder head

WRBeb 1 and block.

2 A (Witness Rau) Mr. Goddard,--

3 JUDGE MORRIS: Could I interject one question,

4 Dr. Wells?

5 In looking at B-9, it appears that the thread --
6 the upper portion of the threads is below the landing area.
7 Is that true on your scale diagram also?

8 WITNESS WELLS: Yes, Judge Morris, that's
9 correct. I don't have a precise dimension here, but there
10 are about....

11 WITNESS RAU: Judge Morris, the schematic
12 illustration at B-9 does not indicate the maximum vertical
13 extent of the threads cut into the block itself. In
14 particular, the threads of the block which are not shown
15 would extend up to within one and a half inches of the block
16 top surface.

17 However, the first thread of the stud which picks
18 up the load is actually located at 1.78 inches down from the
19 top. So in reality if you like the threads in the block are
20 at the same elevation as the liner land, but the thread load
21 which comes from the stud is another .28 inches lower down
22 from the block top.

23 JUDGE MORRIS: Thank you. That helps.

24 WITNESS RAU: The point I was just going to add,
25 perhaps for clarity, is that although the sketch is

WRBeb 1 schematic, Exhibit B-9 can still be used to illustrate that
2 if a 45-degree crack started at the corner of a liner land
3 and extended all the way over to the threads at the stud,
4 you can see, as Dr. Wells has indicated, that there are
5 many, many threads in the stud engaging the block beneath
6 that, and no loss in continuity of those load transfers are
7 required for the operation of the block and liner in this
8 region.

9 WITNESS WELLS: It might help here to grasp the
10 physics of the situation to look at Exhibit B-9 and imagine
11 that the complete ligament -- that is, that area from the
12 liner landing itself up to the block top, that inch and a
13 half dimension by five-eighths of an inch width -- were
14 completely machined away; we no longer counted on that
15 particular piece of material to support any loads at all.

16 I think you can appreciate that there would be no
17 difference in the essential load path or the structural
18 integrity of the block. The liner would still be supported
19 by the lower portion, which is actually a tighter fit than
20 that portion of the liner collar above the liner landing.
21 That is, the gap is smaller down below.

22 Of course in between the studs there is a problem
23 of providing a water seal. You cannot just machine the
24 entire block top away; there would still be the need to
25 provide sealing. But other than that, from a structural

WRBeb 1 standpoint, we don't really count on that particular part of
2 the block above this hypothetical 45-degree crack for any
3 purpose.

4 MR. GODDARD: Thank you.

5 BY MR. GODDARD:

6 Q Dr. Wells, you made reference to the sketch which
7 you have on several occasions here. I wonder if you would
8 mind providing a copy of that sketch for the record as I
9 believe it is somewhat helpful in explaining your oral
10 testimony.

11 A (Witness Wells) Yes, I believe it would be, and
12 I'd be pleased to provide it.

13 MR. DYNNER: We have an objection to that because
14 we don't know what it looks like, what it represents, or
15 what is the basis of it.

16 JUDGE BRENNER: All right. Go over it during the
17 break if you can and/or as soon as copies are available, and
18 then we'll discuss it again and see if you still have an
19 objection then. I don't know what it is either, other than
20 what has been described on the record.

21 Mr. Farley, you have been silent. Do you have a
22 position on it now?

23 MR. FARLEY: I'm delighted to provide it.

24 JUDGE BRENNER: Well, you took back sketches of
25 B-1 through B-6, and I thought maybe this was one of those,

WRBeb 1 but we've got your answer.

2 MR. FARLEY: This was prepared by Dr. Wells.

3 JUDGE BRENNER: Go over it during the break and
4 then the parties can come back to us after they each have a
5 position on it.

6 MR. GODDARD: The Staff has no further questions
7 for this panel.

8 Thank you, gentlemen.

9 EXAMINATION BY THE BOARD

10 BY JUDGE BRENNER:

11 Q I want to return to the cam gallery cracks, if I
12 can take you away from the circumferential cracks. I am
13 looking at page 6 of Dr. Anderson's supplemental testimony,
14 and in the last paragraph on that page, Dr. Anderson states
15 that in his view--

16 Well, first he says that the cracks in the
17 sections he examined--

18 Do you have the testimony?

19 A (Witness Rau) Yes.

20 Q He states that the cracks in the sections he
21 examined -- and again these are the cam gallery cracks --
22 appear to have been-- Let's be more precise. I'm sure he
23 is talking about the old 103 block.

24 Yes, you have to back up a few questions to get
25 that context but that is what he's talking about there.

WRBeb

1 He says that the cracks in the sections he
2 examined appear to have been ground and widened in
3 preparation for the welding repairs.

4 Do you agree or disagree with that view by him?

5 A Your Honor, we don't agree with that statement as
6 written, the reason being that clearly it appears that the
7 initial shrinkage cracks were -- the surface where the
8 original shrinkage cracks emerged in the cam gallery region
9 were either ground or arked out in some way prior to the
10 introduction of the weld repair on the surface, so there is
11 no question that there has been extensive work, if you like
12 modification, done to the surface to create a trench into
13 which the weld material was subsequently placed.

14 And in the act of actually performing the weld
15 repair, certain melting is going to take place right at the
16 bottom of the trench where the shrinkage crack had not been
17 completely removed by the preparation of the trench prior to
18 puddling in the weld material.

19 So I don't believe any conclusions or relevance
20 should be ascribed to the precise details of the opening, if
21 you like, of the shrinkage crack at that location which has
22 been either arked out or hogged out and then has
23 subsequently been remelted in formulating the repair weld.

24 Q You went a little beyond my question, but I was
25 getting to where you were going anyway so it doesn't matter.

WRBeb 1 Well, more specifically later on in that
2 paragraph Dr. Anderson concludes that given the preparation,
3 including grinding of the surface for the weld repairs, that
4 an oxide formed during the cooling process prior to the weld
5 repair -- the initial cooling process, if you want to call
6 it that -- would have been removed in at least the upper
7 area of the crack where the preparation for the welding took
8 place.

9 But he goes on to say that the crack surface from
10 which the weld had separated had a uniform layer of the dark
11 substance from the top to the bottom of the crack.

12 Why is-- Well, let me ask you: Is that right,
13 in your view, that there is a uniform layer of the dark
14 substance from the top to the bottom of the crack at that
15 point in the crack?

16 A (Witness Rau) Your Honor, it's ambiguous I think
17 whether he means by "top to bottom" all the way from the tip
18 of the shrinkage crack out to the surface of the cam gallery
19 which encompasses both the original shrinkage crack and the
20 subsequent crack between the weld repair and the cast iron.

21 I would definitely disagree--

22 Q All right, let's assume he means that.

23 A If he means that, I definitely disagree. As
24 testified yesterday, there is a much thicker and relatively
25 uniform thickness oxide on the original shrinkage crack.

WRBeb 1 There is a very much thinner oxide on the crack between the
2 weld repair and the cast iron.

3 If in fact he were to mean the other he'd be
4 talking only about that portion of the crack between the
5 weld repair and the cast iron. Although I did not examine
6 it in great detail, the oxide is relatively uniform but very
7 much thinner in that region than on the original shrinkage
8 crack.

9 Q If you look at County's proposed Exhibit S-4,
10 these are, according to the exhibit, FaAA photos either
11 taken or at least dated September 4, 1984.

12 Do you know if that is correct? These are of
13 cam saddle No. 7, and one is a 50 power, I guess, or times
14 enlargement, and the other is a 100 power enlargement.

15 Are the FaAA photos of what they purport to be?

16 A (Witness Wachob) Yes, sir.

17 Q I am going to paraphrase Dr. Anderson, and if I
18 do it poorly maybe we'll go back up and look at his express
19 testimony.

20 But somewhere in his testimony Dr. Anderson
21 states that these photographs show a weld material that has
22 pulled free from the crack surface due to operating
23 stresses, and not heat shrinkage. And he describes the
24 white area--

25 Judge Morris points out to me that it is

WRBeb 1 Answer 11 on page 8, by Dr. Anderson.

2 Why don't you take a look at that for a moment
3 rather than depending on my poor paraphrase? And my
4 question is going to be:

5 Do you agree or disagree, and why or why not?

6 He says that the weld material is the white area
7 in the upper left, to complete the thought I had before.

8 A I agree that the light etching or the white area
9 in the upper left is weld material, and disagree with almost
10 everything else Mr. Anderson has said in that answer.

11 Would you like me to explain why?

12 Q Yes, please.

13 A There is absolutely no way, from an observation
14 of the crack, that anyone could distinguish between whether
15 the stresses which caused it were the shrinkage stresses
16 associated with the weld cooling itself or an operational
17 load thereafter. I mean the material, if its strength is
18 exceeded by the loads, will break and that is what it has
19 done. You can tell no more from only the observation of the
20 crack itself.

21 There is no question that there are, if you like,
22 cast iron adhering to the weld material. As I testified
23 yesterday, the fracture does not occur in the weld
24 material. It is much tougher and stronger than the cast
25 iron. The fracture occurs in the heat-affected zone in the

WRBeb 1 cast iron immediately adjacent to, and in general you will
2 find, if you like, cast iron adhering to the weld metal all
3 along that interface.

4 The other point I wanted to make is that there is
5 no question that we have degenerate graphite material, very
6 low tensile strength, compared to the normal gray cast
7 iron. There is no question that we have very little or no
8 preheat in the weld repairs that were made.

9 The combination of those two during the cooling
10 of the weld is going to produce high shrinkage stresses and
11 given the low tensile strength of this degenerate graphite
12 material, cracks are and did in fact form in the
13 heat-affected zone of that material on cooling.

14 Those cracks resulted from that, and certainly
15 not from any operational conditions.

16 Q What is your basis for saying -- I think you just
17 said "certainly" or some fairly definitive word to that
18 effect, that there was little or no preheat in the welding
19 process.

20 A There's really two reasons, your Honor.

21 First of all, with the high nickel weld rods, one
22 of the reasons they're used is because they do not require
23 preheat and therefore, it is less expensive or costly to
24 make weld repairs from a labor point of view.

25 In addition to that, physically the examination

WRBeb 1 of the microstructure in the immediate vicinity of the
2 interface between the weld and the cast iron indicated the
3 presence of -- I am trying to avoid the jargon -- of
4 martensite, which is a metallurgical constituent of steels
5 and irons which results from very rapid cooling.

6 If in fact the cast iron had been preheated to
7 the temperatures where cast iron is called to be preheated
8 for most weld rods, which is well up, 800 to 1,000 degrees
9 Fahrenheit, then martensite would not have developed in the
10 cooldown of that weld because the entire block would have
11 been heated up to a temperature above the conditions where
12 it forms and then it would all slowly cool at a rate such
13 that that particular constituent doesn't form.

14 So its presence in small amounts in the
15 microstructure is indicative that in fact the material had
16 not been preheated prior to the welding process, at least
17 not significantly.

18 Q Did you find martensite -- and I want you to
19 spell it for the Reporter later -- consistently present or
20 such that the general assertion you gave me as to lack of
21 preheat is in fact generally applicable, or did you only
22 find certain instances where that might be true?

23 A We found it wherever we looked, your Honor, but
24 quite frankly, having found it, it was conclusive in my
25 mind again so I did not continue to search in all places

WRBeb 1 in all welds.

2 Q I understand that. The first part of your answer
3 is what I was looking for.

4 I'm assuming, -- let me fill out my thought --
5 when you say you found them wherever you looked, that you
6 looked at more than one or two places. Could you quantify a
7 little bit what you meant by wherever you looked?

8 A I only looked for that particular component in
9 several locations. Perhaps Dr. Wachob looked at some
10 others. He might want to comment.

11 A (Witness Wachob) The presence of the martinesite
12 was observed on one particular weld in cam gallery 7, I
13 believe it was, where it was consistently along the entire
14 weld interface. It was not just in one tiny spot; it was
15 along the entire weld fusion metal interface.

16 Q Is that the only weld it was observed in? Is
17 that the only weld you looked for martinesite in?

18 A (Witness Rau) It's the only one that I looked
19 for it in, your Honor.

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WRBpp

1 Q That happens to be the one that Dr. Anderson --
2 let me ask you, is that the one that these photos presented
3 in Suffolk County proposed Exhibit S4 are of?

4 A It's of the same cam saddle crack, your Honor.
5 There are several mounts, metallurgical mounts. I can't be
6 sure we're talking about the precise mount; but I think we
7 are.

8 Q All right.

9 Let me address this to anyone on the Panel but I
10 think it is probably going to be primarily LILCO. When did
11 you first learn that there were weld repairs -- well, let me
12 make sure I've got the basic facts right. As I understand
13 it there are, in fact, weld repairs on all three of the
14 original blocks, that is, the 101, 102, and the original 103
15 block in the cam gallery saddle area; is that correct?

16 A (Witness Schuster) Yes, sir. All three original
17 blocks have weld repairs in the cam saddle area.

18 Q When did LILCO learn that there were such weld
19 repairs? Was it -- well --

20 A August 1984, sir.

21 Q August 1984?

22 A Yes.

23 Q So this is subsequent to the discovery of the cam
24 gallery cracks which, if I recall correctly, was in the
25 spring of --

WREpp

- 1 A March and April of 1983, sir.
- 2 Q Did LILCO come back and see if any of TDI's
- 3 records reported the fact that these weld repairs had been
- 4 made?
- 5 A Yes, we did, sir.
- 6 Q And what did you find?
- 7 A To my recollection there was no record of the
- 8 weld repairs, sir. At least TDI did not have those records
- 9 available.
- 10 Q They're probably stored along with the B bars.
- 11 (Laughter.)
- 12 A (Witness Rau) I think, your Honor, we should add
- 13 that FaAA did have discussions with TDI at which time they
- 14 indicated to us that it would not be atypical for them to
- 15 make weld repairs on the cast iron block and to not
- 16 necessarily make record of such repairs.
- 17 Q Sometimes there are certain words that come out
- 18 funny in the record. You're saying atypical. That is, it
- 19 would not be untypical?
- 20 A That's what I meant to say, yes.
- 21 Q Well, that's what you said.
- 22 Is that consistent -- well, let me ask does
- 23 anybody on the Panel have enough experience to know whether
- 24 that is correct or not as an industry practice?
- 25 A What are you referring to, your Honor, just

WRBpp 1 making the weld repair or not writing it down or what?

2 Q Well, I didn't ask you about not writing it
3 down. If it ever becomes necessary I can reach my own
4 conclusions as to that. About making the weld repair.

5 A It's not uncommon to make weld repairs in cast
6 iron, your Honor. There are specific procedures called out
7 by ASTM and others for how you go about doing it.

8 Q I mean for diesel engine blocks, not just any
9 cast iron.

10 It may be you don't know and all you can tell me
11 is what TDI told you in which case that would be your
12 answer.

13 A We have no firsthand knowledge from other diesel
14 manufacturers as to what their practices are.

15 Q Was there anything in LILCO's requirements, be it
16 in the procurement processes or vendor inspection processes
17 or anything that would have required LILCO to be informed
18 that those weld repairs were being made to the block by TDI?

19 A (Witness Schuster) The requirements of the TDIQ
20 manual would be that internally they would monitor and, you
21 know, monitor that type of work, yes, sir.

22 Q My question was --

23 A Would they be notifying us? I'm sorry, I don't
24 know the answer.

25 Q Not their requirements; your requirements?

WRBpp 1 A I'm not sure about that, sir. I would not be
2 able to answer that.

3 Q Does anybody know?

4 A (Witness Youngling) Judge Brenner, our
5 monitoring of the manufacturer would be through the audience
6 that we performed on the implementation of the quality
7 assurance program. If there were no indications on the
8 records we would not have picked something like that up in
9 my estimation, no. We wouldn't have picked it up.

10 Q Well the question is, do you know if there was a
11 requirement for you to be informed of something like that --
12 not of something like that, of that?

13 A To the best of my knowledge, there was no
14 requirement for us to be informed of an action like that.

15 Q Were there any inspection reports or audit
16 reports of the condition of the block that would have
17 included an inspection for whether any weld repairs were
18 planned to be performed or were performed but, in fact, were
19 not mentioned on a report. In other words, were the reports
20 on the subject of inspection of the blocks that described in
21 the inspection and what the conclusions were that, as you've
22 told me, did not make mention of the fact that weld repairs
23 were being planned or had been made?

24 A Judge Brenner, the process would call for a
25 shipping inspection, an inspection prior to shipment done by

WRBpp

1 Stone and Webster procurement quality control inspectors
2 that would be dictated by the specification that
3 requirement. However, I do not feel that that level of
4 detail would be in that inspection such that the man would
5 pick up an action like that, no.

6 Q Did you go back and look at what inspections were
7 actually made in the block after you discovered that fact
8 that while repairs had been made, in other words, you're
9 telling me what you would expect as part of the normal
10 processes, and I want to know what actually existed in terms
11 of inspections?

12 A Well, as Mr. Schuster testified, we did contact
13 TDI to see if they had documentation of making the weld
14 repair and there was no documentation.

15 Q Right, and then that shifted therefore to
16 inspections or audits performed by LILCO or its agents?

17 Did anyone working for LILCO or its agents such
18 as Stone and Webster, inspect the blocks? And my next
19 question, I might as well ask it now, is whether that took
20 place before or after painting of the blocks and whether
21 that would make a difference in terms of being able to see
22 the welds.

23 A Our agents inspected the engine prior to
24 shipment. It would have been fully assembled and painted.
25 They did not, to the best of my knowledge, inspect at the

WRBpp 1 detail level that you're referencing. In other words, at
2 the block level the engine would have been fully assembled.

3 Q Have you looked through all the inspection and
4 audit reports to know that that's correct, that is, that
5 there is no inspection or audit report performed by Stone
6 and Webster or LILCO or any other agent of LILCO, of the
7 blocks prior to full assembly of the engine?

8 A (Witness Seaman) As part of the DRQR program we
9 did review all the audit reports that had been prepared for
10 Shoreham. And basically what was done was if an item
11 mentioned in the audit report had some effect on a
12 particular component it would have been referenced in our
13 tracking system against that component. There was nothing
14 in those audits that indicated these cam gallery -- any cam
15 gallery inspections specifically or any indications in the
16 cam gallery area.

17 What we could do is we could look back at the
18 report just to refresh our memory of what's in there, but my
19 recollection is that there's nothing that discusses the
20 block specifically in these older audits for the original
21 blocks, in other words.

22 Q All right. I accept that recollection that there
23 is nothing there that reports on the welds.

24 Then I move to the next area of questioning which
25 is whether there are any inspections or audits that would

WRBpp 1 have been performed of the blocks by an agent for LILCO,
2 Stone and Webster or LILCO or some other agent, that would
3 have been performed at a time when the welds could have been
4 seen. And in other words, but nevertheless were not
5 reported on the inspection. Can you help me out on that?
6 If you know?

7 A (Witness Schuster) I'd like to make one comment.

8 Q I want to get an answer to my question.

9 A It has to do with the painting and I think it
10 helps to clarify a little bit your question.

11 Q Okay.

12 A That block, after it comes out of the mold, is
13 cleaned up. It's painted at that point in time. It then
14 goes into the machining process. Now the repair is not
15 something that is evident once that block is painted. I
16 want to make that point clear.

17 Q You say it's painted as soon as it comes out of
18 the mold?

19 A When it comes out of the mold it's allowed to
20 cool. It's cleaned and painted at that point in time and
21 that's because that block may be stored for a period of time
22 and I don't want a substantial amount of rusting in the
23 block at that point.

24 Q Do you know if it was painted and then welded and
25 then repainted?

WRBpp

1 A I don't have any knowledge at all of the weld
2 repair and how the weld repair was completed.

3 Q Could it have been painted, rewelded -- not
4 rewelded -- but could it have been painted, welded, and then
5 repainted. I will ask anybody, based on your observation
6 of at least the 103 block?

7 A The paint -- I can't answer that question. It
8 would be a pure guess on my part what the sequence of the
9 repair might have been. But I do know from the examinations
10 of the blocks that I had indicated earlier in 1983, that
11 what I saw at Delaval, I looked at a raw block and then I
12 looked at blocks which were on a production line which had
13 been painted but had not gone into certain stages of
14 machining, and that tells me that there is a certain
15 sequence that we look at that block in regard to the paint
16 and that surface.

17 Q All right. Let me get back to my question of
18 LILCO and then I'll come back to ask FaAA about the
19 painting-welding sequence possibilities. I still have the
20 same question. Because, for all I know, there was a Stone
21 and Webster or LILCO person right there when it came out of
22 the mold or, for all I know, it wasn't painted right away
23 because there was a delay for inspection and welding prior
24 to painting and I understand to what might have happened and
25 what typical processes are. But I want to know whether you

WRBpp

1 looked, as to what point in time certain inspection and
2 audits were made, and whether any were made of a point in
3 time when the block could have been viewed prior to full
4 engine assembly and if you could tell me whether it was
5 before or after painting?

6 A (Witness Youngling) Judge Brenner, we're going
7 to have to look at the documentation and get back to you.
8 We don't have that information.

9 Q Okay. Don't do that. The answer is you don't
10 know at this time; correct?

11 A Yes, sir.

12 Q I don't want to hold the record open for that
13 information. I just wanted to know what you knew now and
14 what was done in terms of checking the records and you've
15 answered that.

16 Let me ask FaAA about whether or not any of your
17 examinations of the cam gallery cracks could lead to a
18 conclusion as to whether or not the block was painted prior
19 to the weld repairs being made and then repainted; if you
20 could tell one way or the other?

21 A (Witness McCarthy) I'll let Drs. Rau or Wachob
22 comment on the metallurgical evidence, but from a
23 fabrication point of view it would be highly unusual to
24 paint and then grind out and weld for two reasons. First,
25 epoxy paint makes the grinding more difficult and loads up

WRBpp

1 the wheels and it's just a big hassle. Second, when you
2 welded it, you burn off that paint that was close to the
3 weld and then you would have to come through and sandblast
4 and repaint.

5 Q That would be true if you were planning
6 everything but it would not be true if the cracks were
7 discovered after the painting, right?

8 A I would agree except that every block seems to
9 have these cam gallery cracks and I would agree you might
10 get caught on the first one. But the second time or the
11 third time through the grinding wheels that typically are
12 most efficient at removal of steel for gouging operations
13 like this, are onerously affected by some tough paint like
14 an epoxy and you might get caught the first or second time,
15 but if you were the fabricator regular to making these weld
16 repairs and regularly making this type of weld repair you
17 would reverse the order pretty quickly, I would predict.

18 Q Have you found these weld repairs of cam gallery
19 cracks on other TDI engines which have been purchased for
20 emergency standby service for nuclear power plants? This is
21 the Dr. McCarthy or to anybody who knows.

22 After you answer that I'll broaden the question
23 to other TDI engines anywhere?

24 A (Witness Wells) Your question is directed toward
25 those blocks in nuclear installations?

WRBpp

1 Q Yes. And after I get that answer -- answer that
2 one and also as to other TDI engines in use anywhere?

3 A The TDI diesel generator owners' group is aware
4 of repairs that were made to one block, a V engine block,
5 V16, and to the best of my knowledge that is the only
6 information that the owners' group has on such repairs.

7 Q What about other TDI engines? I ask because
8 Dr. McCarthy gave me this picture, maybe he didn't intend
9 it, of the welds being set up as part of the assembly line.

10 A (Witness McCarthy) I was referencing, and
11 Mr. Schuster can elaborate on it, when they came to TDI to
12 do an inspection of the plant, they found cam gallery
13 cracking in the blocks they looked at on the plant floor
14 just out of the mold. And the one they looked at at Kansas
15 City and, of course, we found it in all the Shoreham
16 engines.

17 Q Mr. Schuster told us about this yesterday, I
18 believe.

19 A (Witness Wells) Judge Brenner, let me clarify my
20 previous answer to you. If I implied that this was a repair
21 of the cam gallery, it was not. It was a repair to the
22 block top.

23 Q Okay. I was asking about the cam gallery. I'm
24 glad you clarified because I was also going to ask whether
25 wasn't the configuration for the V engine different than in

WRBpp 1 the cam gallery?

2 A Yes. As we testified already, the configuration
3 is radically different in the two designs.

4 Q All right. What about other TDI inline engines?
5 Have you looked for, and yes or no, and then if so, are you
6 aware of weld repairs to the cam gallery cracks in other TDI
7 engines?

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AGBwrb 1 A Concerning the cam gallery, the only other in-line
2 engine that has been looked at is the one at River Bend, and
3 I'm not aware of any repairs, but I am also not able to tell
4 you whether that has been examined for evidence of weld
5 repair.

6 Q That's the one you discussed yesterday that you
7 thought may have been just a visual examination?

8 A That's right.

9 Q But you aren't sure; is that also right?

10 A I'm not positive as to the details of that
11 investigation.

12 Q Let's get back, before I forget, to the question
13 as to what the metallography might have disclosed one way or
14 the other as to the sequence of painting and weld repairs.

15 A (Witness Rau) Judge Brenner, there was no
16 evidence of paint entrapment in the shrinkage crack, which I
17 believe, given the sequence of events, would have been the
18 only reliable indication that it had been painted before it
19 was ground and rewelded.

20 So my answer is, there is no definitive evidence
21 that it was painted before the weld repair process.

22 Q Is it also correct that-- Well, would you have
23 expected to find some evidence of such paint entrapment if
24 it had been painted first and then welded, and then
25 repainted?

AGBwrb 1 A Again, your Honor, there is no way to be 100
2 percent sure, but in our opinion if the epoxy paint were
3 sprayed on, the mobility of the paint would be such that we
4 would have expected, given the openness of the largest, at
5 least, of these cam gallery indications in the original 103
6 block, to have perhaps gotten some paint down into, at least
7 to a depth beneath the 3/8, 1/2 inch deep weld repair. And
8 there was no evidence of that.

9 Q Are the blocks spray painted? Does anybody know?

10 A (Witness Schuster) The original blocks are spray
11 painted, yes, sir.

12 Q Is the new block painted differently?

13 A The new block is not painted in that area, sir.

14 Q Is there a reason for that?

15 A I think the manufacturing time probably had some
16 effect on this. I may not be totally correct about that.

17 I know the outside of the block in that area where
18 the cam gallery plates go on is not painted.

19 I'm having a problem now trying to remember
20 whether internally the saddle area was painted. But the old
21 original blocks were painted, and the new block, the
22 external part of it is not painted.

23 A (Witness Wachob) Judge Brenner, in doing the
24 testing that we have recently done, the cam gallery area was
25 painted. And the paint had to be removed from the

AGBwrp 1 replacement 103 block cam gallery area.

2 Q All right.

3 JUDGE BRENNER: It's past time for a break. We'll
4 take it at this point. And let's take a break until elevent
5 o'clock.

6 (Recess.)

7 JUDGE BRENNER: Back on the record.

8 BY JUDGE BRENNER:

9 Q Mr. Youngling, yesterday you said you would see if
10 you could check as to whether there was a specific standard
11 in the LILCO procurement requirements for the Class 40 gray
12 iron; that is, whether the basis for the ultimate tensile
13 strength of 40 Ksi was specified, whether it be a B bar or
14 anything else, or whether it was left unspecified.

15 Were you able to make that check?

16 A (Witness Youngling) Yes, Judge. We are going to
17 bring it up right now, as a matter of fact. Mr. Seaman has
18 the information, and he will go over it with you.

19 A (Witness Seaman) The purchase specification for
20 the diesels required that the drawings be furnished to the
21 engineers for their approval. On the drawing it is stated
22 that the material is ASTM-A-40-A, Class 40. It doesn't have
23 the grade designation, however. That information is
24 contained on the drawings.

25 Q Is that, if you know, a standard practice, to just

AGBwrp 1 have the class without any designation as to how that class
2 would be proved, so to speak?

3 And the reason I ask is, as I understand it,
4 depending on the size of the sample that you're using you
5 will get quite a variation in results of ultimate tensile
6 strength.

7 So how do you know what the strength is of the
8 block you're buying if you don't specify what the basis for
9 that proof of strength would be?

10 (The panel conferring.)

11 The fact that the panel has been conferring is
12 acceptable to me. I'm directing it to anybody.

13 A (Witness Seaman) Let me just start out by saying
14 that Transamerican Delaval specified the material on a
15 drawing. Itt really wasn't LILCO.

16 And with regard to how things are typically done
17 with respect to the ASTM specification, perhaps Dr. Rau
18 could discuss that a little bit.

19 Q Let me see if I understand your answer, first, and
20 then we can go to Dr. Rau.

21 LILCO had no minimum specification for the class
22 of the gray iron to be used in the block or expressed as a
23 class or any other written minimum requirement?

24 A (Witness Youngling) Yes, Judge, the specification
25 is a performance specification to deliver a diesel generator

AGBagb 1 capable of meeting a certain requirement within certain
2 seismic requirements and equipment qualification
3 requirements. Details relative to the block strength are
4 part of the performance spec of the engine supplied to us
5 under that performance spec. And the burden is on TDI, if
6 they specify the class 40, to designate the method to show
7 the class 40. And I think that Dr. Rau can comment on
8 that.

9 A (Witness Rau) Your Honor, in the relevant ASTM,
10 that is American Society for Testing Materials' standard
11 specification for gray iron castings, that's A48-64, there
12 is a specific subparagraph in that specification entitled
13 Basis of Purchase and subparagraph B of that paragraph, it
14 is actually numbered three, indicates, and I quote:

15 "If the class designation in the
16 purchase order or purchase specification does
17 not include the class letter identifying the
18 size of the separately cast test bar to be used,
19 the manufacturer shall have the option of
20 selecting a suitable size test bar."

21 Q All right.

22 We have been told that the class is class 40 for
23 the 101 and 102 block and also that the class for the new
24 103 block is 45 and we have other testimony as to what the
25 actual UTS was of certain specimens; am I correct so far,

AGBagb 1 primarily with the 40 and 45 classification?

2 A Again, your Honor, two things: first of all,
3 yes, in the sense of the manufacturer intended to have a
4 minimum class 45 gray iron for the replacement block. As we
5 have indicated yesterday, that is in fact a 45-B and a 40-B,
6 although it is not written down that way. And of course, as
7 we said the replacement block actually turned out to be a
8 class 50 by the specification and the original 101 and 102
9 turned out to be class 45-B by the actual measurements.

10 Q Well one of my questions was going to be whether
11 it was on the same footing, so to speak, that is, on the B
12 bar and I think in your answer you said that the new 103
13 block was to be a class 45-B, is that right?

14 A Yes, your Honor, that is my understanding.

15 Q All right.

16 Now I am a little surprised because I thought we
17 also had testimony that in fact the size of the test bar
18 changed for the new 103 block and whereas the B bar is
19 approximately -- I forget now, I think, one and a half
20 inches -- the cast-in test bar for the new 103 block is,
21 what, three and a half inches? Correct me if I'm wrong.

22 A Your Honor, that is not quite correct, I'm sorry
23 if you misunderstood what I said yesterday.

24 The new or replacement 103 block was still
25 evaluated on the basis of a B bar. However, in addition to

AGBagb 1 the casting of the 1.2 inch diameter bar, by current
2 procedure -- or at least those in effect at the time of
3 casting the 103, TDI was also casting additional bars of
4 different diameters and in fact not restricted only to a B
5 and a three-inch, my understanding is other bar diameters,
6 too, for a variety of reasons but in any case it is still in
7 fact the B bar which is the criteria for assessing the
8 class.

9 Q All right. Thank you. I don't think you
10 testified incorrectly, I think I drew an incorrect inference
11 from what you said yesterday. Now I've got it.

12 BY JUDGE MORRIS:

13 Q Dr. Rau, could I follow up on that just a little
14 bit. If you would refer to your Exhibit B-12.

15 Would it be correct that it doesn't matter what
16 the diameter of a test specimen is, that knowing its
17 diameter and its properties, one can extrapolate to any
18 section of the same material?

19 A (Witness Rau) The answer is yes, generally
20 speaking. You must, of course, have a typical or normal
21 gray iron microstructure and there must not be any other
22 unusual circumstances of the casting.

23 For example, you could manipulate artificially
24 the cooling rate of a 1.2 inch diameter bar and create, in
25 effect, the equivalent size for a much thicker bar.

AGBagb 1 But given the fact that you put it into a mold
2 and cast it, you know, with comparable pour temperatures,
3 generally speaking Exhibit B-12 provides a vehicle to
4 estimate the strength in any other diameter knowing the
5 results in any one diameter. And it is a generally accepted
6 way in the industry of making those predictions or
7 estimates.

8 Q Thank you.

9 BY JUDGE BRENNER:

10 Q Now the replacement 103 block has a nominal
11 thickness of three inches as compared to a nominal thickness
12 of two and a half inches for the 101 and 102 blocks, is that
13 correct?

14 A (Witness Wells) That's correct.

15 Q Was one of the reasons for -- Let me ask it this
16 way:

17 I take it one of the reasons for increasing the
18 thickness of the replacement 103 block was not to have a
19 greater UTS for the top of that block.

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AGBeb 1 A That's correct. The real reason why the new 103
2 block is three inches is that there was a pattern change and
3 all blocks made with essentially the same upper block
4 detail have to have this general configuration.

5 Q In part to accommodate the larger stud holes --
6 Correct? -- stud boss area?

7 A Yes, those dimensions, too. Both the block top
8 thickness and the new stud bosses are part of the new
9 pattern which is used both for the in-line and the V engine
10 blocks.

11 Q In fact, if the standard for determining -- if
12 the UTS for the replacement block and the 101 and 102 block
13 had been the same as based on the same standard, let's say a
14 B bar, then the fact that the 103 block top is nominally
15 thicker would actually lead to a lower UTS across the top of
16 that block relative to the other blocks if everything else
17 were equal; that is, they were both the same class, based on
18 the same standard. Is that right?

19 A (Witness Rau) To the extent, your Honor, that
20 the actual casting thickness were correspondingly larger,
21 that is a true statement. It would in fact be slightly
22 lower in that region.

23 But I would refer you again to B-12 to realize
24 that the differences between 2-1/2 and 3 or 3-1/2 and 4,
25 because the slope of that line is flattening out, are in the

AGBeb 1 direction you have indicated but are not large, and in fact
2 are much smaller than the change in the class designation
3 from 40 to 45 or the resultant packages, that is, from 45 to
4 50.

5 Q All right. Yes, I recall that, and you had
6 mentioned that the other day also.

7 Incidentally while we're looking at B-12, you may
8 have covered this but if so, I didn't quite understand it.

9 Which line is it appropriate to use in trying to
10 determine approximately what the tensile strength would be
11 as compared to section thickness of a block? The equivalent
12 diameter from the Iron Castings Handbook or the Iron
13 Castings Handbook plates?

14 And I'm not sure what the "two times thickness"
15 reference means to that one. Could you explain that to me?

16 A Your Honor, you can use either one of the lines.
17 The dotted line or dashed line is the equivalent diameter.
18 If you have a plate or, in this case, a block top which is,
19 say, three inches, the general way in which this information
20 is used is that is equivalent to a diameter of twice the
21 thickness.

22 So if you went to two times three inches thick or
23 six inches in equivalent diameter and drew a horizontal line
24 across you would find that you get a comparable tensile
25 strength by either of those lines on that basis. So if you

AGBeb 1 have a roundish section you would use diameter; if you have
2 a flatish section you could use either and either convert it
3 to a diameter and use the equivalent diameter or use the
4 plate directly.

5 Q All right.

6 This is going to be a vague question because my
7 notes are vague, and I hope you know enough to fill it in.

8 I saw a reference in one of the testimonies, and
9 I don't remember whether it was the County's or your own, --
10 that's my problem -- but the reference was that there was a
11 certain grinding performed on the new 103 block on or about
12 September 30th or October 1st, 1984, in preparation for
13 certain unspecified activities.

14 A, do you recall whether that is your testimony
15 or not? It would be the supplemental.

16 And if you don't recall that, then more to the
17 point,--

18 A (Witness Wachob) Our testimony does not address
19 that. It was the County's supplemental testimony.

20 Q All right.

21 Is that correct that -- and I promised you it was
22 going to be a vague question -- that there was such grinding
23 of the new 103 block on September 30th or October 1st, or in
24 that time frame?

25 A (Witness Schuster) Judge Brenner, there was some

AGBeb 1 surface preparation that was done to the new 103 block
2 around that time frame. It was light surface preparation,
3 to clean it. We use a Scotchbright wheel to clean that
4 surface up.

5 A (Witness Rau) Are you asking what it was in
6 preparation for, your Honor?

7 Q Yes, that's part of it. Basically my question is
8 what was done, and why.

9 A (Witness Schuster) That was in preparation for
10 the strain gage placement, sir. In order to provide a
11 reasonable surface for the non-destructive examination that
12 took place there, surface preparation was required.

13 Q All right.

14 For the record, the reference was in the County's
15 supplemental testimony on page 9 in Answer 14.

16 Earlier this morning, one or more of you gave the
17 view that in looking at the circumferential cracks that
18 Dr. Anderson had looked at specimens that were not properly
19 prepared for such examination in that they were not
20 metallographically polished, I guess was your term.

21 My question is what did you gentlemen look at?
22 Did you have specimens that were properly prepared, in your
23 view?

24 A (Witness Rau) Yes, your Honor. I described at
25 some length yesterday the very careful procedures and

AGBeb 1 variations on procedures we did to assure that those
2 evaluations of the presence or non-presence and amounts of
3 Widmanstaetten graphite were compared between 101 and 102,
4 the original 103, and the replacement 103 block.

5 In the area of the circumferential crack which in
6 fact we were dealing with this morning, our measurements of
7 crack depth were made by both visual but also by
8 non-destructive testing methods to quantify the size.

9 I don't know if that's exactly what you wanted
10 but they were--

11 Q Well, Dr. Anderson, in your view, based his
12 testimony that there were some in essence further crack
13 indications below the circumferential cracks on, in your
14 view, specimens that were not properly prepared for such
15 viewing, and that they weren't prepared at all I guess in
16 your view.

17 A Yes, your Honor, in my view that conclusion could
18 not be reached from a visual inspection; that is, a visual
19 alone on an unprepared surface. It could be reached by
20 conventional non-destructive inspection on the as-cut
21 surface or by metallographic polishing followed by visual
22 and microscopic examination of the surface.

23 Q All right.

24 And did you do all of those for the
25 circumferential cracks?

AGBeb 1 A We did the former. We did the non-destructive
2 inspection.

3 Q What was it? Remind me. Dye penetrant and mag
4 particle or--

5 A (Witness Johnson) The tests that were performed
6 on that surface were mag particle, penetrant, and eddy
7 current, and they all gave the same conclusion that it was--
8 The deepest indication was less than 3/8ths inch long.

9 Q Is it reasonable to suggest that there could have
10 been-- No, strike that.

11 JUDGE BRENNER: That's all I have for now.

12 Judge Ferguson has questions.

13 JUDGE FERGUSON: Thank you, Judge Brenner.

14 BY JUDGE FERGUSON:

15 Q I want to begin by saying that I recognize it is
16 difficult to conceive the inconceivable but I want you to do
17 that. I want you to recognize that I understand that you
18 have been through a lot of close questioning, and I am going
19 to shift gears for a moment and ask you a few questions that
20 are rather broad in nature. And I hope your answers will
21 reflect your understanding these questions as being broad in
22 nature.

23 I would like to start by focusing on weld
24 repairs. We have had a great deal of testimony about weld
25 repairs. I would like anyone on the panel to address two

AGBeb 1 concerns I have regarding weld repairs.

2 Can anyone on the panel tell me what a
3 manufacturer such as TDI or any manufacturer that deals with
4 large castings, what factors are necessary in order for them
5 to decide to make a weld repair? That is to say is the weld
6 repair for any reason in addition to perhaps the cosmetic
7 effect of the piece? If so, what further is to be
8 accomplished by the weld repair?

9 Is the question clear? And can someone address
10 themselves to that question?

11 A (Witness Youngling) Judge Ferguson, let me
12 start. And let me also say that perhaps Mr. Schuster can
13 talk a little bit about his knowledge of welding repairs
14 relative to large valves and things like that in the plant.

15 But specifically at TDI, my understanding is that
16 they have a casting review committee. I don't know how long
17 that committee has been in effect. I presume it goes back
18 to the time that our blocks were built and manufactured.
19 And the purpose of that committee is to make decisions
20 relative to the acceptability of castings.

21 I presume that that committee looks at the
22 casting relative to its ability to meet the end product,
23 desired end product. I am sure they are considering the
24 economical basis of the basis, how much money they have
25 invested into the casting vis-a-vis the amount of repair

AGBeb 1 required.

2 The casting committee, as I understand it, has
3 people from the manufacturing end, the engineering
4 disciplines, and although I'm not sure, it may have the
5 quality assurance arm on it. I'm not sure of that, though.

6 Q Let me interject just a moment here, just to
7 focus perhaps your answer.

8 I'm really concerned about the effect the
9 manufacturer hopes to get by making the weld repair.

10 A Well, what I'm trying to say is this committee,
11 representing TDI's judgment committee, puts in place
12 criteria that I'm sure they have established relative to the
13 economics involved and the ability of the casting to meet
14 its intent, and they are weighing those back and forth as to
15 whether they want to make a casting repair or not, such as
16 the weld repair.

17 Now do I know whether that committee performed
18 that analysis for the Shoreham engines? I'm not sure of
19 that.

20 A (Witness McCarthy) Judge Ferguson, if I--

21 Q I would certainly like to hear from you,
22 Dr. McCarthy, but I just want to follow up on you,
23 Mr. Youngling.

24 I guess my question is in your opinion, if weld
25 repairs are made, say, on the block, were these weld repairs

AGBeb 1 made to strengthen the block, or as I said before, simply
2 cosmetic purposes, or for some other reason, or do you know?

3 A (Witness Schuster) Judge Ferguson, maybe I can
4 help with this point.

5 While we were at TDI in 1983, you know, looking
6 at the blocks and the areas that we have been discussing,
7 the fillets and that, we were also there to check into some
8 head work and other work that they were doing for us. And
9 one of the questions we asked about the blocks themselves
10 were when would weld repairs be made on the blocks, and what
11 type of filler materials would be used, and that sort of
12 thing.

13 The response we got from TDI was that weld
14 repairs would only be made in a non-highly-stressed area or
15 a low-stress area, and would be for cosmetic purposes only.
16 That was the response that we got from them, and that is
17 documented in the trip report that went with the work that
18 we did.

19 Q Have you found that to be always the case, that
20 no weld repairs were made in high-stress areas?

21 A Based on my limited knowledge of what a
22 high-stressed area would be, an outside edge of a flange.
23 In the area that we're talking about, in retrospect, with
24 the knowledge I have now, I would consider that to be a
25 low-stressed area also.

AGBeb 1 The areas that we have seen small amounts of weld
2 repair have been typically at the edges of the casting and
3 flange areas which would be more for cosmetic purposes than
4 for the structural integrity of the casting.

5 Q Thank you.

6 Dr. McCarthy?

7 A (Witness McCarthy) Forgive me if perhaps I
8 misunderstood. I was going to just briefly add, for the
9 broader consideration of your question, that certainly weld
10 repair is not used only for cosmetic purposes, that weld
11 repair, properly done, can transform what is a very sharp
12 flaw and discontinuity and stress-raiser in a casting
13 surface. If it is completely ground out, properly filled
14 with weld metal brought up to the surface it can turn what
15 would be a liability in any large casting into material
16 that, for all intents and purposes, is as strong as the
17 parent when it is properly done.

18 A (Witness Schuster) The other thing I would like
19 to add, Judge Ferguson, if I may, is that these indications
20 were first found by visual examination as part of the normal
21 maintenance routine of the engines. They-- Let's see, that
22 was on the 103 engine.

23 If the manufacturer had intended to be -- to have
24 some structural integrity, it was quite obvious that you
25 could see them, and he certainly would not have left them in

AGBeb 1 that condition. In fact, one of the indications had a
2 slight amount of dimpling and exploration that was done to
3 it, and that became evident when we did our inspections at
4 that point in time.

5 In my estimation, if I would have tried to answer
6 your question in the broadest sense that you asked it, if I
7 tried to go back and put together in my mind why that type
8 of repair would have been made, as I understand, those
9 engines were the first nuclear engines that TDI supplied. I
10 think that they were aware of the indications in the cam
11 gallery area, as was evident by their repair, and their
12 attempt was one of cosmetic, to cover that area up because
13 of their knowledge of the indications being there.

14 And when that proved to be fruitless, you know,
15 that they couldn't do the cosmetic portion of it the way
16 that they wanted to, they just stopped their repair, you
17 know. And again they realized that they did not -- that it
18 didn't have any structural impact on that particular
19 location in the cam gallery.

20 BY JUDGE BRENNER:

21 Q Mr. Schuster, what is your basis for any of this,
22 because I thought you earlier told me that there were no
23 records available by TDI, which I took to mean any analyses
24 whatsoever exhibited in such records as to even finding the
25 crack indications or even performing the weld, let alone

AGBeb 1 why they performed certain welds and stopping certain welds,
2 and so on.

3 A (Witness Schuster) Judge Brenner, what I
4 attempted to do was to answer Judge Ferguson's question in
5 the broader sense. I took that to mean that I could use my
6 imagination, to a certain extent, --

7 Q Don't use your imagination.

8 A -- and some of my background knowledge as to
9 why-- I'm sorry, it would be imagination totally, and that
10 is the attempt that I made in doing that. I took it in too
11 broad a sense.

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BY JUDGE FERGUSON:

Q Thank you anyway, Mr. Schuster. Turning back to you, Mr. McCarthy, did I understand what you just said, that a faulty section in a casting could, in fact, be removed by properly performed weld repair? That is, the faulty strength section, the section that had a faulty strength could be removed by properly applied weld repair; is that correct?

A (Witness McCarthy) Not in all castings and all places but, generally, yes. In a wide variety of casting geometries -- some areas you can do it. It would not be good practice to just universally do it in all areas of all casting depending on how the integrity of the parent material must be. But generally it is a widely used procedure to remove problems such as hot tears, porosity, voids that occur in the casting process and can be used to repair those problems completely.

Q Has FaAA ever found in the blocks that we have been talking about weld repairs in regions of high stress, if you know?

A (Witness Wells) Judge Ferguson, not in the engines at Shoreham. I can not make that categorical statement because I am aware of weld repairs made to a block top on another engine.

Q Could you categorize the areas of weld repairs at

AGRpp 1 Shoreham? That is to say, would you characterize them as
2 all in regions of low stress?

3 A Yes, Judge Ferguson, I would. In my opinion, the
4 locations of the repairs specifically in the cam gallery
5 have been areas where the stresses do not reach any, or any
6 significant levels, of tensile stress and therefore
7 essentially their purpose is to transmit either compressive
8 loading or to prevent leakage resulting from verocity or,
9 yes, and possibly cosmetic purposes as well.

10 A (Witness Schuster) Judge Ferguson, could I add
11 one other thing. If we look at the metallographic sections
12 that were done in the cam gallery area, if TDI, in fact, was
13 attempting to add structural integrity to that area, they
14 certainly would have completely removed the crack and that
15 was not done, as one can see, from metallographic sections.
16 The repair was a cosmetic repair in regard to the section
17 thickness and no way would anybody expect that weld to add
18 any structural strength without completely removing that --
19 those indications.

20 BY JUDGE BRENNER:

21 Q Mr. Schuster, once again, I just want to be clear
22 what you're saying. If I interpret your testimony that
23 would be the way you would approach it if you were doing it;
24 is that right?

25 A (Witness Schuster) No, sir. What I'm attempting

AGBpp 1 to is you indicated for me not to use my imagination so what
2 I am doing now is providing you some additional input based
3 on the samples that have been cut and the metallographic
4 sectioning that was done on the old 103 engine. If you look
5 at the cross sections of those indications and as the
6 testimony has indicated the crack, the original crack, is
7 still there. We have a weld repair which is 3/8ths to half
8 an inch thick placed on top of this original crack. Now, if
9 I were going to -- if I were concerned about that area --

10 Q That's my question. You're putting yourself in
11 the place of a -- that is a reasonably prudent intelligent
12 person with expertise who wanted to go about using welds
13 to provide structural integrity.

14 A That's correct.

15 Q And so when you say no way would anyone do it
16 that way, if their purpose was to provide structural
17 integrity you're assuming an actor, if you will, the person
18 or company performing these welds has the proper expertise
19 and is properly performing the work they intended to
20 perform.

21 A Yes. But also, too, you would have what would be
22 standard industry practice in repairing cracks and castings,
23 sir. It would be a little more than --

24 Q All right. You're assuming again that -- I'm not
25 criticizing you, I'm only trying to understand the basis for

AGBpp 1 your testimony.

2 A The basis for my testimony is several things.

3 One is --

4 Q Let me tell you what my problem is.

5 A Yes, sir.

6 Q We have to assume from your testimony and maybe
7 we'd be willing to assume that, but what we have to assume
8 is that TDI knew what they were doing when they were making
9 those welds as opposed to the possible assumption that
10 indeed the thought they were adding structural integrity --
11 although as it turned out for a number of reasons they did
12 not and could not under the processes they employed?

13 A I understand your point. The point that I'm
14 trying to make is that the section thickness there is -- in
15 that area of the fillet -- is almost 3 1/2 inches and then
16 it transitions into about an 1 1/4 section. To apply
17 3/8ths of an inch to 1/2 an inch of weld material in that
18 area and expect it to provide structural strength, and I do
19 have some knowledge of some of the expertise that would be
20 available to TDI, in my opinion, would not be expected. I
21 would not expect it that weld repair would do nothing more
22 than provide cosmetic, you know, be a cosmetic application
23 in that area.

24 BY MR. FERGUSON:

25 Q But in any event, as Dr. Wells has testified --

AGBpp 1 Dr. Wells has testified these welds are in low stress areas
2 so far as the Shoreham diesels are concerned.

3 Dr. McCarthy, you indicated there would be some
4 advantage in weld repairs so far as the structural
5 properties of a piece were concerned provided those welds
6 were properly made; is that what you said earlier?

7 A (Witness McCarthy) Close, that you can restore
8 the structural property of a hot tear affected area by
9 properly executing the weld repair.

10 Q Is that a difficult operation in your opinion?
11 That is, a properly executed weld repair?

12 A Once again, it depends on the geometry in the
13 casting and I haven't made a detailed analysis of this
14 particular block in that area. But it's not a trivial
15 matter to go in and get out 9/10's of an inch deep sort of
16 indications or something of that size. In this sort of a
17 geometry it's not simple to get at. That's a difficult --
18 it's an onerous grinding operation, not un-do-able. And if
19 you're going to do that sort of repair it's going to have to
20 be in multiple passes. In other words, you can't just do it
21 with one layer weld bead. He'd have to lay a layer, pull
22 out your flex, lay another layer until you brought it up to
23 surface, but it's do-able.

24 Q I see. Do you think that was done in the weld
25 repairs that Mr. Schuster just talked about? That is, the

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1 careful application of the weld material?

2 A The welder, in looking at the beads, probably was
3 reasonably careful in applying the weld material but the
4 preparation, which is really the careful part, was not done.
5 The cracks were not excavated to their full depth and
6 multiple passes made on the way out that -- it was not in
7 the procedure I've described.

8 Q Then you would agree with his statement --

9 A Excuse me. I'm sorry. Dr. Rau has one addition.

10 A (Witness Rau) I think, Judge Ferguson, the
11 presence of the cracks between the weld bead and the
12 adjacent cast iron or the indications in the 101 and 102
13 which have typical gray cast iron properties are indicative
14 along with the presence of the Martin site, that the most
15 conservative weld prepare procedures were not employed in
16 that particular case.

17 I wanted to add also that I think I'd go a little
18 further, while I agree with Dr. McCarthy -- go a little
19 further indicating it's not an easy job to weld repair in
20 gray cast iron and in particular in the original 103 block
21 with the degenerate Widmanstaetten structure. Weld repair
22 in that particular block was virtually impossible although,
23 again, under extraordinary cautions and procedures it may
24 have been possible to introduce a weld repair without
25 subsequently cracking the weld bead on cooldown, but it

AGBpp 1 would have been very difficult.

2 A (Witness McCarthy) I would just like to add that
3 I agree with Dr. Rau except if you didn't know it was
4 Widmanstaetten graphite degenerate structure you would
5 probably go in and make your normal weld repair and then you
6 would find out that the material couldn't stand the
7 shrinkage of the weld material and you continually get
8 cracks in the heat affected zone next to the weld.

9 Q Thank you very much. Then is it fair to say that
10 what you Dr. Rau and Dr. McCarthy just testified supports
11 Mr. Schuster's statement that these welds are primarily for
12 cosmetic purposes?

13 A Yes. I think a structural weld repair would have
14 been approached totally differently.

15 A (Witness Rau) I would agree, Judge Ferguson,
16 that they were probably done with cosmetic purposes,
17 although I have no firsthand knowledge of the motivation. I
18 don't want to leave on the record though the misconception
19 that an intact weld repair, even if the original defect or
20 crack was not fully excavated, would have no impact on the
21 structural integrity of the part. Without getting very
22 detailed if, in fact, a sound weld of say, 3/8 of an inch
23 deep were placed over what had been a 3/4 inch deep
24 shrinkage crack, that would substantially improve the
25 strength of that section if, in fact, that section ever had

AGBpp 1 any tensile stresses applied to it.

2 As a rule of thumb, when you do fracture
3 mechanics analysis of parts with flaws, if you had a crack
4 in the center of the body, the effective crack size for
5 where that crack will grow is related to half the size of
6 the crack, if it's centered tip to tip, take half of it. As
7 compared to a crack which is on the surface where the
8 entirety of the crack is affective in driving the crack. So
9 if you did nothing more than take a crack which was 3/4 inch
10 deep to start with and weld up the tip of it and not, say,
11 change its total length at all you'd reduce its effective
12 length for crack extension by a factor of 2.

13 And that's not to say that in the original 103
14 block where the weld repairs cracked on solidification, that
15 it added much because in that case there was no sound weld.
16 But if, in fact, the sound weld existed it would, in fact,
17 improve the structural considerations.

18 Q Thank you very much, Dr. Rau. Let me move on
19 quickly to a second area that I had some concern and this
20 has to do with casting. Now, my simplistic view of a
21 casting process is that you have a mold with the shape of
22 the object that you want to cast or you want to make and
23 then you pour the hot material in the mold and allow it to
24 cool. Now, I'd like to focus on this B bar sample that's
25 made.

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1 Is anyone on the Panel familiar enough to know
2 where the actual location is in the mold that the B bar is
3 actually cast? Is it near the block? Is it far from the
4 block -- do you know?

5 A I know that we do not know where it was in the
6 original 101, 102 and 103 because we have asked for records
7 and explanation that was not forthcoming from TDI. As
8 mentioned yesterday we do know that in the more recent
9 casting of the replacement block that some of the test bars
10 at least were cast within what would be the place where the
11 cylinder hole is. So it is kind of within the total mass of
12 the casting but not intimately in contact with the adjacent
13 wall of the block. But even in that case I'm not personally
14 sure that the B bar is in that same cavity where the bars of
15 increasing thickness are.

16 Q The reason that came to my mind is that there was
17 a great point made about cooling rates and the question was
18 stimulated because I was wondering what the temperature
19 distribution in the mold was around the B bar versus the
20 temperature distribution around the block. In your -- does
21 anyone know whether or not they are vastly different?

22 A I would suggest, your Honor, that the results of
23 the tensile strength measured thereafter are clearly
24 indicative that they were in fact substantially different.

25 Q But you do not know why they would be

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1 substantially different because you don't know where they
2 were cast; is that correct?

3 A Well, I certainly cannot quantify for you but
4 even if they were in reasonable proximity the cooling rate
5 of the smaller diameter bar is going to be more rapid. It's
6 really a matter of degree. And obviously the fuller the way
7 it is and the less well-insulated the entirety of the pit in
8 which all the bars are would effect the relative rates.

9 Q And that would kind of depend on some kind of
10 temperature gradient through them all, wouldn't it?

11 A Yes, sir, very definitely.

12 Q If they had the same temperature gradients
13 through the molds the rates would not be different; is that
14 correct?

15 A Well, let me just indicate it depends upon the
16 heat capacity of the mold to start with and to what extent
17 the mold is preheated. If you start off with a hugh mass of
18 sand and it's at room temperature and you pour --

19 Q Excuse me, Dr. Rau, did you hear my question?

20 A I probably did, I'm sorry, maybe I didn't.

21 A (Witness McCarthy) The answer to your question
22 is yes. With the same temperature gradient you would get
23 the same cooling rate. However, Dr. Rau's point is that
24 when the metal first hits and you start your formation of
25 the casting microstructure even though the ultimate steady

AGBpp

1 state also does affect the initial formation of the casting
2 at the internal microstructure of the steel.

3 Q Dr. Rau, let me ask you this question. Could you
4 very briefly fill in a few blank spaces that I have, at
5 least in my understanding, of what in fact FaAA did as
6 regards the effect of changing the proudness from the
7 cylinder collar, cylinder liner and collar, I guess. You
8 said that you had done a number of studies where you had
9 gone from a proudness height to zero proudness and you sort
10 of stopped at a point that I began to get interested in.
11 And that is what was the effect of that study on the
12 downward pressure, I guess, on the liner landing area due to
13 the preloading stresses? And be as brief as you possibly
14 can but surely as complete as you want to be.

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AGBagb 1 A (Witness Rau) Okay.

2 We did not physically vary the proudness. What
3 we did do is with our finite element stress analyses we
4 varied the amount of force from the head which is
5 transmitted down through either the liner or the block top
6 adjacent to the liner.

7 Our finite element analyses assumed, for example,
8 in one extreme that all -- the entirety of the force from
9 the heads was on the liner, which would be a proudness large
10 enough to keep the head off of the block completely, if you
11 like, except for the seal --

12 Q Excuse me. I understood the two extremes that
13 you studied. All I am interested in is what were your
14 results as regards the stresses at the edge there of the
15 liner landing area and the collar?

16 (Pause.)

17 Just to save time, Dr. Rau, if it is going to
18 take you some time to do that --

19 A Let me explain, Judge Ferguson, why it might take
20 a minute:

21 We did a series of calculations. The ones which
22 I summarized and used as the basis of our testimony are in
23 fact the ones I consider the most conservative in the sense
24 that we used the one which has the 100 percent of the head
25 loads transmitted down through the liner, because that did

AGBagb 1 in fact produce the highest stresses in the vicinity of the
2 liner land where the circumferential cracks were observed in
3 the original 103. I have those numbers. What I don't have
4 at my fingertips are the corresponding ones that go for the
5 assumption that the load is distributed between the block
6 top and the collar.

7 Again my recollection is that those differences
8 are not nearly so large as you would expect. They are in
9 fact lower at the corner where the circumferential cracks
10 start when in fact the load is on the block top, and the
11 differences become even less as you move away from that
12 sharp corner during the path -- along the path that the
13 circumferential cracks have been observed to progress in the
14 original 103 block.

15 Q Did someone testify earlier -- and I don't have a
16 transcript reference for this -- that there would be changes
17 in the amount of proudness of the collar, is that correct?

18 A Dr. Wells perhaps would want to comment on what
19 changes have been proposed or are incorporated in the
20 replacement 103 block.

21 A (Witness Wells) Yes, I think we mentioned
22 already that the new block for 103 was assembled with a
23 smaller liner proudness, not by machining the block
24 differently but just by reducing some material from the
25 liner itself. And we had suggested to LILCO that they

AGBagb 1 should consider this some time in the future, as convenient,
2 to reduce the load from the liner top and, as Mr. Youngling
3 I believe said, they will try to do that in the future.

4 The effect of reducing the liner proudness is
5 probably to take some of the concentrated stresses from the
6 circumferential corner between the liner landing and the
7 counterbore. Because that is such a sharp corner, one
8 really cannot reduce that level of stress by a large amount
9 and the stress concentration factor will remain very high.
10 And I would say the benefit of reducing liner proudness is
11 much less certain from our standpoint than the effect of
12 reducing the radial gap between the liner collar and the
13 counterbore.

14 Q Just to complete what I think I understood you to
15 say, you said that Mr. Youngling or LILCO is going to reduce
16 the pressure, was that what you just said? And if so, how
17 is that going to be done?

18 A Not quite, Judge Ferguson, the reduction of liner
19 proudness will reduce the pressure between the cylinder head
20 and the top of the liner.

21 Q I understood that but how is that going to be --
22 you are going to reduce the proudness, you say?

23 A Yes, that was the suggestion we made to LILCO,
24 but Mr. Youngling should speak for their intentions.

25 A (Witness Youngling) I think, Judge Ferguson,

AGBagb 1 you are asking how are we going to implement it? We will
2 machine the liner to a new dimension to reduce the
3 proudness.

4 Q I see.

5 Will there be a proudness -- I don't know what
6 the recommendation was, it may be in your testimony
7 somewhere -- will there in fact be a proudness after the
8 machining operation?

9 A (Witness Wells) Yes, sir, there must be a finite
10 proudness. I think the -- I would have to look at the
11 actual dimensions but it is on the order of 1- to 3000ths of
12 an inch, somewhere in there.

13 The reason for that is there must be a clamping
14 force on the top of the liner to prevent relative motion.

15 Q Dr. Wells, while we have you there, let me ask
16 you a very broad question. This one is really broad, I
17 believe.

18 Looking at transcript page 24,851 and 24,852 --
19 the day is Wednesday, October the 24th. And what I would
20 like to get at in my next question is really an
21 understanding of some comments that you made in reply to
22 some questions that were asked.

23 A question was asked on page 24,850 that had to
24 do with strain gage data of the cam gallery area. And in
25 reply -- Do you have that in front of you, Dr. Wells, page

AGBagb 1 24,851?

2 A I do, sir.

3 Q In reply you say:

4 "Our problem with verification of the
5 tests conducted in the past by TDI have been the
6 same, we have not been able to confirm the
7 calibration of instrumentation, the accuracy of
8 reporting and in some cases the reduction of
9 strain data to test data. Therefore I think
10 all of these gage readings are essentially
11 tarred with the same brush."

12 Keeping that in mind and turning to the next
13 page, page 24,852 and here again in response to a question
14 that deals with strain gage data you reply:

15 "I don't recall any specific
16 violation that would suggest that we should
17 discount measurements. However, I have
18 little faith in the mean stress values."

19 And I am going to skip a part of your answer down
20 to the last part and you continue to say:

21 "Again these have been variously
22 at various times attributed to the lack of
23 calibration or compensation. I should say
24 for temperature effects and in that regard I
25 think these measurements suffer from the same

AGBagb 1 problems that the cam gallery did, only in the
2 case of this location we are dealing with
3 higher temperatures and more complex heat
4 transfer situations, so I am doubly pessimistic
5 about the validity of the results."

6 Now I interpret those two parts of your answer,
7 Dr. Wells, as essentially saying that you have -- you lack
8 full confidence in some of the information that you have
9 gotten from TDI and I think I have heard that same chorus
10 repeated from time to time in other witnesses. Now this is
11 my broad question and I hope that you can answer it as
12 completely as you possibly can without being too subjective:

13 Do you have confidence, based on the
14 investigations that you have been involved with concerning
15 these engines produced by this manufacturer, do you have
16 confidence that you have done enough investigation to
17 override some of these pessimistic views that you have had
18 in the past such that you can wholeheartedly support the
19 conclusion that I see at the end of your testimony, namely
20 that these engines will in fact perform their intended
21 function?

22 That was a very long question, I know, but I hope
23 you get the gist of it and answer it as best you can.

24 A I very clearly understand the point of your
25 question, Judge Ferguson, and I will try to answer it as

AGBagb 1 directly as I know how.

2 Obviously it is impossible to know all of the
3 factors, all of the diameters, all of the information that
4 went into the design, manufacture, assembly and so forth of
5 these engines.

6 We have been on the subject of these engines,
7 many of us have, for well over a year. We have seen each
8 engine taken apart completely at least once, and, in some
9 cases two, and, in certain instances three times.

10 Many of us have looked at all of the parts. We
11 have witnessed the inspections, we have verified dimensions,
12 we have verified the materials and in some cases, as you
13 have heard this week, verified even the microstructure in
14 the attempt to sort out information which we would not
15 obtain from TDI.

16 We have, I think, been aggressive in pursuing all
17 of the problems and to a reasonable extent, I think, the
18 anticipated problems, possible problems, I think probably to
19 LILCO's chagrin in some respects.

20 I, myself, must confess that I brought the
21 problem of piston boss cracking to their attention when it
22 had not been seen to be a problem in this particular type of
23 piston and in this particular environment. However, we
24 insisted that LILCO take apart pistons and look for any
25 evidence of fatigue cracking and, in retrospect, probably

AGBagb 1 those cracks were of no significance but you are familiar
2 with the piston saga and the outcome of that.

3 This occurred in many other areas. Our design
4 review has covered, to the best of our knowledge, not only
5 the significant structural members of the engine but all
6 those elements that are in relative motion.

7 And I believe that the problems at TDI that are
8 of concern to you, while obviously we may yet -- LILCO may
9 yet encounter some surprises, to the best of our knowledge
10 and to the best of our ability to probe, to inspect, to
11 dissect and investigate, we feel that we have uncovered all
12 of the significant ones.

13 Q Okay. I appreciate that, Dr. Wells. I am going
14 to interpret what you have just said in the light of the
15 things that we have been discussing -- specifically the
16 blocks, the crackshafts and the pistons, but right
17 immediately the blocks.

18 I have one last question that I would like to
19 raise just before the lunch break and I hope it can be
20 answered very briefly, and that is to you, Mr. Youngling:

21 On the 22nd of October, in discussing another
22 matter, you introduced the fact that the engine could not be
23 run at 3900 Kw and did in fact operate only at 3830, I
24 believe, Kw and that was because of the quality of the fuel,
25 was that correct?

AGBagb 1 A (Witness Youngling) Yes, Judge Ferguson. The
2 quality of the fuel was the problem, the quality of the fuel
3 was too good. As you refine diesel fuel and make it more
4 refined, to what they call a Number One diesel fuel, the
5 heating value of the fuel decreases.

6 And we were seeing, and we have seen, a trend on
7 Long Island of diesel fuel whereby in the summer it is a
8 less refined fuel and in the winter it is a more refined
9 fuel, and we think that trend is really applied to the
10 automotive use and the truck engine use --

11 Q I am going to interrupt you for just a minute
12 because I do want to shorten this. I guess my question
13 really is accepting those facts, what in fact are you doing
14 to prevent the problem from occurring in the future?

15 A Yes. What we have done is we have taken a very
16 positive step. We have on-site storage capability in an
17 adjacent facility of in excess of 50,000 gallons of fuel.
18 And what we do is we stockpile fuel in there to give us the
19 proper fuel available to us. In addition we have, behind
20 that stockpile, additional sources of fuel of that quality
21 that we feel is more appropriate. So we can then take care
22 of these trends, if you will, and keep in our stockpile the
23 kind of fuel that we want to give us the assurance that we
24 can achieve what we want to do with the engines.

25 Q You have some method of determining the quality

AGBagb 1 of the fuel?

2 A Absolutely, yes. Through sampling, yes.

3 Q That's all I have.

4 JUDGE BRENNER: We are going to take our lunch
5 break.

6 I guess one minor note that occurred to me as a
7 result of one of Judge Ferguson's questions and that was
8 until we started referencing transcript pages bearing the
9 numbers they did I didn't realize yesterday we passed 25,000
10 pages in this part of the proceeding under the auspices of
11 this original Board and I think it is correct that only two
12 of us in this room have sat through each and every page.
13 And on that note, I am ready for the lunch break.

14 MR. DYNNER: Judge Brenner, I wonder if it would
15 be possible, because all of us have -- we have a witness
16 panel to prepare -- to get an estimate, if there is a more
17 accurate estimate, of redirect and also how many more
18 questions the Board is likely to have.

19 JUDGE BRENNER: Yes, I am glad you reminded me
20 because I had intended to volunteer the estimate for the
21 Board's questions and I had forgotten. The Board has about
22 approximately a half-hour of questions remaining.

23 Mr. Farley, can you give us an estimate for your
24 redirect?

25 MR. FARLEY: Your Honor, I would think at the

AGBagb 1 most it would be three hours.

2 MR. DYNNER: I would say at this point I have a
3 minimum of one hour of recross.

4 (Pause.)

5 He's looking at you --

6 JUDGE BRENNER: No, I'm looking at the clock and
7 I am not getting any extra hours on the clock, although I am
8 staring at it angrily it is not doing me any good.

9 I was not looking at Mr. Goddard, but you can
10 volunteer if you want to.

11 MR. GODDARD: I have no recross at this point.

12 JUDGE BRENNER: I had hoped to finish this panel
13 today, and it may still be feasible to do that. Let's take
14 a break until 1:45.

15 (Whereupon, at 12:10 p.m., the hearing in the
16 above-entitled matter was recessed, to reconvene at 1:45
17 p.m., this same day.)

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AFTERNOON SESSION

(1:45 p.m.)

JUDGE BRENNER: Back on the record.

Whereupon,

ROGER LEE MC CARTHY,
HARRY FRANK WACHOB,
CHARLES A. RAU,
CLIFFORD H. WELLS,
EDWARD J. YOUNGLING,
CRAIG K. SEAMAN,
DUANE P. JOHNSON,
and
MILFORD H. SCHUSTER

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

JUDGE BRENNER: Mr. Dynner.

MR. DYNNER: Judge, if I may raise one
preliminary matter, I requested this morning of LILCO that
LILCO bring back to this room all of the samples of the
cracks which were furnished as being all of the samples that
FaAA had sectioned from the block and examined, and being
the same samples which Dr. Anderson examined initially here,
and then again at FaAA on October 12th under microscopes,
and which are the subject of the testimony.

I also requested that LILCO at the same time

WRBeb

1 furnish an explanation or statement concerning any physical
2 changes which had been made to those samples since they were
3 -- if any, since they were inspected by Dr. Anderson on
4 October 12th.

5 The purpose of that request was, in the first
6 place, to see whether changes had been made and what the
7 effects would be. The testimony is in direct conflict as to
8 the appearance of those samples and it seemed to us that
9 this was a means by which not only could parties have the
10 samples here for purposes of testimony but that the Board
11 itself, given especially the technical and scientific
12 background of the members, might want to look at some of
13 these samples and particularly under a microscope which we
14 can have available.

15 JUDGE BRENNER: No, we don't want to look at them
16 under a microscope. We're looking at the evidence under a
17 microscope, not the samples.

18 MR. DYNNER: All right.

19 JUDGE BRENNER: Number two, I don't recall ever
20 knowing that, as you say, all the samples were here in the
21 room. The only thing that I know of was that big section
22 that we all looked at together, and I did observe that
23 somebody on the panel had another, which appeared to be a
24 smaller section.

25 MR. DYNNER: I would clarify that what I meant

WRBeb 1 was a number of the samples were brought here and were
2 looked at in this building. I'm not referring only to the
3 single sample that was looked at in this room.

4 At any rate, I made that request for the reasons
5 that I stated, and the request has been rejected.

6 JUDGE BRENNER: Well, assume for the moment that
7 the Board does not want to look at the samples. What would
8 you want to do with them?

9 MR. DYNNER: The principal thing we would like to
10 know is if there have been physical changes made to the
11 samples. For example, if subsequent to Dr. Anderson's
12 examination some of those samples have been polished or
13 otherwise altered, then we would want to have an explanation
14 on that, as well as an opportunity to again examine those
15 samples given any physical alterations that might have taken
16 place.

17 JUDGE BRENNER: Well, frankly, I am not sure you
18 are clear on the chronology, and if you are right then I am
19 certainly not clear on the chronology, and I don't see
20 necessarily the direct contradiction that you seem to see.
21 And I suggest that you ask some follow-up questions if you
22 want, based on what was asked here. And then Dr. Anderson
23 will be on the stand in the future also, and then we'll see
24 where it all takes us.

25 The main point, as I understand it, is that

WRBeb 1 according to these witnesses, and we'll learn more from
2 Dr. Anderson, they believe Dr. Anderson just looked at it
3 visually. And we're talking about the circumferential
4 cracks particularly. And that is where the testimony came
5 up.

6 And I don't even recall that there were any
7 samples of the circumferential cracks, but that's an aside,
8 any samples here that we ever saw.

9 In any event, I don't see the direct
10 contradiction that you see, and we can ascertain-- You can
11 pursue it further with these witnesses, and we can ascertain
12 quite easily from Dr. Anderson what he looked at. And if it
13 was just visual, then I don't see the contradiction that you
14 seem to think exists. And if it is something else then
15 we'll decide it then.

16 It may be that at that time if you then want to
17 make a request for the samples we'll grant it. So I suggest
18 that if the samples are convenient right now that they not
19 become inconvenient between now and then.

20 MR. DYNNER: Thank you.

21 JUDGE BRENNER: Mr. Ellis, did you have
22 something?

23 MR. ELLIS: Yes, your Honor.

24 JUDGE BRENNER: I want to finish the Board's
25 questions of this panel, but what did you have?

WRBeb

1 MR. ELLIS: I am here to respond to the
2 Board's questions that were raised yesterday concerning
3 the footnote in the cylinder head agreement, and also to
4 address the Board generally on the question of load if it
5 wishes. I must say I apologize to the Board that I wasn't
6 available yesterday, and I appreciate the Board giving me
7 until noon today to be here.

8 JUDGE BRENNER: We said whenever it was
9 convenient, although we were hopeful of doing it by
10 tomorrow. So we suffered no inconvenience.

11 I don't want to get into the full question of
12 loads I don't believe. I want to see where the-- Well,
13 maybe. But let's see what the first answer is.

14 Are the other parties ready to take that up now?
15 That is our question about the footnote in the piston
16 agreement.

17 MR. DYNNER: We are prepared to try to answer any
18 questions you might have about that.

19 JUDGE BRENNER: Mr. Goddard, is that all right
20 with you?

21 MR. GODDARD: Yes, sir.

22 JUDGE BRENNER: All right, let's do it now then.

23 Why don't we let the witnesses relax. I think
24 this is likely to take at least 15 minutes, based on past
25 experience. And if you all want to relax someplace for 15

WRBeb 1 minutes, as long as somebody knows where you are, we will
2 take a brief break at the time until we're ready to call you
3 back. If you insist on being here you're welcome, but if I
4 were you I would keep walking.

5 (Laughter.)

6 'Witness panel temporarily excused.)

7 JUDGE BRENNER: Mr. Ellis.

8 MR. ELLIS: Yes, sir.

9 Judge Brenner, I believe you had a question
10 concerning the footnote on page 5 of the settlement
11 agreement which related to the qualified load.

12 JUDGE BRENNER: Right. I'm probably as
13 interested in the County's view of the footnote as anybody's
14 view, but I'll let you start off, Mr. Ellis.

15 MR. ELLIS: All right, sir.

16 In general, I think a little history may help the
17 Board in this connection.

18 As the Board knows, the FSAR continuous load is
19 currently, and has been since the submittal of the FSAR,
20 3500 Kw, and that was the design load.

21 In August of this year, the Staff issued its TDI
22 Owners' Group SER and in that SER indicated that a qualified
23 load could and should be defined for the diesels.

24 Almost contemporaneous with that LILCO completed
25 its integrated electrical test which is a test, as the Board

WRBeb 1 may know, that enables, among other things, LILCO to
2 determine what the actual loads are, at least as a first
3 cut.

4 Thereafter, as I reported to the Board in the
5 Status Report, LILCO undertook to define a qualified load,
6 and on October 15th it finally succeeded in identifying,
7 with the requisite degree of confidence and certainty, a
8 load of 3300.

9 Very shortly prior to that, LILCO had agreed to
10 -- or had in essence agreed to undertake some confirmatory
11 testing as called for in the SER at that load, and at the
12 time that this agreement was drafted, I had some sense that
13 this would be coming about. And as the footnote indicates,
14 I wasn't sure that we would succeed at 33. Then that was
15 our present hope and intention, but there was still testing
16 and there was still analysis going on.

17 So the footnote in effect says that for purposes
18 of the agreement it will be 33 if 33 is ultimately
19 approved. The Staff has not yet, as I understand it,
20 approved the 33. It is still examining that, and LILCO has,
21 on a risk basis, undertaken confirmatory testing based on
22 its confidence that the 33, as of October 15th, is the
23 correct maximum load that the diesel generators will see on
24 a loop LOCA. And then of course it goes down in the load
25 profile after that in the course of the loop LOCA.

WRBeb

1 JUDGE BRENNER: You said maximum load?

2 MR. ELLIS: Yes, sir. It is in fact the maximum
3 load that the diesel generators will see. And of course we
4 had proceeded on that--

5 JUDGE BRENNER: All right. I only asked because
6 the footnote defines it as the continuous load.

7 MR. ELLIS: It's the maximum. In fact, it is
8 actually lower than 33, but the 33 bounds all three
9 engines. The 33 is the load that the engine will see for
10 approximately .2 or a little bit more of an hour, and then
11 it will drop off during a loop LOCA.

12 But the test is being run at 33 for 740 hours as
13 indicated in SNRC 1094.

14 JUDGE BRENNER: Mr. Dynner?

15 MR. DYNNER: It is the County's position that the
16 footnote is irrelevant to this litigation. I'd be happy to
17 answer any questions the Board has about it.

18 JUDGE BRENNER: You had better tell me why a
19 footnote in a settlement agreement that is being submitted
20 for our approval is irrelevant to the litigation.

21 MR. DYNNER: All right.

22 The settlement, as any settlement of an issue, is
23 based upon evaluations by both parties of the evidence, the
24 strengths and weaknesses of the case that each side has, the
25 practicalities of the situation, and therefore, concessions

WRBeb 1 are made by both sides in any settlement negotiation.

2 The purpose of the settlement is to try to arrive
3 at a compromise in which at least, speaking for the County,
4 we feel reasonably secure that in this case the component in
5 question, once the requirements of the settlement agreement
6 have been met, will not provide a significant risk to the
7 operation of the diesel engines. That element of acceptable
8 risk is based on compromise.

9 It is not what the County would view as the best
10 situation by any means, but it is a situation that, based
11 upon all of the facts, the evidence, and the way we see the
12 Board in our own view as leaning-- Of course lawyers always
13 try to figure that out--

14 JUDGE BRENNER: When you figure that out you tell
15 me.

16 (Laughter.)

17 MR. DYNNER: But based upon all of those factors,
18 we made a decision that we should settle this particular
19 issue.

20 The settlement negotiations involved, from our
21 point of view, consideration of a number of factors which
22 are not necessarily apparent in the agreement itself. For
23 example, between the time that the County first filed its
24 contention on cylinder heads and indeed those contentions
25 were admitted to the time when this agreement was accepted

WRBeb 1 by the County we are aware that these particular cylinder
2 heads experienced a large number of hours of operation at
3 load factors that were appreciable, and that cracks and
4 leaks did not develop.

5 We weighed that also in connection with the fact
6 that our principal concerns with the cylinder heads had to
7 do with manufacturing quality, and we took into
8 consideration our experts' review of the barring over
9 procedures that were suggested both initially and that were
10 added on by the Staff.

11 We also took into consideration in arriving at
12 the settlement the Staff's views about the extent to which
13 barring over on a weekly basis should be continued. For
14 example, the Staff felt that we originally had wanted
15 barring over to continue on a weekly basis for the entire
16 period that these engines would be in effect.

17 After careful consideration we listened to the
18 Staff and their position that when one considered the time
19 at which only diesel engines would be available because a
20 third was being barred over, and therefore the additional
21 risk that if an emergency arose during that period, there
22 would be only two engines to answer the call rather than
23 three, and we again compromised and reduced the length of
24 time during which we would insist on the weekly barring
25 over.

WRBeb 1 We also took into consideration the fact that
2 LILCO and the Staff were proceeding bilaterally with the
3 testing program, and we considered the fact that if the
4 testing was done at full load for 740 hours on these
5 particular heads that although that would necessarily reduce
6 to zero the risk that these heads would develop leaks, it
7 would considerably reduce our concerns.

8 The fact of the difference between--

9 JUDGE BRENNER: I think you said 740 hours at
10 full load just now.

11 MR. DYNNER: Yes, sir. At full load, 3500 Kw.

12 We then took into consideration the fact that
13 being what it was that if we were going to settle this issue
14 we had to realize and recognize the fact that this test was
15 -- might be performed under circumstances in which LILCO and
16 the Staff were going to run it at less than 3500 Kw
17 continuously.

18 The purpose of the footnote of course was to, and
19 only to, allow LILCO to be relieved of the obligation to bar
20 over the engine once a week after the engine had been run
21 with these particular cylinder heads in them for at least
22 740 hours at full load, and then been inspected in
23 accordance with the requirements of this settlement
24 agreement.

25 The footnote was to, at LILCO's insistence, to

WRBeb 1 recognize LILCO's expressed intention at that point in time
2 to prepare a FSAR amendment which would reduce the
3 continuous load rate to 3300 Kw. At that point we had to
4 make a decision about whether we wanted to blow the entire
5 settlement over the issue of whether the engine was run at
6 3300 or 3500 Kw strictly for purposes of confirming that
7 these particular cylinder heads did not leak over an
8 extended period of time with an extended number of hours in
9 order to relieve LILCO of the obligation to bar over once a
10 week.

11 The footnote of course does not affect the other
12 requirements in the agreement as to inspection, inspection
13 criteria, rejection criteria, et cetera.

14 So that was the reason for the footnote and that
15 was our thinking that went into finally bending to LILCO's
16 insistence on that reduction from 3500 to 3300 for this
17 particular point.

18 JUDGE BRENNER: Has the County reached the point
19 where it has taken a position on whether or not the reduced
20 loads requirements put forward by LILCO in its FSAR amendment
21 are correct or not?

22 MR. DYNNER: No, sir. In fact, we took with
23 seriousness the comments that you made on the record several
24 weeks ago when Mr. Ellis raised the issue, and I think
25 you've repeatedly indicated that it was too late -- for

WRBeb 1 purposes of this litigation, the crankshafts having already
2 been litigated, and the blocks being about to be litigated,
3 and testimony in, it was too late for consideration that
4 LILCO might derate the diesels or amend the FSAR at some
5 future time to be considered in the context of the
6 litigation.

7 JUDGE BRENNER: That wasn't exactly my question.

8 MR. DYNNER: I am trying to give you the
9 background for the answer.

10 JUDGE BRENNER: All right.

11 MR. DYNNER: And that is the background for the
12 answer. And therefore the answer is that we have conducted
13 no--

14 JUDGE BRENNER: You should answer the question
15 first and give the explanation afterward.

16 (Laughter.)

17 MR. DYNNER: It was not capable of a Yes or No
18 answer.

19 (Laughter.)

20 Seriously, the answer is that we have not
21 conducted any analyses of the load factors, the amount of
22 equipment that LILCO now says is -- the amount of kilowatts
23 that LILCO says is now required to run different pieces of
24 equipment, and therefore, we haven't even attempted to
25 analyze whether 3300 or some other number would be

WRBeb 1 appropriate.

2 JUDGE BRENNER: Well, if you performed that
3 analysis and ended up not materially disagreeing with LILCO,
4 then we wouldn't have to worry about whether or not they are
5 inconsistent loads put forward in the litigation versus
6 outside the litigation. Isn't that correct?

7 MR. DYNNER: I don't think so, because first of
8 all I have to tell you, as you know, that all of our
9 calculations, particularly on the crankshaft and the Lloyd's
10 Rules, et cetera, were made on the basis of the 3500 and the
11 3900 requirements that now exist in the FSAR.

12 And we haven't attempted to redo that work at the
13 reduced load levels, although we know, and it is on the
14 record, that some work was done by Dr. Pischinger and I
15 think Dr. Sarsten along those lines. But we haven't
16 addressed that at this time, nor have we addressed the issue
17 of the margin of safety that we think is inherently required
18 by the diesel engines at particular load levels.

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1 Our approach has been to say clearly that at 3500
2 or 3900 overload these diesels are deficient. Our testimony
3 goes on to say and it is in the introductory part of the
4 testimony where we, at one point, were told by letter that
5 LILCO intended to reduce the overload to 3500 and I think
6 the continuous to 3450 that we did not view that margin at
7 all -- we did not view those numbers at all providing a
8 satisfactory margin for safety. We have not addressed the
9 issue of the margin of safety at 3300.

10 I would note parenthetically that there is
11 testimony and evidence to the effect that normally there is
12 about a 15 percent margin of safety that is used by even
13 non-nuclear utilities when they are running these diesel
14 engines and that they run them at about 80 to 85 percent of
15 rated load. And while we haven't analyzed that in the
16 context of LILCO's new numbers, it's readily apparent to us
17 that even if their FSAR amendment is found by the Staff to
18 be acceptable that is a reduction, I think, of about 10
19 percent. But we haven't done that analysis for the reasons
20 I've given.

21 JUDGE BRENNER: I understand what you're saying.
22 And I'm afraid I didn't ask my question precisely enough but
23 I don't want to -- I can followup but I don't want to
24 prolong the discussion too much right at this point. I
25 think we may want to come back to a further discussion of

WRBpp 1 testing at certain loads on the LILCO status report and the
2 premises in this hearing which were discussed several times
3 and I have not yet gotten fully satisfactory answers. And
4 if I never get fully satisfactory answers, that will be
5 somebody else's problem, not my problem in the end.

6 But I think there are -- let me put it this way
7 to you, Mr. Dynner. I think there are some situations in
8 which it would indeed make a difference as to whether or not
9 the County disagreed, with a reasonable basis for that
10 disagreement, with whether or not there would be the
11 requisite equipment available in the event of a loop LOCA
12 under LILCO's proposal which would result in lower loads,
13 less equipment being tied to the diesels. And under
14 certain scenarios it could make a difference even though we
15 would still proceed to our findings of the components at
16 issue in the litigation before us on the basis of the higher
17 loads, because you have already given the background on that
18 in some of what I've said to LILCO about how they had the
19 option to proceed differently but did not choose that
20 option. And but I don't want to pursue it fully right ow.

21 Mr. Johnson, let me ask you if you had anything
22 to add or any different views as to the meaning of that
23 footnote from the standpoint of the state as a party to this
24 agreement?

25 MR. JOHNSON: The State is in agreement with

WRBpp 1 the County's reading of that footnote.

2 JUDGE BRENNER: Mr. Goddard, did you want to add
3 anything in the footnote?

4 MR. GODDARD: I probably wouldn't have a fully
5 satisfactory answer, either, Judge Brenner. But the Staff
6 at this time is reviewing the PSAR amendment. I can
7 present that as a matter of a status report in effect. The
8 power systems branch has put out its second round of
9 questions seeking additional information from the
10 Applicant.

11 I would state that the decision to test at 3300
12 was more of a unilateral decision by LILCO than a bilateral
13 agreement in that the decision was made, as Mr. Ellis
14 stated, with LILCO at risk before the Staff had, in fact,
15 reviewed the revised loads which are presently being
16 considered by the Staff.

17 MR. ELLIS: Judge Brenner?

18 JUDGE BRENNER: I did want to ask you a question,
19 Mr. Ellis, but if you wanted to comment first, I'll let you.

20 MR. ELLIS: No, sir. I'll wait and answer the
21 question.

22 MR. DYNNER: I have a comment if I can make one.

23 As I read what you said to me at the end of our
24 colloquoy --

25 JUDGE BRENNER: I was purposely vague.

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1 MR. DYNNER: I know but it ties in with what
2 Mr. Goddard just said.

3 JUDGE BRENNER: All right.

4 MR. DYNNER: Because if you think it would be
5 wise or useful for the County to involve itself in an
6 analysis of the FSAR amendment then obviously we would want
7 to be privy to information that the Staff is analyzing and
8 obtaining from LILCO on that amendment and, of course, we
9 haven't been. And I just wanted to bring that to your
10 attention.

11 JUDGE BRENNER: If I was you I would want to know
12 what was going on without necessarily jumping whole hog into
13 the operation in terms of full preparation for litigation.
14 That's as of today.

15 I think the Board does intend to come back to a
16 discussion again of what's going on with these loads outside
17 the litigation, whereas, we have got certain premises that
18 we discussed more than a couple of times now in the
19 litigation and, depending on where that discussion takes
20 us, you might be able to adjust and, in fact, there may come
21 a time when we would ask the County to tell us whether it
22 disagrees with the proposal by LILCO and, if so, why. That
23 is still short of saying we are going to litigate it but it
24 is something further than what we have now.

25 There are a lot of reasons why you should know

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1 what's going on and, you know, you've been in this
2 litigation, you're a sophisticated party. No matter what we
3 say somebody above us might disagree with certain things
4 we've done such as the Appeal Board. And for that body you
5 may have to have been cognizant of other things also.

6 In previous documents, perhaps in passing, but
7 nevertheless in some previous documents by the County there
8 was at least the assertion of concern that those lower loads
9 might not be proper to supply everything needed. So I've
10 got the inference that the County has done some thinking
11 about it, albeit, apparently preliminary in nature.

12 But I think we're going to have another
13 discussion of it on the record in this proceeding perhaps
14 this week, perhaps next week. And we'll see where that
15 takes us.

16 Maybe I should ask one question now of you,
17 Mr. Ellis, realizing it gets us into the other area, but I
18 don't want to explore all the ramifications but,
19 nevertheless, can you explain to me where there is -- let me
20 put it this way. I see an inconsistency, an apparent
21 inconsistency, between LILCO stressing time and time again
22 that it has been ready and desires and is, in fact, by its
23 actions and words continuing with the litigation of the
24 issues in this proceeding, the crankshafts and the blocks
25 and the pistons on a premise of the loads in the existing

WRBpp 1 FSAR. Yet, at the same time it is, at this point,
2 unilaterally and perhaps later, depending on Staff actions,
3 bilaterally, going to be performing a testing program at
4 different lower loads.

5 And the one possible scenario -- an I'm only
6 suggesting it to illustrate one example of why there may be
7 an inconsistency in LILCO's position -- might be that the
8 Board agrees in some part with the Staff's position. That
9 in order to ascertain that there is reasonable assurance
10 that some of these components are acceptable, as LILCO
11 claims, that indeed the testing program is necessary, then
12 you're going to have a testing program at different loads
13 than the loads at which you've premised the litigation of
14 this proceeding. So that would not be a testing program at
15 the loads on which you insisted you wanted to proceed to
16 litigation on.

17 And I see that as one example of an apparent
18 inconsistency. And I assure you that I have spent some time
19 spinning out various combinations and permutations of
20 possibilities and, as permutations and combinations do
21 happen, they're premised on -- there's a series of
22 conditional things that may or may not be realistic and may
23 or may not happen -- but I've done it in my own mind, at
24 least, for purposes of trying to understand how you could
25 keep coming before us saying some of the things you've been

WRBpp 1 saying and the one I just gave you is but one example and
2 maybe you can help me with that example.

3 MR. ELLIS: I'll try.

4 I understand the Board's view. It has also been
5 something that LILCO has thought about at some length.

6 Originally as I said the SER called for the
7 definition of qualified load. That was August 20, by which
8 time matters --

9 JUDGE BRENNER: You need some history but you
10 know I disagree with some of your view of the history. So
11 don't pursue it more than necessary. I think you knew
12 there was something afoot, to put it that way, long before
13 August 20.

14 MR. ELLIS: Well, I will pursue it only so far as
15 I need to try to answer your question. And I think that
16 the history is helpful.

17 In any event, it was LILCO's view, continues to
18 be LILCO's view that it can and should prevail at the
19 existing loads and the reason that it would like to prevail
20 at the existing loads is simply the fact that it would like
21 to have an opportunity for load growth, that has been its
22 view. The design loads and actual loads do differ and that
23 happens in the licensing of plants. The testimony was
24 prepared in August and earlier on the basis of the 3500
25 rather than the 3300 and LILCO considered then and considers

WRBpp 1 now that it can and should prevail.

2 However, one fact I think that is important to
3 bring out that is of fairly recent vintage, this weekend or
4 the day before yesterday LILCO has learned that it is the
5 Staff's present intention to issue a license only at 33.
6 We also know that the loads we now, as I said as of the date
7 that I mentioned in the status report, had confirmed that
8 the loads were, in fact, bounded by 3300.

9 It does present LILCO with a dilemma.

10 JUDGE BRENNER: Let me stop you right there.

11 What would you have expected the Staff to do if you come in
12 and say you're going to test at 33? I mean, you know, you
13 sound like this is hindsight, suddenly some surprising thing
14 happened.

15 MR. ELLIS: We think that the Staff -- that maybe
16 legally if the Board issues a partial initial decision
17 permitting licensing at the premised loads it may be that
18 the Staff has no legal recourse but to issue a license at
19 that. Nonetheless, the Staff has made very clear its
20 desire to limit a license to that effect. And the technical
21 specifications are likely to be approved if they have that
22 limitation of operating the diesels.

23 I think what has happened is that the picture of
24 the real world has changed a little bit, fairly
25 substantially, in the course of time and I think the dilemma

WRBpp 1 that the Board puts is a dilemma that has become much
2 sharper more recently than it was before. LILCO made the
3 judgment that it could and should prevail at the existing
4 loads and --

5 JUDGE BRENNER: All right, let me stop you
6 there. I understand that. And I understand that up until
7 today and including today that this is still LILCO's
8 position; right?

9 MR. ELLIS: Yes, sir. But I --

10 JUDGE BRENNER: Let me try to get it so that I
11 understand it.

12 MR. ELLIS: Yes, sir, but -- go ahead. But I
13 did want to tell you that LILCO is also currently
14 considering, and I hope that we can reach a decision within
15 the next 24 to 48 hours, to consider doing something along
16 the lines that the Board did with the Budnitz deposition in
17 7B, I guess that's ancient history now.

18 JUDGE BRENNER: Were you here this morning when I
19 referred to the number of pages?

20 MR. ELLIS: No, sir, I wasn't.

21 JUDGE BRENNER: You should have been because,
22 although you would not have shared fully in the comment, you
23 would have been probably number 3 in the room in terms of
24 number of pages that anybody has sent through. I remember
25 very well the Budnitz deposition. A very interesting

WRBpp 1 deposition it was. What about it?

2 MR. ELLIS: But the Board's ruling in that when I
3 sought to reopen the record, was that I think the Board
4 indicated that it considered my efforts to be untimely, but
5 that it would not rule on the motion to reopen until such
6 time as it found whether the issue was going to be material
7 to its decision or not. And one of the courses that LILCO
8 is currently considering is filing a motion to reopen to --
9 we would still want findings at the 35 level, but filing a
10 motion to reopen only the pistons -- I mean -- only the
11 crank and the -- perhaps only the crankshaft or the
12 crankshaft and the block -- for 33 as well to give the Board
13 an opportunity if it did not conclude that they were
14 licensable at 35, that it could do so at 33 and defer a
15 ruling on that motion until such time -- because the testing
16 is not yet completed. And the testing won't be completed
17 nor will the Staff complete their review of the 3300 for
18 some time. I don't know how long but it will take some time
19 and in the meantime the Board could defer ruling on that
20 motion until such time as it became either necessary to do
21 so or unnecessary to do so.

22 If the Board concluded that the machines were all
23 right for 35 it would never be necessary just as it was
24 never necessary to rule on the Budnitz motion.

25 JUDGE BRENNER: All right. Well, I understand

WRBpp 1 what you're saying and it recognize it as building upon some
2 of the views you expressed in the status report.

3 But some things are a little more complicated
4 than the way you put it and I still want to come back to the
5 example I put to you. But I'm going to try it another way
6 but it's going to be the same example.

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WRBagb

1 Right now LILCO has had the litigation proceed at
2 3500 -- and we are using these round numbers, we recognize
3 that that represents a round number for a particular load
4 and there are other numbers for other types of loads -- but
5 at 3500 continuous load and as I say the corresponding
6 overloads and so on. And LILCO believes that, if we believe
7 its testimony, that LILCO has carried its burden of proof in
8 its testimony that we can find the components at issue are
9 acceptable at those higher loads.

10 Let's say that we can do that. However that
11 also, as part of that ruling, that we agree in part with the
12 Staff that the confirmatory testing -- which may be finished
13 by the time we get to the ruling for all I know -- but that
14 the confirmatory testing is an important component to that
15 ruling, either before our decision or after our decision
16 with certain procedures and so on.

17 And I have also heard what you said that
18 originally LILCO believed it wanted some room for load
19 growth, even if it thought it could justify the lower loads
20 and that was another reason for proceeding this way --
21 although I put to you that that wasn't your primary
22 motivation considering everything involved -- but
23 nevertheless it is a factor.

24 Why then is it not consistent with that for LILCO
25 to perform the tests at 3500, even though it hopes to

WRBagb 1 justify 3300 with the Staff? Because if we end up saying
2 all right, we have premised the whole litigation on 3500
3 because of the actions taken by LILCO before and at the
4 beginning and in the middle of the hearing but the
5 confirmatory testing is part of it, you've got no
6 confirmatory -- or you don't have the full confirmatory
7 testing at those higher loads. Why are you unilaterally
8 electing -- or even if it turns out to be bilateral but
9 nevertheless outside of the context of the contested issues
10 -- of the contested litigation before us within the
11 contested issues, to test at the lower load? I don't
12 understand. That's where I see the inconsistency.

13 It seems to me that it would be consistent
14 with your thinking if you wanted to proceed before us, as
15 you say you are, to test at the higher loads even while
16 trying to justify the lower loads to the Staff.

17 MR. ELLIS: The lower loads -- the testing at the
18 lower loads is appropriate because those are the actual
19 loads. And it makes no sense to run them higher. And, in
20 the hypothetical you put, it would seem to me that even
21 though -- it would seem to me that the Licensing Board could
22 approve the machines at 35 predicated on the confirmatory
23 testing but then the license would only issue at 33 since
24 the confirmatory testing was done only at 33.

25 But in a perfect world, Judge Brenner, it would

WRBagb 1 have been nice to have had everything from the SER forward
2 or back a long time earlier but that is a matter of
3 hindsight and, as I say --

4 JUDGE BRENNER: I don't fully agree with you.

5 MR. ELLIS: Yes, sir. Well let me put it this
6 way:

7 I can certainly accept that some people have
8 better foresight than others.

9 JUDGE BRENNER: I don't have any great
10 foresight. I saw something like this coming on the July 5,
11 I believe it was, conference of parties, which is why I
12 raised it when I did.

13 MR. ELLIS: Yes, sir. Well I can only --

14 JUDGE BRENNER: I didn't realize the glorified
15 details but nevertheless -- and I did not realize it would
16 get this complicated but I saw something like this coming
17 and I believe anybody else observing the proceeding or
18 anybody else intimately involved in the proceeding did, too.

19 But even as late as the date at which you chose
20 the loads in the letter to the Staff -- which is of recent
21 vintage, in the last two to three weeks, I believe, I think
22 it was on or about October 19th, if I recall the date of the
23 letter --

24 MR. ELLIS: Yes, sir.

25 JUDGE BRENNER: -- from Mr. Leonard --

WRBagb 1

MR. ELLIS: Yes, sir.

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JUDGE BRENNER: -- you could have elected to test

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at the higher loads if you wanted to be consistent with the

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premises on which you say you want this litigation

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conducted. Or if, for some reason, you think it is a

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mistake to test at the higher loads, then you have got to do

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something to adjust somewhere because I see a potential

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inconsistency.

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Now we could find that the diesels are okay -- as

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I say, there are a lot of permutations and combinations --

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they are okay at the higher loads and no confirmatory

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testing is needed. We could. I don't know at this point.

13

And if I don't know, I submit you don't know.

14

MR. ELLIS: Well another reason that the testing

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was performed at the 33, the new qualified load, is that in

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the SER the clear intent was to require all owners of TDI

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diesels to get as close to 185 BMEP as they could, if they

18

couldn't be under it.

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LILCO is not able to get under 185 BMEP. But

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what I was able to do through the testing and the analysis

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and some of the work that has been described is to get to 33

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-- actually below 3300 and that is -- it has really been

23

proceeding in the testing along the lines of the SER, the

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interim licensing basis of the Staff.

25

I would welcome an opportunity to discuss it

WRBagb 1 further with the Board and I would certainly welcome any
2 guidance and I will discuss it with the parties as well. I
3 do hope to get some decision on this motion that I mentioned
4 to the Board within the next 24 hours or so.

5 JUDGE BRENNER: All right. Let me suggest this:
6 You think everything through, including the
7 motion, but you might consider holding off on filing it and
8 I will give you and the other parties an opportunity to try
9 to fully discuss this very complicated topic again soon, not
10 this week but at a time when we are not delaying witnesses
11 who are here to testify. And I would be willing to talk
12 about scheduling such a session -- we can talk about the
13 schedule later this week and we will schedule it for a
14 future time.

15 MR. ELLIS: One last thing I might mention by way
16 of a progress report: Mr. Dynner has responded to our
17 proposal for piston settlement --

18 JUDGE BRENNER: Don't change the subject yet.

19 MR. ELLIS: I'm sorry.

20 JUDGE BRENNER: When we do talk about the
21 scheduling, we could talk a little more definitively about
22 what should be discussed there. I thought -- take this in
23 the right vein, but I thought part of your status report was
24 cute.

25 MR. ELLIS: I beg your pardon.

WRBagb

1 JUDGE BRENNER: I thought part of your status
2 report was cute -- take it in the right vein. In other
3 words, it was This is what we think but maybe you think this
4 but we are going to proceed like that, but if you think we
5 should do something different tell us now. If you think we
6 should do something different three weeks from now, tell us
7 then as soon as you can. If we have to wait until the
8 decision and you are going to find against us, don't, but
9 come back and give us another chance.

10 (Laughter.)

11 I want you to take it in the right light. In
12 other words, I think it was -- you know, from a litigative
13 advocate point of view I think it is worthy of compliment,
14 but from the point of view of trying to get everything you
15 were seeking in that report, I think it is good that you are
16 thinking of some other avenues to effectuate the same ends,
17 such as you know fishing-or-cutting-bait and getting to the
18 point where you are going to decide what you are going to do
19 on behalf of -- what LILCO is going to do in terms of this
20 whole picture: you want to proceed now, you want to stop
21 now and do some further testing....

22 It is also tied up with the motion we discussed
23 this morning with confirmatory testing: do you want to test
24 at the lower loads and come in and try to justify those
25 lower loads in the litigation if another party disagrees

WRBagb 1 with you -- and it may be that another party doesn't -- do
2 you want to proceed on the higher loads and, if so, bring
3 the testing into conformance with the premises of the
4 litigation? All of those various types of things.

5 I will give you a little insight to the extent
6 this helps your thinking: this is a complicated litigation
7 before us. It is not likely that we are going to be able to
8 tell you before we sort all of the evidence -- in fact, we
9 are not going to be able to tell you -- before we go through
10 all of the evidence in an organized fashion as presented to
11 us in the proposed findings and our own review of the record
12 and actual drafting of a decision before we can tell you
13 that we are going to find certain important things certain
14 ways.

15 So although I have said at other stages in this
16 long proceeding where we could give guidance along the way
17 we have tried to do that. You are not going to be able to
18 get the guidance you are thinking on the status report.
19 Although you didn't quite phrase it that way, that's what
20 you are seeking there.

21 MR. ELLIS: Judge Brenner, I do take your
22 comments I think the right way. I guess I have always been
23 an open book for the Board. But we will be looking very
24 hard at the issue, particularly in light of the Staff's
25 concern or desire not to issue a license above 33.

WRBagb 1 So I understand your comments about the status
2 report, I hope to have a fish-or-cut-bait decision well in
3 advance of that.

4 JUDGE BRENNER: But you have to put it all
5 together. It is not just what you are litigating here, it
6 is what you are going to do -- what you plan to do in terms
7 of real world testing outside the litigation.

8 MR. ELLIS: Yes, sir. I think the real world has
9 overtaken us. But I understand your comments and we will --
10 When would you like.... I will be able to, this week,
11 address this.

12 Would the Board like to revisit this at the end
13 of the week or --

14 JUDGE BRENNER: I would like to discuss the
15 schedule for it at the end of the week.

16 MR. ELLIS: Yes, sir.

17 JUDGE BRENNER: But I don't think I would like to
18 get into it fully because I would like the parties to
19 discuss it quite fully before we discuss it again and the
20 parties have to do some thinking also.

21 And you know we are ready to finish the record
22 here, as I said this morning in another context, and you
23 should take that into account also.

24 MR. ELLIS: Yes, sir.

25 JUDGE BRENNER: You have had some actions by

WRBagb 1 another Board that we are all cognizant of and that may
2 affect the thinking of the parties, too. I don't know.

3 MR. ELLIS: Yes, sir.

4 Shall I now report to you on pistons?

5 JUDGE BRENNER: Yes.

6 Before you do that -- although we got into it in
7 terms of the back door, we do have the proposed agreement on
8 the cylinder heads and we are prepared to approve it. We
9 had a minor comment about the draft, the parties may recall,
10 and it was only for the parties to consider whether or not
11 there was an ambiguity.

12 And since there is no change from the draft to
13 the final, that means to me that the parties have read it
14 and decided that there is indeed no ambiguity. I, too, have
15 reread it with our comment in mind and I am reasonably
16 satisfied that although it could have been spelled out a
17 little better it is reasonably set forth and as long as the
18 parties are happy we are happy also.

19 MR. DYNNER: If I could just have one minute.

20 (Pause.)

21 MR. DYNNER: Judge Brenner, I would like to state
22 for the record that your expressed comment was in fact
23 considered by the parties and that there is an agreement
24 among the parties which is not reflected here but there is
25 an agreement -- and I am happy with it -- orally that the

WRBagb 1 barring-over or blowing over procedures that are described
2 in the settlement agreement in fact will be implemented by
3 means of a modification of the existing LILCO barring-over
4 procedure and that procedure will be reviewed by all of the
5 parties and it will take into consideration the comment that
6 you made.

7 JUDGE BRENNER: Okay.

8 MR. ELLIS: That is correct, Judge.

9 JUDGE BRENNER: As I say, I characterized it as a
10 minor comment on our part and that's what it was, we
11 recognize that the parties seemed to know what the situation
12 was.

13 Well we can approve it and if we did not commend
14 the parties for their effort at the time we looked at the
15 draft -- I believe we did -- but in any event we certainly
16 commend the parties now, as we have many times.

17 It should be a source of pride to all of the
18 parties and counsel in this proceeding that, notwithstanding
19 all of the hotly contested litigation in the hearing and the
20 apparent strong disagreements over issues in the hearing,
21 that you have always been able to talk with each other
22 eventually and sometimes very quickly and reach some what I
23 consider significant settlements over the lengthy course of
24 this proceeding and this is another example of that.

25 And I think your efforts -- the Board appreciates

WRBagb 1 your efforts and I think the efforts of counsel should be
2 appreciated by their clients, and apparently the clients'
3 litigative position also deserves commendation.

4 We cannot make this an exhibit in the hearing, it
5 is not necessary, but I did notice through the other part of
6 the proceeding that sometimes it was difficult to keep track
7 of all of the settlement agreements when we just left them
8 for formal filing. And if the parties want whenever it is
9 appropriate we can make it a Board exhibit since it might be
10 difficult to label it with any one party -- it is an exhibit
11 of all of the parties. You probably don't have the -- Off
12 the record.

13 (Discussion off the record.)

14 JUDGE BRENNER: On the record.

15 We will make it Board Diesel Exhibit 1, and in
16 that way it will accompany the record.

17 (Whereupon, the document previously
18 referred to was marked as Board
19 Diesel Exhibit 1 for
20 identification.)

21 JUDGE BRENNER: Judge Morris suggests binding it
22 in in addition to making it an exhibit, so let's bind it
23 into the transcript if you can give us a fourth copy.

24 (The document follows.)

25

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 (OL)
(Shoreham Nuclear Power Station,)
Unit 1))

RESOLUTION OF SUFFOLK COUNTY
DIESEL GENERATOR CONTENTION REGARDING CYLINDER HEADS

After submission of pre-filed testimony on the Suffolk County diesel generator contention concerning cylinder heads, discussions were held between the parties that have resulted in resolution of the contention. The parties have agreed to do the following:

(1) Suffolk County will withdraw its diesel generator contention concerning cylinder heads from consideration in this ASLB proceeding.

(2) In return, LILCO will do the following with respect to all cylinder heads currently in use at Shoreham:

(a) Perform an ultrasonic inspection of the firedeck of all the cylinder heads at six locations to verify that the minimum thickness requirement of .400 inch is met. The six locations are specified as follows:

(i) The first location is on the firedeck between the exhaust gas ports approximately directly between the two exhaust gas ports.

(ii) The second location is approximately 1 1/2" from the first location in a direction toward the exhaust side of the cylinder head.

(iii) The third location is approximately 2" from the first location in a direction toward the intake side of the cylinder head.

(iv) The fourth location is approximately midway between the injector port and the exhaust port on the governor side of the head.

(v) The fifth location is approximately directly between the two intake gas ports.

(vi) The sixth location is approximately midway between the injector and exhaust port on the flywheel side of the head.

Cylinder heads not meeting this thickness requirement will be replaced. Credit for previous inspections conducted by the Owners Group and the NRC on the Shoreham cylinder heads is acceptable to meet this requirement.

(b) Perform surface inspection (either liquid penetrant or magnetic particle) of intake and exhaust valve seats and the firedeck area between the exhaust valves to verify that they are free of unacceptable

surface defects. LILCO will be permitted to take credit for previous DRQR inspections of the existing cylinder heads provided those inspections were performed after the cylinder heads had completed 100 hours of operation at greater than or equal to full load (3500 kw). Cylinder heads with unacceptable and irreparable surface defects will be replaced. Acceptance criteria are as specified in ASME § III, paragraph NB-5350.

(c) Ascertain from shop records or otherwise whether any heads have through-wall weld repairs of the firedeck where the repair is performed from one side only. Any such heads will be replaced.

(d) Cylinder heads purchased as replacements will be inspected in accordance with paragraphs 2(a) and (b) and subject to paragraph 2(c) above.

(e) LILCO will bar the engines over with the barring device and roll the engines over with the air start system prior to any planned starts, unless that planned start occurs within four hours of a shutdown. In addition, after engine operation, the engines will be barred and rolled over on air after four hours but not more than eight hours after engine shutdown and then

barred and rolled over once again approximately 24 hours after each shutdown. In the event an engine is removed from service for any reason other than the barring and rolling over procedure prior to expiration of the eight hour or 24 hour periods noted above, that engine need not be barred or rolled over while it is out of service. Once the engine is returned to service, LILCO will bar the engine over and roll it over with air once at the time that it is returned to service.

(f) In addition, LILCO will bar over and roll on air each engine on a once per week basis for a period ending six months after the engines are turned over to Plant Staff and monthly surveillance testing begins. If no leakage from cylinder heads is detected during this period, this procedure will be discontinued for each engine as to which this is the case. If cylinder head leakage is detected during this period in any engine, this procedure will be continued for another six month period only for that engine. This weekly barring and rolling over is not required with respect to an engine that is out of service for any reason other than the barring and rolling over procedure. Any engine that has been out of service for any reason other than the barring and rolling over

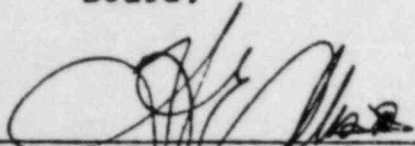
procedure will be barred over and rolled over with air once at the time it is returned to service. The requirements of this subparagraph (f) will cease for all three engines at such time as at least 740 hours of operation at the FSAR continuous load* are accumulated on any one engine while it has the currently installed cylinder heads and all the cylinder heads are inspected after the 740 hours are accumulated in accordance with paragraph 2(b) above and found to be free of unacceptable surface defects. In determining whether the 740 hours have been accumulated, credit may be taken for any hours of operation at or above the FSAR continuous load accumulated since the installation of the currently installed cylinder heads.

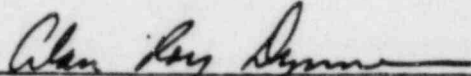
(g) Any head which leaks due to a crack will be replaced.

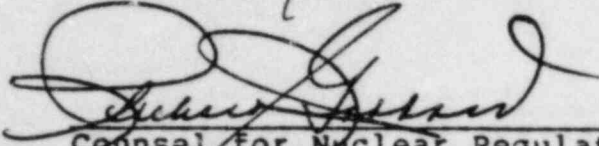
(h) The obligations of LILCO set forth in this agreement become effective immediately upon the

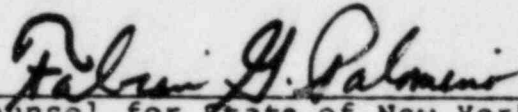
* The current FSAR continuous load is 3500 kw. At present, LILCO is preparing an FSAR amendment that redefines the continuous load as 3300 kw. LILCO expects to submit this FSAR amendment to the Staff for approval in the near future. It is contemplated by the parties that this revised continuous load of 3300 kw will be the "FSAR continuous load" for purposes of this agreement provided that the amendment is approved by the NRC Staff. In the event this or a similar amendment is not approved by the NRC Staff, the parties contemplate that the FSAR continuous load to be used for purposes of this paragraph is 3500 kw.

acceptance of this settlement agreement by the Licensing Board.


Counsel for Long Island
Lighting Company


Counsel for Suffolk County


Counsel for Nuclear Regulatory
Commission


Counsel for State of New York

DATED: September 21, 1984

WRBagb 1 JUDGE BRENNER: I believe you wanted to discuss
2 the pistons, the status of the piston negotiations.

3 MR. ELLIS: Yes, sir. I just wanted to report
4 very briefly that Mr. Dynner has responded to our proposal
5 and we have that under consideration. I hope to respond to
6 his response either later today or tomorrow, and I would
7 hope -- and I will also furnish that to the Staff as well --
8 I hope that by the end of the week that we can have a better
9 idea -- that we will have a better idea of the prospects for
10 settlement by that time.

11 JUDGE BRENNER: All right.

12 We are approaching the time when we would get to
13 the testimony, although not as rapidly as I had hoped. So
14 you are all aware of what the time frame is.

15 Going back to the other subject of having a
16 further discussion on pulling together everything related to
17 the different loads in different contexts, it might be
18 useful to have something in writing before a discussion but
19 not before the parties discuss it, and we can factor that
20 into the time frame also.

21 But since we are not going to be in hearing next
22 Monday and Tuesday, it might be useful -- although not
23 essential, I recognize the time frame might be tight with
24 everything else going on -- but it might be useful for the
25 Board to receive some writing on Monday as to -- reflecting

WRBagb 1 the discussions the parties on this whole subject and
2 what LILCO would seek to do or . contemplating doing and
3 then we can have an oral discussion and give-and-take among
4 the Board and the parties based on that.

5 I am not setting that schedule, you think about
6 it, and then when we discuss it later this week you can all
7 tell me what is feasible from your individual points of
8 view. All right.

9 We can go back to the testimony if there is
10 nothing further from the parties.

11 Let's take about a five-minute break and then you
12 can get the witnesses here.

13 (Recess.)

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JUDGE BRENNER: Back on the record.

2

Whereupon,

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ROGER LEE MC CARTHY,

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HARRY FRANK WACHOB,

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CHARLES A. RAU,

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CLIFFORD H. WELLS,

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EDWARD J. YOUNGLING,

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CRAIG K. SEAMAN,

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DUANE P. JOHNSON,

10

and

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MILFORD H. SCHUSTER

12

were called as witnesses and, having been previously duly

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sworn, were examined and testified further as follows:

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JUDGE BRENNER: Mr. Goodard, you said you wanted

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to discuss some matter related to the testimony?

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MR. GODDARD: Yes, Judge Brenner.

17

This morning during the cross-examination of the

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LILCO panel I asked Dr. Wells if he would be good enough to

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provide the Staff and parties with copies of the drawing to

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which he had referred as clarifying some of the dimensions,

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especially in the sketch which was LILCO Exhibit B-9.

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He has done so and I find that the use of that

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sketch is helpful in understanding some of the oral

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testimony provided by Dr. Wells this morning, and

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accordingly the Staff would request that it be marked as

WRBeb 1 Staff Diesel Exhibit 9 for identification, and be appended
2 to the record.

3 This has been discussed with the parties and they
4 have no objection.

5 I would like to ask a couple of clarifying
6 questions of Dr. Wells at this time with regard to that
7 document.

8 JUDGE BRENNER: Okay. I don't have any strong
9 preference. Do you want it as a Staff exhibit as opposed to
10 a LILCO exhibit? It doesn't matter.

11 MR. GODDARD: A Staff exhibit would be fine, sir.

12 JUDGE BRENNER: Is there no objection by any
13 other party?

14 (No response.)

15 JUDGE BRENNER: All right. So it will be Staff
16 Exhibit 9.

17 (Whereupon, Dr. Wells' drawing
18 was marked as Staff Exhibit
19 9 for identification.)

20 JUDGE BRENNER: You are going to ask Dr. Wells if
21 in fact this is the drawing?

22 MR. GODDARD: Yes, I am.

23 JUDGE BRENNER: Why don't you go ahead and do
24 that.

25 MR. GODDARD: Thank you, your Honor.

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FURTHER CROSS-EXAMINATION

BY MR. GODDARD:

Q This is a copy fo the drawing I have provided to the Reporter for inclusion at this point in the record, and to tne Board and the parties. This is in fact the drawing to which you were referring this morning during your oral testimony. Is that right, Dr. Wells?

A (Witness Wells) That's correct, Mr. Goddard.

Q On that drawing, the original of which you provided me, has certain colors set forth therein. Is there any significance to the colors red and yellow on the original drawing, the red being used to indicate the cylinder liner and the yellow used to represent the solid portion of the block?

A Yes, Mr. Goddard. Starting at the top of this drawing there is what you will note as a ligament marked by the .61 inch dimension, horizontal dimension at the top. That was cross-hatched a somewhat darker color in the copy of the exhibit. I had initially colored that red in an attempt to show the typical ligament crack that has been under discussion here in these proceedings.

The other colors-- The use of this yellow felt-tipped pen which xeroxs a somewhat lighter color of gray in the exhibit just shows a cross-section through the cylinder stud boss.

WRBeb

1 I have no shown a section through the gusset.
2 You will understand that a section through the centerline of
3 the stud would also go through this gusset that continues
4 the casting down below the boss, but I have not attempted to
5 put that into the sketch.

6 And finally, connecting the gap between the liner
7 and the cylinder stud boss there is a arrow which is not too
8 clearly outlined in the xerox copy but which I had
9 originally colored in blue. That indicates the potential
10 path of a leak if the ligament crack were to extend that
11 additional distance from the liner landing surface down
12 below the last dimension which is indicated on this exhibit
13 which says "Lower block to liner gap (radial)," and it says
14 .0035/.0015.

15 Right at that arrow you'll see there is a top of
16 a clearance. Now normally at operating temperature this
17 lower block to liner gap is closed tightly because of the
18 difference in thermal expansion between the liner and the
19 boss or the liner landing area in regions where -- in
20 between the bosses.

21 Therefore, in order to have a leak during
22 operation it is necessary for this ligament crack to extend
23 approximately one inch and more below the liner landing
24 surface. If the crack extends just one inch below, that is,
25 to a depth of 2-1/2 inches, the tip of the crack just

WRBeb 1 starts to intercept that clearance area and really water
2 cannot leak at that point because there is no
3 cross-sectional area of a flow path.

4 But if the crack should extend below that, then
5 this blue arrow indicates that it would be possible for such
6 a deep crack, which we really don't know of -- we haven't
7 seen it before -- it would be possible for water to seep
8 through that crack into the clearance shown between the stud
9 and the stud hole counterbore above the threads. And then
10 the water would leak onto the top of the block underneath
11 the cylinder head.

12 That's the purpose of the blue arrow and the
13 shading.

14 MR. GODDARD: Thank you, Dr. Wells.

15 EXAMINATION BY THE BOARD (Resumed)

16 BY JUDGE BRENNER:

17 Q Dr. Wells, did you perform this drawing or verify
18 that the drawing is accurate, and if so, how?

19 A (Witness Wells) Judge Brenner, the drawings are
20 consistent with the TDI drawing of this part, and also with
21 dimensions that LILCO has taken of the studs, the block and
22 the liner. We feel this is an accurate representation of
23 the range of tolerances.

24 The dimensions here I would add do not represent
25 any specific liner or any specific counterbore, but the

WRBeb 1 range of gaps, liner diameters, pilot diameters, et cetera,
2 that are given on the drawing.

3 Q Would that range-- Would the new 103 block
4 dimensions be included within the ranges presented here?

5 A The dimensions of the 103 block are the same. I
6 believe we were discussing the actual dimensions of the new
7 103 block before, indicated that in the 103 assembly, the
8 liner outside diameters, the ones called on this exhibit the
9 block upper pilot diameter -- excuse me -- the liner upper
10 pilot diameter and the liner lower pilot diameter have been
11 decreased in order to increase the gap between the liner,
12 and this dimension of course is different for the 103
13 block.

14 Currently of course the new 103 block would have
15 a deeper stud boss in addition to these dimensions and a
16 different block top thickness which is not shown on the
17 exhibit.

18 What is represented here is essentially the 101
19 -102 blocks.

20 Q All right.

21 And we can adapt what you are trying to portray
22 here by factoring in the other dimensions in the evidence
23 for the 103 block.

24 A Yes. One has to imagine that this stud has been
25 moved down to the dimensions that were given in previous

WRBeb 1 testimony.

2 Q Okay. I think I understand that now. Thank
3 you.

4 JUDGE BRENNER: All right. We will, in the
5 absence of objection, admit the Staff Diesel Exhibit 9 into
6 evidence.

7 (Whereupon, Staff Diesel Exhibit 9,
8 having been previously marked
9 for identification, was
10 received in evidence.)

11 JUDGE BRENNER: Perhaps we should bind this in
12 also. We tend to lose single pages sometimes.

13 MR. GODDARD: Thank you, Judge Brenner.

14 JUDGE BRENNER: So we will make these exhibits as
15 well as binding them in for redundancy.

16 (The document follows:)

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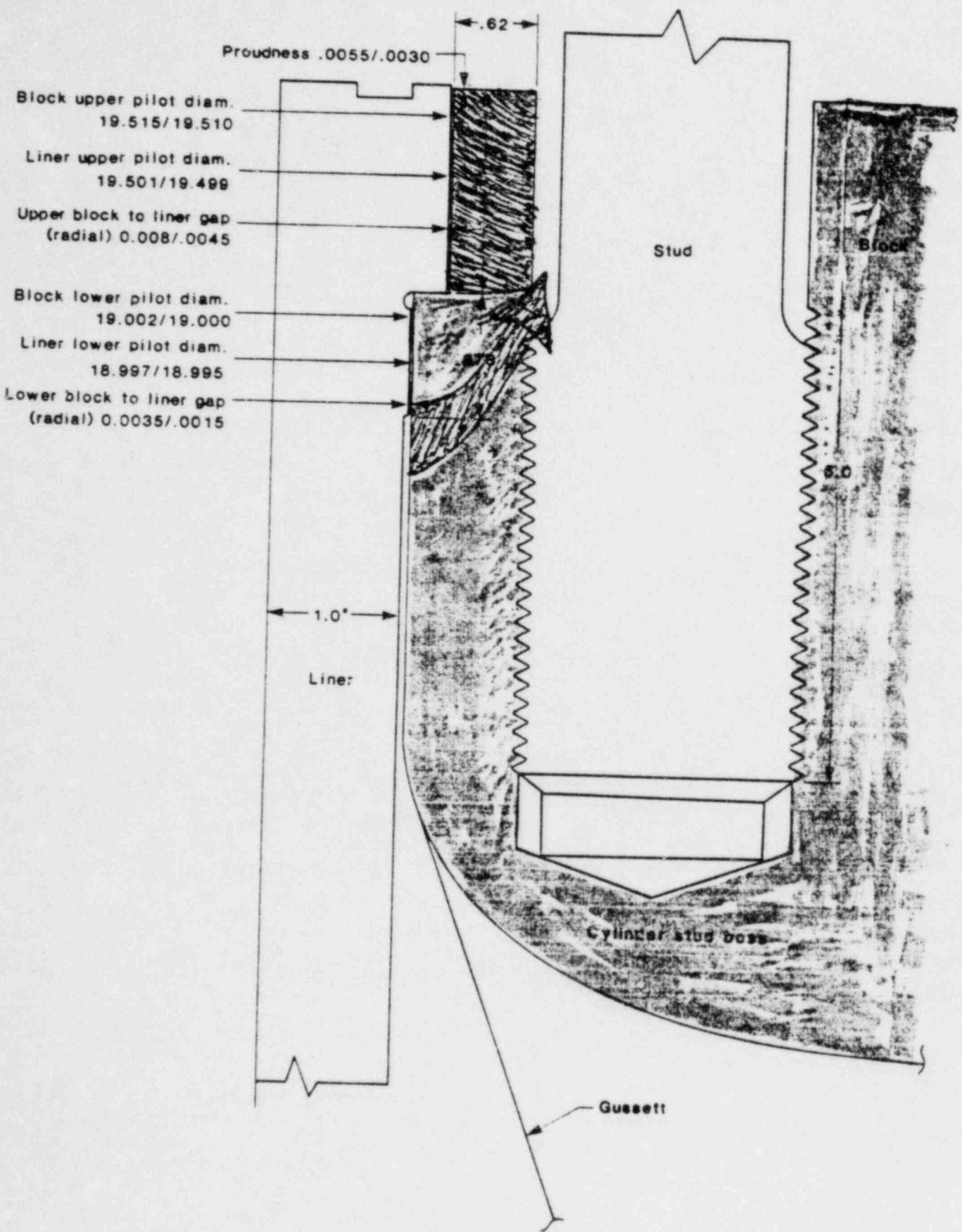
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Block and liner interface (original TDI dimensions).

WRBeb

1 JUDGE BRENNER: We will return to our questions
2 now.

3 BY JUDGE BRENNER:

4 Q When was the new 103 block fabricated by TDI,
5 approximately?

6 A (Witness Youngling) The new 103 block was
7 fabricated during the month of May of 1984.

8 Q Now was the new 103 block examined for the
9 presence of cam gallery cracks other than the visual
10 examination performed by Mr. Isleib, I guess it is,
11 previously testified to, prior to the time of any operation
12 of that block?

13 A Judge, the only examination done was the visual
14 examination at the factory, and that was consistent with the
15 specification requirements.

16 BY JUDGE MORRIS:

17 Q Mr. Youngling, in your answer were you
18 considering only LILCO employees?

19 A (Witness Youngling) No, LILCO employees or our
20 agents.

21 Q So to your knowledge, no inspection was made of
22 that area by TDI or Stone and Webster or anybody else?

23 A When the inspection was made, it was made by the
24 corporate metallurgist, our consultant, Dr. Isleib, and
25 there were people there from Stone and Webster PQC also.

WRBeb

1 Also, Mr. Seaman informs me that TDI was also
2 there.

3 Q But there were no prior inspections by TDI, to
4 your knowledge?

5 A We are not aware of any TDI inspections prior to
6 our inspections.

7 BY JUDGE BRENNER:

8 Q You said a corporate metallurgist. You mean a
9 LILCO metallurgist?

10 A (Witness Youngling) Yes.

11 Q Were these-- You're talking about a visual
12 inspection. Correct?

13 A Yes. In fact, in County Exhibit....

14 Q -- S-5?

15 A S-8 in the report from Dr. Isleib.

16 In here, on page number 7, he describes the
17 examination which he performed which was a visual
18 examination with the naked eye and a five-times magnifying
19 glass.

20 Q When was the first operation of the 103 block,
21 approximately?

22 A It was approximately July. Do you need a more
23 precise number than that?

24 Q No.

25 Now prior to the May 1984 fabrication of the new

WRBeb 1 103 block, LILCO of course was aware of cam gallery cracks
2 in its original three blocks, the original 103 block and the
3 101 and the 102 blocks. Correct?

4 A Yes, that is correct.

5 Q Was not LILCO also aware that-- Well, was LILCO
6 aware that there were cam gallery cracks, the presence of
7 which could be detected by certain testing methods but could
8 not be detected by visual examination in the old 103 block
9 and the 101 or 102 block?

10 I am directing this to anybody on the panel.

11 A Could you repeat the question?

12 Q Yes, let me phrase it better.

13 Is it correct or not correct that it was also
14 known prior to May 1984 or in any event and more to the
15 point, prior to July 1984, that there were cam gallery
16 cracks present in the original 103 block and the 101 and 102
17 blocks which could not be detected by visual examination but
18 which could be detected by other non-destructive examination
19 methods?

20 A (Witness Schuster) As I had indicated earlier in
21 my testimony, the way these indications or cracks were
22 discovered was visually. What happens is the oil from the
23 engine, as we indicated, runs down that side and gets into
24 the breaks in the paint. And when you look at them
25 visually, they become quite evident.

WRBeb

1 Q I didn't forget that testimony. I am asking
2 whether it is correct or not correct that there were also
3 cam gallery cracks in the original blocks that were not
4 detected or detectible visually but which were detected by
5 other non-destructive examination methods.

6 I understand you discovered the first one
7 visually.

8 A The bulk of the discontinuities that are in those
9 areas are visible by eye when that paint is off of there,
10 off of the areas we're talking about.

11 The original investigations we did were done
12 visually, as I indicated, and then supplemented with
13 magnetic particle to avoid having to contaminate the engine
14 with a lot of grinding particles and paint, et cetera. But
15 there were visual indications in those areas that would tend
16 to substantiate what was done with the, you know, subsequent
17 mag particle.

18 It is true that they would be more evident when
19 you looked at them with the magnetic particle or with the
20 penetrant exam, or the fineness of the discontinuity, the
21 resolution of the discontinuity would be better, but the
22 gross discontinuities were quite evident visually.

23 Q All right.

24 You said more evident through methods other than
25 visual examination, and that is helpful to know. But I am

WRBeb 1 asking whether or not the presence of some of the cam
2 gallery cracks could be detected only by non-visual methods.

3 A (Witness Rau) Can I perhaps clarify something
4 here?

5 Although I don't have first-hand knowledge of
6 what was done, it is clear that the knowledge of the-- The
7 inspection done at the time of fabrication before painting,
8 if done visually, would be a much easier task to detect the
9 shrinkage cracks at any kind of depth at all. So I think to
10 answer your question you have to talk about degree.

11 Clearly if you're talking about a surface
12 discontinuity of the order of 10 mills, ten-thousandths of
13 an inch in depth, then surely you could see those sort of
14 things with non-destructive inspection methods and you may
15 not see them or resolve them with the eye.

16 But if you're talking about a half-inch deep
17 shrinkage crack which is open before there is any repair
18 weld and before there is any paint, you don't need a
19 non-destructive inspection methodology to reveal it.

20 It depends on what you're looking for, what you
21 believe to be of any significance in that particular
22 location.

23 Q Well, I want to know whether in fact when the
24 follow-up examinations were done prior to July 1984 of the
25 original blocks, it was discovered that there were cam

WRBeb 1 gallery cracks which were only discovered with the further
2 non-destructive examination methods such as mag particle,
3 which had not previously been visible to -- which had not
4 previously been discoverable by the visual examinations.
5 Yes or No?

6 A (Witness Schuster) Yes, sir, it would be
7 I had a bit of a problem initially because I know
8 the amount of surface preparation that took place between
9 the original examination in February -- I mean March and
10 April of 1983, and then subsequently during the DR/QR
11 program. But there would be--

12 Q What was the time frame when you say
13 "subsequently"?

14 A Well, it would be approximately a year from the
15 time that we originally performed the examination. We
16 performed the examinations in--

17 Q The time frame I'm interested in is before the
18 new 103 block was placed into operation.

19 A This is the time frame we're talking about. We
20 did examinations in March and April of 1983, and then
21 repeated examinations in March -- February and March again
22 of 1984.

23 Q We're talking about the cam gallery cracks. Were
24 they magnetic particle examination?

25 A We did magnetic particle examinations in both

WRBeb 1 cases.

2 Q What else?

3 A We also did liquid penetrant. We also did
4 visual.

5 Q All right.

6 Were there cam gallery cracks discovered by the
7 magnetic particle and liquid penetrant examinations which
8 were not discovered by the visual examinations prior to July
9 1984?

10 A Yes, sir, there were.

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WRBpp

1 MR. DYNNER: I would like clarification, sir,
2 what block are we talking about?

3 JUDGE BRENNER: We're talking about any of the
4 original blocks, but not the new 103 block.

5 MR. DYNNER: Thank you.

6 BY JUDGE BRENNER:

7 Q Were you with me on that, Mr. Schuster?

8 A (Witness Schuster) Yes, sir. I assumed you were
9 talking about the three original blocks.

10 Q I was, so we were on the same wavelength.

11 A (Witness Rau) Your Honor, could I add
12 something. I misunderstood the answer. I thought there
13 were no visual inspections done of the original three blocks
14 by LILCO people prior to painting. So when they arrived and
15 LILCO looked at them they had paint on them and surely at
16 that time a visual resolution would have been very much more
17 difficult than an inspection at the time of fabrication
18 without painting. So under those conditions the first
19 identification of those indications, I believe, is with
20 magnetic particle with the paint on.

21 I think the impression I was left with by the
22 answer was he looked visually and didn't see anything and
23 then found something but it's not -- I think it's an apples
24 and oranges kind of comparison.

25 Q All right.

WRBpp

1 A (Witness Schuster) I think I indicated that the
2 indications were first discovered visually during routine --

3 Q Because the oil was leaking.

4 A Because the oil somewhat like a penetrant, filled
5 the indications and then you have a painted white surface
6 and you can see it.

7 Q I understand that. After that did you take the
8 paint off the cam gallery areas of the three original blocks
9 in order to perform visual examinations of those areas?

10 A We took paint off of selected cam saddles and
11 those cam saddles that were selected were based on magnetic
12 particle examinations we did with the paint on.

13 Q All right. After you took the paint off you then
14 performed further visual examinations?

15 A We performed the visual examination and then we
16 also repeated a magnetic particle and a liquid penetrant
17 examination.

18 Q All right. Did the latter two examinations
19 reveal further cracks that were not apparent based on the
20 visual examination of the selected areas with the paint
21 removed?

22 A They revealed further indications, yes, sir.

23 Q Okay.

24 Given that, why did you not perform magnetic
25 particle and liquid penetrant examinations of at least

WRBpp

1 selected cam gallery areas of the new replacement 103 block
2 prior to commencing operation with it.

3 A (Witness Youngling) Judge, when we performed the
4 inspection of the block out at the foundary without the
5 paint on, did the visual examination in accordance with the
6 spec by the LILCO people and by our consultant, we felt we
7 had enough confidence to move forward with that block and
8 put it in service. And that was the basis for moving
9 forward.

10 Q Well, how could you have that confidence when, as
11 I understand it, that confidence -- that basis is
12 inconsistent with your own recent sad experience with the
13 cam gallery cracks on the three blocks you previously had.

14 A Well, first of all our experience now on the new
15 replacement 103 block is showing that by penetrant
16 inspections and measurements that we have very light
17 indications, they are at maximum for --

18 Q I know what your testimony is on that. Well, I
19 don't know what your testimony is on that. I know what
20 other people have put into the record on that. But, I'm
21 asking you based on what you knew prior to putting the new
22 103 block into operation. And you've told me a few times
23 that the specification only required visual examination and
24 that's why I began my inquiry into what your experience
25 was. Because, after all, the specification is what you choose

WRBpp 1 to specify, no more or no less.

2 A But our experience had been with an examination
3 out at the foundry in an unpainted situation and based
4 upon that experience and what we had gained from the other
5 blocks, we had felt that we had confidence to move forward
6 with that block. That was the judgment that we made.

7 Q I thought what you had gained from the other
8 blocks was the knowledge that indeed there are cam gallery
9 cracks that are not apparent by visual examination even of
10 an unpainted surface?

11 A No, because when we made our inspections in the
12 spring of 1980 -- I'm sorry -- yes, in the spring of '83, if
13 you remember, we visited the foundry and we were able to see
14 cam gallery indications. Mr. Schuster talked about that the
15 other day.

16 Q There's no question that you can see bad
17 indications or larger indications. There is also, as I
18 understand it, no question that you can have smaller
19 indications that you cannot see; am I right?

20 A Yes.

21 Q And did you do that based on your experience with
22 the 101, 102, and the original 103 cam gallery areas, right?

23 A Yes, sir.

24 Q And you knew that prior to the time you put the
25 new 103 block into operation in approximately July 1984?

WRBpp

1 A Yes.

2 Q All right.

3 JUDGE BRENNER: That's all I have, thank you.

4 Judge Morris has questions.

5 WITNESS RAU: May I add something to the last
6 statement? Maybe it's restating the obvious, but at the
7 time of the replacement 103 block there was no indication
8 anywhere in the industry or even from LILCO's three engines
9 that the cam gallery regions were any kind of a problem at
10 all. And the visual inspection done without the paint on it
11 compared to the experience which LILCO had had prior to that
12 point with the original 101 and 102 and 103, were a clear
13 indication that whatever there was in the replacement 103
14 casting was not visible at all visually and was clearly much
15 less severe an indication, even if there were to be one
16 there, that anything that was in any of the other three
17 engines --

18 JUDGE BRENNER: Well, I don't understand that,
19 Dr. Rau, because I thought I heard testimony that there were
20 indications in the other engines -- well, look, we've been
21 through it a lot and I'll put together what you've just said
22 with what I think the other witnesses said. But, I don't
23 hear it as fully consistent. But as happens from time to
24 time when I read the transcript maybe I'll see something I
25 missed the first time around.

WRBpp 1 A (Witness McCarthy) At the risk of one quick
2 statement, it appears to me --

3 JUDGE BRENNER: I'm tempted to -- in fact, I'm
4 going to say hold it. Put it together with your own Counsel
5 and I'm sure he may have some suggestions on redirect and we
6 can get it out in an orderly question and answer fashion
7 that way.

8 BY JUDGE MORRIS:

9 Q Coming last, I have the problem of sorting out my
10 original questions from those that have already been
11 answered. So if I repeat, please forgive me.

12 Also, the purpose of my questions is partly to
13 give you a chance to kind of summarize your testimony on
14 specific items.

15 I guess, Dr. Rau, I will ask my first question of
16 you. If you would turn to the County's Exhibit S3 which is
17 represented as an FaAA photo of a cam gallery bearing saddle
18 number 5 of EDG 103 in the original block?

19 Could you describe to me what I'm looking at in
20 that photo?

21 A (Witness Rau) Yes, sir, I will attempt to
22 although Dr. Johnson may wish to add additional comments
23 because it does involve some nondestructive inspection
24 indications.

25 Q Well, as usual, any help you need feel free.

WRBpp

1 A Okay.

2 What we're doing in this particular view is, if
3 you like, standing on the side of the engine and looking
4 horizontally in toward the side of the engine at one of the
5 cam gallery saddle locations, in particular the fifth one.
6 That is the one adjacent to the fifth cylinder. In the
7 center bottom, if you like, is a web which is protruding and
8 that is, in fact, is a stiffening web which protrudes out
9 toward you, the viewer. And as you move up the center of
10 the picture you're actually going in -- excuse me, away from
11 the viewer and you're going through a fillet and then at the
12 top center you're coming back out again. At the very top of
13 the figure we have a boss which protrudes from the side of
14 the block and that basically is the flange on which is
15 mounted the fuel pump.

16 So the cam, of course, would run horizontally
17 left and right on that view. And the cam shaft bearings
18 would of course be supported by this saddle amongst the
19 others.

20 Dr. Wachob has indicated that in the Staff's
21 supplementary testimony there is a sketch between page -- on
22 page 2 which might be helpful in visualizing this figure, if
23 you would like to refer to that?

24 Q Well, I'm less interested in the geometry than I
25 am in the features that are displayed in the center just

WRBpp 1 below the ruler.

2 A Fine, let me just quickly describe and then I
3 will ask Dr. Johnson to say more.

4 What we are viewing -- what you are seeing in
5 this picture beneath the ruler running horizontally is a
6 dark line, rather ragged. That dark line is the result of
7 the bleed-out of the dye penetrant. It is running along the
8 bottom edge of the repair weld. The repair weld runs
9 horizontally and extends from the leftmost edge above that
10 dark line over to where the end of the ruler is. And if you
11 like the dark line outlines the perimeter of the repair
12 weld.

13 At the far right you see some discontinuous
14 indications which are associated with the termination or the
15 boundary between the weld and the cast iron.

16 The other point worth observing in the -- almost
17 the center of the dark line, almost immediately below the
18 number 4 on the ruler, although it is not in sharp focus, is
19 an excavation. And that is, in fact, the excavation to
20 approximately $3/8$ of an inch which was present in the number
21 5 cam saddle.

22 Perhaps Dr. Johnson may wish to add something.

23 A (Witness Johnson) I think you essentially
24 described what's there. The noncontinuous rounded
25 indications at the end of the ruler near the 6-inch side of

WRBpp 1 the ruler is evidence of some porosity in that area.

2 Q Can you tell me the relationship between the
3 width of the weld as indicated here and the width of the
4 crack at the surface?

5 A (Witness Rau) Judge, I'm not quite sure I
6 understand what you're asking. Are you interested in the
7 width of the weld, that is, the height vertically of the
8 weld, or the weld length horizontally?

9 Q The width, not the length.

10 A Okay. The width is not clearly visible in this
11 particular exhibit because in the shadow beneath the ruler
12 would be the top of the repair weld. The repair weld in
13 this facility, my recollection was of the order of 3/4 to
14 one inch in height from the bottom where the dark line is up
15 to the top which you cannot see. It's in the shadow.

16 The relationship of that weld width or thickness
17 to the -- you're asking the opening of the crack?

18 Q Right.

19 A At the surface the crack which appears through
20 the liquid penetrant to be very thick and wide, is not
21 anywhere that thick and wide. It is, in fact, at the
22 surface reasonably tight. If you cleaned off the penetrant
23 and just looked visually with no oil seeping out, you could
24 see it but it would be tight. I don't know if I can give
25 you a precise number, but perhaps 5 mills, five thousandths

WRBpp 1 of an inch opening, something of that order. It's certainly
2 not an eighth of an inch open or anything like that.

3 Q Fine.

4 A (Witness Johnson) The appearance of a wide
5 indication is because you have a lot of bleed-out on the
6 surface from the crack and such bleed-out is an indication
7 of something with some depth as opposed to a very fine
8 penetrant indication which would be an indication that it
9 didn't have much depth.

10 Q Fine, thank you. I just wanted to understand
11 what I was looking at here.

12 Mr. Youngling, occasionally questions have been
13 asked about the consequences of cracks should they
14 propagate. Is it correct that is LILCO's position that
15 consequences -- and I want to get an answer that is
16 operationally oriented, what does it mean to the operator or
17 to the operation of the engine. Is it correct that LILCO
18 believes that cracks in the cam gallery area would have no
19 effect on the engine operation?

20 A (Witness Youngling) Yes, Judge Morris. We feel
21 there would be no effect on engine operation and, in fact,
22 the EDG's at Shoreham have operated in excess of 1200 hours
23 very successfully.

24 Q And do you have other technical bases for that
25 conclusion?

WRBpp

1 A Yes. As you are aware the FaAA people have
2 provided us with analytical examinations of the area to show
3 that the area is in compressive strength stress. We have
4 performed examination of other engines which have operated
5 with these cam gallery cracks both in limited service and
6 very high hours of operation up to 50,000 hours. And those
7 engines have performed satisfactorily.

8 That's it.

9 Q Turning to the ligament cracks there's been some
10 reference to the possibility, I believe Dr. Wells mentioned
11 it, with respect to his drawing that if the crack propagated
12 below the liner landing area, there could be leakage of
13 water and that water would go then up through the stud hole
14 into the head region; is that correct?

15 A (Witness Wells) Well, that is a possible, but we
16 don't believe a likely, possibility.

17 Q Yes, I understood that but I wanted to be sure to
18 set the ground for the next question that, if you were to
19 hypothesize that and water did get into the head region,
20 what would then be the consequences on the operation of the
21 engine?

22 A Let me first add that the water leakage would be
23 to the top of the block and not into the cylinders.
24 Therefore, from at least our perspective, the operational
25 problem would be one would have water dripping down the side

WRBpp 1 of the engine.

2 But let Mr. Youngling add what the other problems
3 might be.

4 A (Witness Youngling) Judge, the consequences of
5 that hypothesized event would be the water leakage outside
6 along the side of the engine. If the leakage were
7 sufficient enough to cause a loss of significant inventory,
8 coolant inventory, the stand pipe on the engine which is
9 like a reservoir for the coolant has a low level alarm.
10 That alarm would signify to the operator that there was a
11 loss of water and there is a makeup capability to that
12 system. So we can add additional water.

13 So if we were operating during the LOCA event and
14 we had that situation develop, we could make water up to the
15 engine and proceed quite satisfactorily.

16 Q So the loss of water would be the only
17 operational effect on the operation of the engine?

18 A The seepage would be small and I don't think we
19 would see a detrimental effect at all other than this low
20 level alarm. I don't think we would see any effect on the
21 temperatures of the engine.

22 Q Turning now to the stud-to-stud cracks, if you
23 will, if you will hypothesize the crack running from one
24 stud to another, what then would be the operational
25 consequences on the engine?

WRBwrb 1 A Judge, it certainly would depend upon the size.

2 Q Pick a small one, then a medium one, and then a
3 large one, if you like.

4 A Well, a small one, I don't feel there would be any
5 consequences at all; a medium one, I don't feel there would
6 be any consequences. I'm not sure where I want to break
7 that point to a large one, but if we use the experience that
8 we have at Shoreham, which is the 3-inch crack that
9 developed on the 103 engine, when we were running with that
10 crack we saw no detrimental effect on the engine operation,
11 and we have put in a program to ensure that prior to
12 releasing the engine for stand-by service between each
13 operation at greater than 50 percent -- each operation from
14 stand-by, where the engine has previously operated at
15 greater than 50 percent load, we will detect by eddy current
16 the lack of crack, stud-to-stud cracking in the region
17 between the heads.

18 The cumulative damage analysis that FaAA has done
19 has shown that under the postuled loop LOCA profile, which
20 is a very conservative profile, we would not see any
21 cracking beyond a depth of an inch and a half, and,
22 therefore, we don't anticipate any problems in meeting that
23 loop LOCA event if we have it.

24 Q I understand that. But I guess I wou'd, contrary
25 to Judge Brenner and Mr. Schuster, I would like you to use

WRBwrp 1 your imagination to visualize the most serious consequence
2 of a stud-to-stud crack.

3 A The situation where we had such a serious
4 stud-to-stud crack, where I had, for some reason, lost the
5 ability of those two adjacent studs to hold that cylinder
6 head down, having seven other studs on each of those
7 cylinders holding that head down, I feel that that engine
8 would probably be able to carry load.

9 Q Has an analysis been made of that, to your
10 knowledge?

11 A (Witness Wells) Judge Morris, I would like to
12 respond to your question, and, I hope, to the point.

13 We have not gotten into an analysis of the effects
14 of extensive cracking. It goes without saying, I suppose,
15 at this point, that we don't believe that large cracks that
16 would approach all the way through from the block top to the
17 bottoms of these cylinder stud bosses would be possible.

18 But, going beyond that, your question was: under
19 the worst imaginable scenario, what might happen if we did
20 in fact have severe stud-to-stud cracking. And by "severe"
21 let me refer to cracks that would be considerably deeper
22 than three inches, and would, if you glance again at this
23 exhibit showing the stud, would have to be on the order of
24 six or seven inches deep in order to sever the structural
25 material.

WRBwrb 1 In that case, between two cylinder heads there
2 would be some loss in the ability of the block top to
3 withstand the bending moment caused by the support of the
4 cylinder heads to the block top.

5 Now, at this point there are two mitigating
6 factors, even in this what I consider to be the worst
7 possible scenario. For one thing, perpendicular to this --
8 to the plane, to this sheet of paper showing this exhibit,
9 is a web. These webs separate the cylinder compartments
10 every two feet. It's a vertical metal plate, if you will,
11 attached to the cylinder stud bosses, and runs in between
12 the two neighboring bosses, and gussets reinforce the stud
13 bosses to the web. And these members have considerable
14 bending rigidity.

15 Of course, if a crack progresses to that extreme
16 depth that we have hypothesized, then this web would resist
17 that bending.

18 But, in addition to that, the cylinder heads
19 themselves are fairly rugged structures. They are almost
20 box beams. The cylinder heads straddle the block with very
21 little distance in between adjacent heads, only on the order
22 of a 1/4-inch. The heads are secured to the block top by
23 the eight studs, and the only way the block top could bend
24 significantly is if the adjacent cylinder heads were to bend
25 at the same time.

WRBwrb

1 Since these cylinder heads consist of three metal
2 plates connected by several ports -- exhaust ports, intake
3 ports, and the like; valve ports -- there is a substantial
4 stiffness in that structure, and the entire head assembly is
5 approximately a foot high as compared to the 2-1/2-inch or,
6 in the new block, 3-inch nominal block top thickness. So it
7 is unlikely, even in the worst possible case, that the
8 engine could, if you will, either split from one end to the
9 other or buckle in the middle and try to part company by the
10 left side and the right side trying to move opposite
11 directions.

12 We think that those conditions are verging on the
13 impossible.

14 As a practical matter, if the crack did approach
15 the dimension of 5 or 6 inches or so, there is not even an
16 opportunity for a water leak, because of the intervening
17 metal. The situation is not equivalent to a ligament crack
18 from the standpoint of water leakage, because there is no
19 water until one gets down below the cylinder stud bosses.

20 The bending moment of the cylinder heads is
21 essentially resisted by the heads themselves. In our
22 evaluations of the cylinder heads we have assumed that the
23 pressure loading applied to the underneath of the cylinder
24 heads is merely transmitted through the block down into the
25 nuts that attach the block to the base through the through

WRBwrb 1 bolts. Therefore, the bending moments in the block itself,
2 in the event that the block were cracked, would drop off.
3 At that point the pressure loading would be applied directly
4 from the heads into the remaining structure.

5 I apologize for that rather long answer to your
6 question.

7 Q I thank you for it.

8 Does anyone else from FaAA wish to comment on
9 consequences of severe breaks or distress on the operation
10 of the engine?

11 A (Witness McCarthy) Yes, sir. Obviously, we
12 have-- While we do not have a rigorous mathematical
13 analysis of the various consequences of crack propagation
14 either down into the stud boss area or, as Dr. Wells has
15 described at some length, in extensive stud-to-stud
16 cracking, we believe we have thought qualitatively long and
17 hard about the various scenarios. And part of the
18 confidence and comfort we draw from the predictions we have
19 made with regard to the suitability of these engines is the
20 fact that basically we're talking about material failure,
21 and the blocks being-- We have based our predictions on the
22 belief that the block would not, in fact, just live through
23 a loop LOCA type event but, in fact, would withstand this
24 service very credibly.

25 Part of the conservatism in that assumption is

WRBwrp 1 that even as one postulates more and more severe events,
2 either for growing ligament cracks or stud-to-stud cracks,
3 there is a huge remaining margin that really has not formed
4 the basis, or become a significant part, of any other
5 conclusions that we have expressed here today, but is, in
6 fact, an additional factor of safety in the operation of
7 these engines.

8 A ligament crack, even growing down to the coolant
9 water area, would have such a tortuous fluid flow path that
10 the coolant -- any reasonable or even, I guess, remotely
11 possible coolant loss leak would be very small. And you
12 cannot realistically get to the coolant area in the
13 between-stud -- with a stud-to-stud type crack. So this
14 forms an additional of the conservatism that we had in mind
15 when we have made our recommendation that these engines are
16 suitable for back-up emergency diesel service.

17 Q Thank you, Dr. McCarthy.

18 I have a few specific questions now.

19 Do you have the County's supplemental testimony
20 before you? If you would turn to page 8, please, and review
21 the question and answer No. 10. And my question will be
22 whether or not you agree or disagree with that answer.

23 A (Witness Rau) I disagree with that answer, Judge
24 Morris, for the reasons I think I testified yesterday. If
25 you like, I could go through them again.

WRBwrb 1 Q Well, I thought there was a little bit of
2 difference here, in that the words "brittle nature" are
3 used, and I don't think the brittleness was discussed
4 yesterday; perhaps I'm wrong.

5 A You may be right, your Honor. I may not have used
6 that particular word. But discussions which I gave
7 yesterday in response to the questions dealt with the
8 various ways in which a mark, a beach mark or some other
9 indication of gradual progression of a crack might be left
10 on the fracture surface.

11 The beach mark, again, is the generic slang,
12 technical slang term for such marks.

13 It is, in fact, true that in those materials where
14 a crack extension is more brittle in nature -- and this a
15 very-- We have to come back to that; but in most cases
16 where it's more brittle in nature, some of the mechanisms
17 which are available in more ductile materials are not
18 available to leave a mark on the fracture surface.

19 But certainly in cast iron you're not precluded
20 from the differences in oxidation, differences in loading
21 rates, and other features which can, in fact, leave a mark,
22 or a beach mark, on the fracture surface.

23 I think the only last comment I would make, of
24 course, is that the cast iron is not completely brittle,
25 it's not like glass; it does have, between the graphite

WRBwrb 1 flakes, which are in fact brittle in the classical sense,
2 there is steel, perlitic steel, if you like. And that
3 perlitic steel has some ductility, some ability to deform.
4 So even the statement that it is brittle is not precisely
5 correct, and for those reasons I disagree with the general
6 statement.

7 Q Thank you.

8 If you would turn now to page 10, the last
9 paragraph in the answer to question 15 which begins "We
10 therefore conclude..." do you agree with that statement?

11 A Definitely not.

12 Q And again your reason?

13 A There are numerous reasons, your Honor.

14 Q I guess we have heard some of them, so if you
15 could --

16 A I would like to take a few minutes to write them
17 down because it has been so long I am afraid I am going to
18 forget half of them.

19 Q Well you can do that in your findings but maybe
20 you could just summarize it here.

21 A Okay. Let me try to give you the major ones.

22 First of all, there is absolutely no evidence of
23 subsurface defects. We have described in great detail what
24 we have as a shrinkage crack in the cam gallery area which
25 was originally surface connected and was subsequently

WRBwrb 1 covered over on the surface by a repair weld, and that
2 repair weld subsequently cracked on cooldown in the welding
3 procedures.

4 The oxide present on the shrinkage crack and the
5 absence of any thick oxide down by the tip or the
6 deepest-most extent of that crack clearly indicates that
7 that crack has not extended under operating conditions for,
8 if it had, there would be a region somewhere beyond where
9 the shrinkage crack originally was and where it was
10 hypothetically to have grown during operation where the
11 oxide would be markedly thinner.

12 Q Excuse me, Dr. Rau. Are you focusing your answer
13 on replacement DG 103?

14 A I'm sorry, Judge Morris, I am not. I have been
15 discussing the original 103.

16 Give me one minute, please.

17 (Pause.)

18 Let me start over again. My answer to your
19 question again is I disagree with that statement for the
20 following reasons:

21 First of all there is absolutely no indication by
22 direct physical measurements that there has been any growth
23 or extension of any of the indications in this region. The
24 original visual inspection indicated no reportable
25 indications. Visual inspection even today reports no

WRBwrp 1 reportable indications by the same standard.

2 The general location and appearance of the
3 indications on the surface is completely consistent with
4 shallow casting induced defects.

5 The crack depth gage measurements that have been
6 performed at that location, as well as comparable locations,
7 in the original 101, 102 and 103 clearly indicate that these
8 indications are very shallow.

9 MR. DYNNER: I am going to object to that. That
10 is part of the supplemental testimony that the Board ruled
11 this morning would not be submitted and he is trying to get
12 it in in a tangential way.

13 MR. FARLEY: May I respond?

14 JUDGE BRENNER: Yes.

15 Tell Mr. Dynner that he is selective, because
16 that is about the third time we have heard that orally
17 today. But go ahead, Mr. Farley.

18 MR. FARLEY: Well I don't think the objection is
19 sound, your Honor, because the witness has not stated that
20 he has focused on non-destructive examinations of the
21 replacement 103 performed after the filing of the
22 supplemental testimony on behalf of LILCO.

23 JUDGE BRENNER: He hasn't stated that, but is it?

24 MR. FARLEY: I don't know. That's for recross-
25 examination or examination by the Board. But the objection
is not well-founded.

WRBeb

1 JUDGE BRENNER: I am not going to strike it. I
2 guess I'm going to overrule the objection, Mr. Dynner, for
3 these reasons:

4 We are not capable of separating out precisely
5 when we're asking expert witnesses what they think about
6 certain things. Granted we did not admit the supplemental
7 testimony for the reasons we discussed this morning, and
8 when we review the record here we will take into account
9 those reasons. To the extent anything comes into the record
10 related to that, we will take into account our ruling on
11 that other motion if it becomes important. And of course we
12 depend on findings by the parties to alert us to it. And we
13 will do that to the best we can.

14 But it may be that there are some facts that are
15 logical extensions of information already in the record that
16 come out of witnesses' on-going work. Not only can't I
17 separate it, I suggest it is hard and in fact unduly
18 artificial to ask the witness to make that separation when
19 asked a question that touches on that area.

20 And you can follow up and we will judge the
21 extent of what is new as opposed to what is nominally
22 available. But one problem we have is we have this
23 testimony that is going to be put forward by the County
24 which would have been filed after-- Any supplemental
25 testimony timely filed by LILCO still would have been

WRBeb 1 before the time LILCO would have been able to see this
2 testimony on the schedule we set. We would have wanted to
3 ask LILCO about it anyway. I'm sure parties other than
4 ourselves are going to be interested in asking the County
5 witnesses what they think of some of the testimony of these
6 witnesses. Then we'll try to put it all together.

7 But I'm not going to try to separate it out now.
8 We just cannot, number one. And number two is even if we
9 could, we might regret doing it when we put all the facts
10 together.

11 Nothing I've heard orally so far-- Well, at this
12 point I cannot say that there is prejudice in terms of the
13 inability to follow up and ask questions about it, and you
14 can do that. I realize it is going to overlap with some of
15 the material in the further supplemental testimony that we
16 did not admit, and that's not the first time it has come up
17 today. I don't know where you were the other times.

18 But I've heard other testimony touching further
19 work on the cam gallery areas. In fact, some of it was
20 within ten minutes of our ruling on the motion, and I
21 noticed it. But just because I don't say things doesn't
22 mean I don't notice things.

23 BY JUDGE MORRIS:

24 Q Were you through with your answer, Dr. Rau?

25 A (Witness Rau) No, I was not, Judge Morris.

WRBeb

1 In addition to the direct physical measurements,
2 this conclusion is based upon a statement about subsurface
3 defects. Clearly the County's experts have no opportunity
4 to cut up and examine the material subsurface. There is
5 absolutely no basis or evidence whatsoever for subsurface
6 initiation of any indication, and quite frankly, it would be
7 quite inconsistent with my general engineering knowledge
8 that we would have subsurface defects under this particular
9 circumstance.

10 Last but not least, my disagreement with this
11 statement is based upon the stress analyses and fracture
12 mechanics calculations I've done in this area which clearly
13 indicate that the stresses are compressive, always
14 compressive, and that even under the most conservative
15 assumptions I felt were remotely reasonable, that cracks
16 very much larger than these, if they were present, -- I'm
17 talking about cracks as deep as the ones which were measured
18 in the original 103 block, that is, between a half inch and
19 one inch deep -- would not extend under any operating
20 condition.

21 For all those reasons I disagree strongly with
22 that statement.

23 Q Thank you.

24 If you would turn now to page 13, to Question and
25 Answer Number 20?

WRBeb 1 Do you agree that a circumferential crack could
2 permit some up-and-down movement of the cylinder liner?

3 A (Witness Wells) No, Judge Morris, I don't
4 agree.

5 Q And why is that, Dr. Wells?

6 A For reasons I think we discussed earlier.

7 The cylinder liner is actually supported by the
8 eight cylinder stud bosses, and in order to get relative
9 motion, up-and-movement of the cylinder liner relative to
10 the seal, there would have to be large vertical cracks. By
11 that I mean large, on the order of several inches, that are
12 not at all of the same nature as the 45-degree cracks coming
13 out of the corner of the liner landing, as Dr. Rau I believe
14 described.

15 Q Mr. Youngling, would you turn to Suffolk County's
16 Exhibit S-8? This is Mr. Isleib's letter to Mr. Kascsak.
17 And will you turn to page 2?

18 At the end of the first incomplete paragraph it
19 says:

20 "A review of design stresses in this
21 area should be made to ascertain this."

22 Do you know whether or not such a design review
23 was made?

24 A (Witness Youngling) Judge Morris, let me explain
25 the outcome of this observation. Okay?

WRBeb 1 Q May I borrow a line from Mr. Dynner?

2 A There was no need for an analysis because of the
3 outcome of the actual machining process.

4 Q So the answer is No, that there was no need for
5 it?

6 A No need for it.

7 Q Do you want to summarize the reasons why that was
8 not necessary?

9 A Yes. There was a loss of metal in the rough
10 casting down at the lower flange, the feet at the bottom of
11 the block where it mounts to the base, and when the
12 machining operation occurred, the amount of metal loss was
13 vitually negligible.

14 Also the area that the loss occurred in was
15 between two adjacent hold-down studs and backed up by the
16 rib going between two adjacent cylinders, and it was felt
17 that the loss of metal was so small that it was a very, very
18 acceptable condition in the final configuration.

19 JUDGE MORRIS: Thank you, gentlemen. That is all
20 I have at this time.

21 JUDGE BRENNER: Let's take a 15-minute break,
22 until 4:20 p.m. I'm not sure if the Board has any
23 additional questions or not, but if we do they won't be
24 many, and at that point we will begin the redirect.

25 (Recess.)

AGBagb

1 JUDGE BRENNER: Back on the record.

2 BY JUDGE BRENNER:

3 Q I, too, have a few more questions similar to the
4 questions Judge Morris asked about what would happen from an
5 operational point of view, operation of the engine. I am
6 interested in that with respect to the camshaft gallery
7 cracks.

8 And I want you to assume that those camshaft
9 gallery cracks will propagate in the future. What effect
10 would that have on the operation of the engine?

11 We'll start out with that general question and
12 if we need to make it more specific, we'll see.

13 A (Witness Rau) Just a clarification: Are you
14 asking us to assume that it will grow all the way through
15 the wall?

16 Q Well take me through the various stages up until
17 that point and including that point.

18 A Well I don't believe, even if it is going to
19 start to grow, it is going to grow anywhere.

20 But if I have to assume it will take a rate which
21 is many -- infinitely higher than I think it will be and
22 progress... That's what you want to know?

23 Q Yes.

24 A Okay.

25 Let me just --

AGBagb 1 Q But I want it from an operational point of
2 view --

3 A I understand.

4 Q I'm not sure you're the right witness, but go
5 ahead.

6 A I just want to say one thing which puts the
7 hypothetical in perspective, because I don't think the
8 operational people can comment upon how it is going to grow
9 until it leaks. If you want us to assume it is already
10 leaking then I can just be quiet.

11 Q No, I'm talking about progression.

12 A Well assuming it progresses hypothetically the
13 stress distribution in the area of the cam saddle, given the
14 general shape of the crack indications at least in the
15 original 103 -- Let me assume that that is the shape they
16 are in this hypothetical case, too -- in that case if there
17 were to be any crack progression at all, the crack
18 progression would occur at the deepest-most point of the
19 crack -- which is assumed to be of the general thumbnail
20 shape, that is, it is deeper in the center and it gets
21 shallower as you go left and right until it merges at the
22 surface -- under those conditions the largest crack-driving
23 force, if it were large enough to cause crack propagation,
24 would be at the deepest point.

25 And so if the indication were going to extend,

AGBagb 1 it would extend to the deepest-most point and if you like
2 tunnel through at a single point. The ends of the cracks,
3 left and right, would not go anywhere. Therefore the start
4 of the hypothetical is you would get a pinhole leak just as
5 the deepest-most point started to touch the inner wall.

6 And I will at that time turn it over to
7 Mr. Youngling or one of the LILCO people to talk about what
8 operationally that means.

9 Q All right.

10 Could you tell me a little more graphically what
11 that leak would be from and to?

12 A Again Mr. Youngling is probably better than I but
13 there is a water jacket, there is water on the back side of
14 the cam gallery wall and on the front side where the weld
15 repair is there is oil for the camshaft region.

16 So you would have a drop of water starting to
17 dribble back -- again I don't know the exact pressures,
18 maybe it wouldn't go that way, but I think the water might
19 dribble back into the oil system of the camshaft gallery,
20 but I would like Mr. Youngling to comment.

21 A (Witness Youngling) Judge, what you would see is
22 an outflow or a seepage, a drop of water outflow out into
23 the cam gallery area. That water would mix with the
24 lubricating oil which passes from that area down into the
25 lube oil sump to return to the system, into the large lube

AGBagb 1 oil sump.

2 However, as you are aware, we do periodically
3 inspect the oil and, as part of the examination, we look for
4 water contamination of the oil. If the leak were large
5 enough to cause a significant amount of water inventory
6 loss, that same scenario that I spoke about earlier where
7 there would be detection by water level loss would occur,
8 but I would not anticipate that there would be that much
9 water loss considering the general clamping forces in the
10 area.

11 Q How deep would the crack have to get before it
12 would pierce the water jacket or the wall between it and the
13 water jacket such that you would have any leakage?

14 A 1-1/4 inch.

15 Q If leakage through a cam gallery crack was great
16 enough to trigger the low level alarm on the water makeup,
17 the coolant water makeup system for the diesel, what would
18 have been the effect on operation of the engine prior to
19 that point, given that amount of water in the lubricating
20 oil?

21 A (Witness McCarthy) I just happen to be looking
22 at a tug that ran its diesel two weeks continuously with a
23 50/50 water-oil mixture in its sump, about a 4000 horsepower
24 diesel, and it ran for approximately two weeks with a half
25 and half mixture of salt water and oil as near as we can

AGBagb 1 determine continuously.

2 Q Should we apply that experience to these diesels,
3 and why or why not?

4 A Yes, to a first order if it wasn't for the
5 oxidation essentially all of the fluid mechanics that makes
6 lubricating oil work would make water work as a lubricant.
7 The real problem is after an extended period of time the
8 additives that are in the oil and have attached themselves
9 to the metal surface get overcome and long-term degradation
10 does set in. But the water has approximately the right
11 viscosity and it cleans up the inside of the crankcase, but
12 it will run for a while.

13 Q Well will it run at the required loads?

14 A The only problem that the load would cause is if
15 there was local heating of the water obviously above its
16 vapor pressure. And at least in this particular unit, which
17 -- it was not run at full speed, it was obviously a marine
18 application so I can't comment directly -- they didn't see
19 any signs of steam flashing or characteristics of the
20 lubricant where the steam temperature water would be very
21 different than the oil.

22 The typical oil operating temperature, even in
23 the high slip areas of the bearing, is less than 200 degrees
24 Fahrenheit, so until you got to some abnormal loading
25 condition in the bearings, they should hang on even with

AGBagb 1 water as a lubricant. And based on experience -- this is
2 the only data point I know of personally where a diesel of
3 this size has tried to use water for a lubricant for an
4 extended period of time and managed to do so for about two
5 weeks.

6 Q That was an interesting experiment. I guess it
7 is not material for us to know whether it was planned or
8 unplanned.

9 Does anybody else have an opinion as to what the
10 effect on the Shoreham diesels of enough water in the
11 lubricating oil to cause the low level alarm on the water
12 reservoir to sound would be based on anything else?

13 (No response.)

14 All right, hearing nothing....

15 (Pause.)

16 Mr. Youngling, you mentioned the monitoring of
17 the lubricating oil for water contamination.

18 Is that a regularly scheduled check? Can you
19 fill me in on the timing of that?

20 A (Witness Youngling) Judge, the lubricating oil
21 will be analyzed on a monthly basis under the regular PM
22 program.

23 Q Is that frequency increased at all based on any
24 operation of the engines or is it a monthly basis regardless
25 of whether the engine is operated to different extents

AGBagb 1 during that period?

2 A Presently it is based on normal operation. It
3 would also be based on what the analysis showed us. If we
4 were seeing something adverse in the lubricating oil, it may
5 trigger us to take more frequent samples.

6 Q Aside from water leakage causing the
7 contamination in the lubricating oil, are there any other
8 operational effects on the engine of hypothetical
9 propagation of the cracks in the cam gallery area such as
10 dependence on the geometry of that gallery for operation of
11 various things including the camshaft or anything of that
12 nature?

13 (Pause.)

14 A (Witness Wells) Judge Brenner, if a crack were
15 to penetrate one of the quarter-inch-thick walls, as you
16 mentioned, and if it were not in compression, there is still
17 support for the cam saddle because of a structure which is
18 difficult to describe to you.

19 There is a horizontal channel, in effect,
20 comprised of essentially a vertical plate and a horizontal
21 channel element which -- I can hold up and wave my fingers,
22 I guess (displaying document).

23 Q I see you are holding up a drawing. Is there
24 anything in any of the exhibits that would be helpful,
25 perhaps the Block Report itself or something else?

AGBagb 1 A In the Staff's supplementary testimony, Judge
2 Brenner, on page two, there is a very schematic
3 representation of this channel structure that I referred to.

4 Q I've got mine in chambers next door --

5 MR. GODDARD: Do you want to borrow ours?

6 JUDGE BRENNER: Yes, could I borrow one?

7 (Document handed to the Court.)

8 JUDGE BRENNER: I have it now. Thank you.

9 WITNESS WELLS: That is a considerable
10 oversimplification of the situation. There are lots of
11 pieces of metal not shown there. You don't see, for
12 example, the vertical channel that surrounds the
13 through-bolt that holds the block down onto the base. I
14 guess that is the most significant missing structural part.

15 But in any event, I think you can appreciate that
16 this horizontal channel element lends considerable support
17 so even if the wall were penetrated by the crack you would
18 not lose the ability to support the camshaft bearing. And
19 of course that is necessary because of the forces imposed on
20 the camshaft by the lifters.

21 BY JUDGE BRENNER:

22 Q What would the effect be on operation of the
23 camshaft if one of the camshaft bearings -- well if the
24 saddle shifted position somewhat due to hypothetical
25 cracking under one bearing -- Let me back up and make sure

AGBagb 1 I am understanding this correctly; if it is somewhere in the
2 testimony and I missed it.

3 Am I correct that the camshaft saddle supports --
4 each saddle supports a bearing for the camshaft, is that
5 right?

6 A (Witness Wells) That's correct, Judge Brenner.

7 Q Okay.

8 What would the effect be on the camshaft if the
9 saddle were to move a little bit or vibrate somewhat due to
10 cracking of one saddle?

11 A If it could move transversely again it would have
12 to do so by taking the -- I guess the entire wall of the
13 engine along with it. But should that happen then there
14 would be, of course, a concentrated load and bending of the
15 camshaft at that location.

16 If I had to speculate on that it is a matter of
17 degree, it is hard to imagine that significant displacement
18 could occur at all without sort of massive damage to that
19 portion of the engine. But if you hypothesize significant
20 displacement then there could be damage to the bearings.

21

22

23

24

25

AGBpp 1 A (Witness Rau) If I could just add, Judge
2 Brenner, if you're asking if just when you got the crack
3 penetrating the wall to where it was leaking, it's not going
4 to have any significant effect on the relative motion of the
5 cam support. We already have a crack which is .9 deep in
6 the original 103 which ran for 1200 hours and going another
7 couple tenths of an inch at one point is clearly not going
8 to change even measureably or perceptively, certainly not
9 significantly, the stiffness of that support, which again,
10 you have to envision that web is running all the way down to
11 the bottom of the engine and the true support for the
12 bearing of the cam shaft is not really very dependent upon
13 whether that crack is there or not.

14 Q Okay. Do you want to add something?

15 A (Witness McCarthy) Yes, just in terms of the
16 volume of any sort of water leak you would expect from a
17 crack that was as tight as Dr. Rau has indicated previously,
18 we have seen the surface part of the crack on the order of
19 five mills, a few thousandths, and an inch and a half deep.
20 That is a very torturous path, once again, for water flow.
21 And you would not expect any significant volumes of water
22 edition.

23 Q All right. Thank you, that's all I have.

24 JUDGE BRENNER: Mr. Farley, it's 20 to 5. We
25 would like you to begin now. I realize that based on your

AGBpp 1 time you're not going to finish, however. I don't suppose
2 -- well, sometimes it happens that many questions asked
3 duplicate questions that were planned but, perhaps not two
4 hours and 45 minutes worth.

5 MR. FARLEY: I agree. I was going to suggest
6 that it might be more efficient for me to take the plan I
7 have for redirect and consider it in connection with all of
8 the questions that were asked by the Board and it might be
9 more expeditious to start first thing in the morning on
10 redirect. And, as an aside, I just have an easier way of
11 remembering when a particular thing started if it starts on
12 one day rather than breaking it up.

13 JUDGE BRENNER: Well, the last part isn't
14 important because we can help remind you, if you mean the
15 time. But, we can defer the beginning of your redirect
16 until tomorrow morning if you prefer. If you'd like, if you
17 have a few questions that you'd like to proceed with and
18 then stop at any time, you could do that also. All the
19 options are yours, whatever you want to do.

20 MR. FARLEY: I'd prefer to defer it to first
21 thing in the morning.

22 JUDGE BRENNER: All right. We'll do that.

23 Getting back to something we raised this morning,
24 does the Staff know whether it would be prepared to answer
25 our question regarding the Staff's request for information

AGBpp 1 on the crankshaft tomorrow? And if you're ready today, we
2 can do it now. But that's up to you, I won't force you.

3 MR. GODDARD: The author of that letter has
4 advised me we would be best doing it tomorrow as opposed to
5 trying to do it today, Judge Brenner. We will be ready to
6 proceed anytime tomorrow on that.

7 JUDGE BRENNER: All right. Why don't you try and
8 tell the other parties first what you were going to tell us
9 and then after you have had a chance to do it raise it with
10 us. But I would like to hear about it before the lunch
11 break tomorrow and if you can be ready first thing in the
12 morning having first discussed it with the other parties,
13 that's fine. Otherwise, at some point later tomorrow
14 morning.

15 MR. GODDARD: We will shoot for first thing in
16 the morning, Judge Brenner.

17 JUDGE BRENNER: Okay, thank you.

18 MR. FARLEY: Judge, I beg your pardon. I do find
19 that I have a pleading that has already been mailed but I'm
20 supposed to serve on everybody in connection with a very,
21 very small portion of the supplemental testimony by the
22 Staff to strike one little answer.

23 JUDGE BRENNER: When we adjourn for the day you
24 can give us the pleading.

25 MR. FARLEY: Thank you, sir.

AGBpp 1 JUDGE BRENNER: All right. And we will adjourn
2 for the day and pick up at 9:00 tomorrow morning.

3 (Whereupon, at 4:45 p.m., the hearing was
4 adjourned, to reconvene at 9:00 a.m., Wednesday, October 31,
5 1984, at this same place.)

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CERTIFICATE OF OFFICIAL REPORTER

This is to certify that the attached proceedings before the
UNITED STATES NUCLEAR REGULATORY COMMISSION in the matter of:

NAME OF PROCEEDING:

LONG ISLAND LIGHTING COMPANY
(Shoreham Nuclear Power Station)

DOCKET NO.: 50-322-OL

PLACE: Hauppauge, New York

DATE: October 30, 1984

were held as herein appears, and that this is the original
transcript thereof for the file of the United States Nuclear
Regulatory Commission.

(Sigt) William R. Bloom Anne G. Bloom
(TYPED) William R. Bloom & Anne G. Bloom

Official Reporter

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