50-322 OL

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10/1/84

OFFICIAL TRANSCRIPT
PROCEEDINGS BEFORE

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:)
)
LONG ISLAND LIGHTING COMPANY) Docket No. 50-332-OL-3
) (Low Power)
(Shoreham Nuclear Power Station)
)
Unit 1))

DEPOSITION OF RICHARD WOYTOWICH,

HOWARD C. BLANDING and ROBERT A. GIUFFRA

New York, New York

July 18, 1984

NUCLEAR REGULATORY COMMISSION

Docket No. 50-322 Official Exh. No. #72

In the matter of LILCO

Staff ______ IDENTIFIED ✓

Applicant ______ RECEIVED ✓

Intervenor ______ REJECTED ______

Cont'g Off'r ______

Contractor ______ DATE 10-1-84

Other COUNTY'S Witness ______

Reporter WRB

ALDERSON REPORTING
(202) 628-9300

indicated.

Q 4875?

WITNESS WOYTCWICH: Yes.

I don't have a calculator to convert that to kilowatts for you.

Q That is all right.

I refer you to 34.3.2 of the rules, 1984 rules. What is meant by the first phrase of that first sentence in the paragraph, that the design equations don't take into consideration the possibility of dangerous torsional vibration stresses?

Which design equations does the phrase refer to?

WITNESS GIUFFRA: For example, the basic crankshaft diameter formula, 34.17.1. That would assume that the stress values are lower than those appearing in the later table or the formulas in the 1984 rules.

So that you would--you would approve the design with that consideration. If the stress values are higher, we have to go into a further detail in our review of the design.

Q In this case, were the torsional vibration stresses higher than those indicated in the table?

WITNESS GIUFFRA: Yes.

Q They were higher?

WITNESS WOYTOWICH: Yes.

Q Did the existence of those values as being higher than this allowable limit or limits have any effect on your prior calculations as to whether the design equations had been met for this crankshaft?

WITNESS GIUFFRA: When we considered the vibration analysis itself, as part of that consideration, on the acceptability for marine service, we went back and re-examined the crankshaft for that particular application or installation.

Q Were those higher vibratory stresses?

WITNESS GIUFFRA: Yes.

Q What were your conclusions?

WITNESS GIUFFRA: We found them to be acceptable, in conjunction with the total submittal. Total submittal of Delaval.

Q What do you mean?

WITNESS CIUFFRA: Well, it means that we went back and did some additional calculations. We reviewed their strain-gauge measurements as well as torsiograph measurements and looked at the service documentation they had given to us, which is available here.

We used those in conjunction with our own check calculations to determine that it was acceptable for a mar--for a non-marine calculation.

Q Are those contained in Exhibit No. 3?

WITNESS WOYTCWICH: Yes.

Q Can you point those out to me?

WITNESS WOYTCWICH: First page of Exhibit 3 is a--I have it as the first page. Do you have that?

Q No.

WITNESS WOYTCWICH: All right. You start at the front. I will state that the first thing we have here is a check of the natural frequency calculations discussed this morning.

Q All right.

WITNESS WOYTCWICH: Following that,

there is the discussion or the check calculations pertaining to the torsional vibration stress levels.

Q Are those the handwritten or typed ones?

WITNESS WOYTCWICH: Handwritten. We covered this morning as far as sheet No. 3 of six. I assume you will want to come back later to the remainder of that.

Then, after the handwritten calculation that is marked "Sheet 6 of 6," there are two pages which consist or three pages which consist of copies of calculator printouts. These were the safety factor calculations which we made according to our modified version of the CIMAC draft method.

Then, following that--

Q If I can stop you there, what is "SI"?

A System International, international system of units.

Following that, there should be some--a sheet indicating safety factors. We calculated the safety factors in several ways. We began with the fatigue stress, which we obtained from the calculator printout marked "Sheet 3 of 3" by AJD/FTW.

There is a--the fourth printout line up from the bottom gives the stress in Newton's per square millimeter, converted to psi.

Q What is that figure?

WITNESS WOYTCWICH: 29,940 psi.

Q Relating to what?

WITNESS WOYTCWICH: That relates to the equivalent combined alternating stress by Von Ness' theory.

Going back to the handwritten sheet, we compared that stress against each of the three fatigue strength values, which we had to consider. One was the result of the theoretical formula proposed by CIMAC.

That indicated a safety factor of 1.105. Then we compared it to the fatigue strength value which TDI Indicated was derived from tests on the failed crankshaft, without shot peening.

And the safety factor was found to be 1.309.

Then we concluded the 20 percent extra strength which they claimed for shot peening, and that increased safety factor to 1.57.

We then went to do a combined steady and alternating fatigue analysis, similar to what is shown on page 27 of Exhibit 2. You don't have to look through Exhibit 2. That is attached as the next page of Exhibit 3.

We found the equivalent alternating stress and the equivalent mean stress, again, by our in-house adaptation of the CIMAC method.

We found a combined safety factor, and those numbers are indicated on the page, when comparing against each of the three fatigue limits.

Q Located where?

WITNESS WOYTOWICH: On the sheet marked "Sheet 1 of 3, Safety Factors Calculations."

That was a bit of a--oh, that sheet that you have is the tail end of a sheet before it, that got mixed up in Xeroxing. What runs off the right of the page matches up there.

Q And the safety factor on that page 1 of 3, 1.16643, is that correct? Page 1 of 3?

A No. This page 1 of 3, handwritten, that I have.

Q One moment.

WITNESS WOYTCWICH: Maybe I could arrange this for you, right here. (Indicating)

Q Thanks.

WITNESS WOYTCWICH: Okay.

Q The second line of that, "Safety Factors," underlined, with a dash, "desired minimum equal 1.34"?

WITNESS WOYTCWICH: Right.

Q Okay.

WITNESS WOYTCWICH: I have discussed the first few lines of that. Now we are looking at the next heading down, "Combined S.F. Goodman Method."

Based on the ultimate tensile strength of the forgings and on the steady and alternating loads, we calculated combined safety factors, once by the Goodman method, which uses reciprocal addition of the steady and alternating safety factors, once by the eliptical theory for combined loadings, which uses the squares of each of those safety factors.

Different authorities prefer different ones, so we ran it both ways.

The numbers are all there. As you can see, with the submitted fatigue limit established by strain-gauge testing and no shot peening, the safety factors are marginal, but when we included the 20 percent credit for shot peening, they went well over the desired minimum.

I might also add here that in this case, those numbers were determined at the 110 percent load rating. We didn't go back and recalculate when we decided not to address that question in our letter, because we felt since it was acceptable, for the most part, under these circumstances, that we would not go back and recalculate it, for the maximum continuous rating.

We also compared the values we found against the values submitted by TDI. That is the next sheet back.

We marked it on there, a copy of their Goodman diagram. We agreed quite closely, as you can see, especially considering the fact that we were including somewhat higher loads than TDI had included.

Q Were all of these calculations based on

1700 psi as being the maximum firing pressure?

WITNESS WOYTCWICH: Let me go back and make sure.

Q Take your time.

WITNESS WOYTCWICH: We need a calculator to be sure, because the maximum firing pressure is expressed in different units.

Q Maybe we will get back to the desired minimum that you referred to, on that page, safety factors-desired minimum equal 1.34.

How is the desired minimum derived?

WITNESS WOYTCWICH: That was the lowest value for which we had previously approved an engine of a different manufacturer, according to the same method.

Q How as that value derived?

WITNESS WOYTCWICH: From consideration of that other manufacturer's supporting data.

Q What kind of calculations were involved in reaching that figure?

WITNESS WOYTCWICH: Essentially the same ones that you see here, just repeated for the other engine and compared against submitted results and again

compared against the manufacturer's stated service experiences with those engines.

Q For the Goodman method calculations--

WITNESS WOYTCWICH: Yes.

Q --does this document indicate that, for the CIMAC theoretical fatigue limit and for the fatigue limit without shot peening, that the values calculated do not meet the desired minimum?

WITNESS WOYTCWICH: They do.

Q For purposes of clarification, sir, is it your testimony that those values do not meet the desired minimum value? That is, 1.34?

WITNESS WOYTCWICH: That is correct.

Q You answered the question properly, but it is just that it raised some doubts.

WITNESS WOYTCWICH: Okay.

Q Back to my original question, sir, which was, does the fact that the vibratory stresses exceeded ABS allowable limits have any effect on the design equations, other than--the design equations that you referred to concerning crankshaft--

WITNESS WOYTCWICH: Rather than going

back to the formula in the book, we went to the fatigue method I described. This is in--this is used in lieu of the equations in the rule book, though.

WITNESS BLANDING: No, it doesn't have any effect on the equations. That is an additional consideration for a complete system. The equations in the book for the crankshaft are based on the engine itself.

When you add something to the engine, like a generator, or these rules are directed more towards the main propulsion system, possibly with reduction gears and so on, so it doesn't change the basic equation referred, but it gives you another dimension.

That is what this refers to.

With a slow-speed diesel engine, you will probably exceed allowable vibratory stresses, where it--in that case, it mentions a range.

Most of the engines we are dealing with in this section on main propulsion engines, which don't have a constant speed, necessarily.

Q So you didn't perform any calculations

under the formulas for size of the crankshaft webs, with regard to this particular submission by TDI?

WITNESS WOYTCWICH: That is what these fatigue analyses are.

Q You didn't use the formulas in the rule book?

WITNESS WOYTCWICH: No.

WITNESS GIUFFRA: They had been used when we did the original approval on the engine.

Q Referring to Exhibit No. 3, sir, or rather Exhibit No. 5, the second page thereof, which, the top of which is form No. M-341NBO--

WITNESS WOYTCWICH: Yes.

Q --dated April 3, 1984.

WITNESS WOYTCWICH: All right.

Q What does this page involve?

WITNESS WOYTCWICH: That is the calculator program which we have in-house, to perform the calculation of 34.17.1 of the rules.

Q WT squared must be greater than or equal to--

WITNESS WOYTCWICH: No, this is the

crankshaft diameter formula.

Q What is that?

WITNESS WOYTCWICH: The formula. I can't repeat it.

Oh, here, d = c cube root of--that formula.

The web calculation is not shown here, but the surveyor did make a note, "web okay," from DiDonato, so that I have to assume that he did perform that calculation very quickly on his hand calculator and didn't write down all of the numbers.

He did make a check.

Q What is the maximum firing pressure indicated?

WITNESS WOYTCWICH: Clearly shown to be 1700 psi.

Q That factor does have an effect on the adequacy or non-adequacy of the pins and journals?

WITNESS WOYTCWICH: According to this formula, yes, it does.

I might also point out that in this particular calculation, the ultimate strength was the

design minimum specified on the drawing reviewed, 83,COO psi.

Whereas the engines discussed in the TDI submittal of torsional stresses were stated to have an ultimate strength considerably higher than that.

Q In that formula, there is a reference to an I value, span between the bearings?

WITNESS WOYTCWICH: Yes.

Q How is that figure derived, if you know?

WITNESS WOYTCWICH: Normally, it would be taken between the ends of the web--sorry, between the ends of the main bearings, not from center line to center line of the main bearing, but from inner edge to inner edge.

In this case, I would not be able to guarantee without going back and looking at the drawings, which of those two values was used.

Either is acceptable. We sometimes try to be a little conservative in our approach and use center line to center line, even though in the rule section it is quoted as being from bearing edge to bearing edge.

Q Referring you to 34.17.4, relating to solid crankshaft webs.

WITNESS WOYTCWICH: All right.

Q Does ABS Only take the diagonal distance referred to in the last sentence of the rule, when there is an overlap of the pin and journal?

WITNESS WOYTCWICH: That would be our usual procedure.

Q do you ever make any allowance for the section formed by the diagonal drawing of the fillet radii?

WITNESS WOYTCWICH: I'm not sure how that differs.

Q In your mathematical analysis of crankshaft webs, would you treat the webs of the crankshaft with a deep re-entering fillet the same as a crankshaft with a normal fillet?

WITNESS WOYTCWICH: Under the formula given here, I honestly am not sure, because I haven't done detailed plan review of diesels, and--would you know, whether we usually take the actual metal dimensions or the nominal dimensions from web to web?

I think we take the actual metal dimensions.

WITNESS BLANDING: I'm not sure what the question is regarding re-entrant fillet.

WITNESS WOYTCWICH: An undercut into the web?

I think we would measure from metal to metal rather than from arbitrary line to arbitrary line.

Q In that same rule, what is meant by the term, the effect of resisting moment of the web in bending? Can you define that term for us or that phrase?

WITNESS WOYTCWICH: The section modulus. Quotient of moment of inertia of the section divided by the distance from the neutral axis to the outer fiber.

MR. STROUPE: Makes perfectly good sense.

Q If you take into account the actual measurement of the re-entering fillet in determining the effect of moment of resistance--

WITNESS WOYTCWICH: I believe that our normal practice would be to measure that dimension from

the boundary of the actual crankshaft material, at one fillet to that at its opposite fillet, rather than constructing the arbitrary lines of a face of the web and going between them.

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

Q Is the maximum firing pressure value a factor which affects the adequacy of the crank webs under the ABS rules?

WITNESS WOYTOWICH: Yes. Because it affects the rule required diameter, and the rule for the crank webs proportions the webs according to the crank pin value.

Q In paragraph 34.17.2, which related to maximum firing pressure and BHP, it states the surveyor is to verify the maximum firing pressure, P, and full brake horsepower during a trial of the engine.

Was this done in this case for the TDI submission?

WITNESS GIUFFRA: No, it wasn't, as far as we are aware.

Q Is it required to be done?