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RELATED CORRESPONDENCE

Suffolk County, September 5, 1984

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

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Before the Atomic Safety and Licensing Board

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

SUFFOLK COUNTY'S OPPOSITION TO LILCO'S SUPPLEMENTAL MOTION TO STRIKE PORTIONS OF THE JOINT DIRECT TESTIMONY OF DR. ROBERT N. ANDERSON, ET AL.

Suffolk County opposes LILCO's August 29 supplemental motion to strike portions of the joint direct testimony filed by the County on July 31. LILCO's supplemental motion to strike should be denied in its entirety for two reasons. First, the motion is untimely. Second, the motion is based upon a fundamental misconception of the requisite expertise needed to offer the expert opinions in issue.

I. LILCO's supplemental motion to strike portions of the County's testimony should be denied as untimely. LILCO did not

*add. J. Horn  
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file its supplemental motion to strike until August 29, twelve days after it received the County's August 17 Identification of Witnesses Offering Specific Elements of Testimony Regarding the County's Emergency Diesel Generator Contentions. This is far in excess of the seven-day time period for filing motions to strike as established by the Board's July 17 order. Furthermore, LILCO has offered no explanation whatsoever for its failure to comply with the schedule established by the Board. As LILCO's supplemental motion to strike portions of the County's joint direct testimony is untimely, this Board should deny the motion in its entirety.

II. LILCO's supplemental motion is premised on the notion that the County's expert witnesses lack the qualifications needed to proffer the testimony in issue and most of LILCO's objections pertain to the County's testimony commenting upon weaknesses or errors in FaAA's finite element and fracture mechanics analyses. LILCO's objections to that testimony reduces to the notion that the County's experts do not have the expertise to perform such analyses themselves; hence, they allegedly should not be permitted to comment on the analyses by FaAA.

LILCO's position may sound plausible but it misconceives the law governing experts' qualifications. Thus, in Holmgren

v. Massey-Ferguson, Inc., 516 F.2d 856 (1975), the Eighth Circuit reversed a trial court's decision excluding expert testimony because the trial court apparently believed, like LILCO, that an expert cannot give his opinion about a process or result unless the expert can perform the process or reach the result himself. Holmgren was a product liability suit premised upon defective design of a corn picker. The court below had excluded the expert testimony of a professor of mechanical engineering, which was proffered by the plaintiff to establish that the design of the corn picker was defective, because the professor was not a design engineer familiar with design practices in the farm machinery industry. Notwithstanding the discretion of a trial court on such questions, the Court of Appeals reversed on the following reasoning (Id. at 858):

Acceptance of an expert's qualifications cannot depend on his precise skill or background in a particular profession or industry. If the subject matter (safe design) falls within a person's experience in or overall knowledge of a specialized skill (engineering), this is sufficient to qualify the witness as an expert. We deem it too strict a standard that one must have manufactured or previously designed machinery to understand principles of safe design.... General technology within scientific disciplines is not shared by so few.

See also Gardner v. General Motors Corp., 507 F.2d 525, 528

(10th Cir. 1974); Smith v. Uniroyal, Inc., 420 F.2d 438, 442 (7th Cir. 1970).

Case law aside, LILCO's position here is indefensible based upon plain logic. The testimony objected to does not require a working knowledge of how to undertake a finite element or fracture mechanics analysis. Instead it concerns the accuracy and completeness of the factual predicates used by FaAA in the analyses. By reason of their educational training and experience, the County's experts understand the principles underlying FaAA's analyses, and the uses and limitations of such analyses. Moreover, they possess the scientific expertise to recognize when FaAA's analyses proceed on inaccurate factual predicates or fail to consider facts which are relevant to the issues, together with the expertise to understand how and why inaccurate or incomplete factual predicates destroy the validity of FaAA's analysis. That is all that is necessary to qualify their testimony in the circumstances attacked by LILCO.

At best, all of LILCO's arguments go to the weight to be given to the evidence. Clearly, the County's testimony on the accuracy of the assumptions and data used in FaAA's analyses is relevant and is based upon the witnesses' knowledge, skill, experience, training or education. Furthermore, this testimony

will assist the Board in understanding the evidence and in determining the facts in issue.

Each of LILCO's objections is discussed specifically below. The County submits that, with one minor exception, those objections are invalid and the supplemental motion to strike should be denied.

A. AE PISTON SKIRTS

(1) Page 28, first question and answer, sponsored by all witnesses.

In this testimony, the County's witnesses dispute FaAA's claim that the 28% disparity between FaAA's finite element analysis and its experimental results is "quite good." As the testimony shows, that disparity is the difference between two opposite conclusions -- cracking or structural integrity -- which are critical to the results of FaAA's study. Contrary to LILCO's claims (Supp. Motion at 2-3), it is not necessary for an expert witness to possess a knowledge of the intricacies of finite element modeling to come to the conclusion that two separate analyses that predict totally conflicting outcomes are not in good agreement. All of the County's expert witnesses are sufficiently familiar with the uses and limitations of

finite element analysis, experimental tests, and the process of scientific research to come to this conclusion.<sup>1/</sup>

(2) Pages 28-29, second question and answer sponsored by Anderson and sentences on page 29 by all witnesses.

LILCO mischaracterizes the thrust of this testimony and thus its arguments as to lack of expertise are without merit. Contrary to LILCO's claim (Supp. Motion at 5), Dr. Anderson does not "opine as to the percentage of accuracy or inaccuracy of the finite element results." Rather, Dr. Anderson testifies that the experiments performed by F&AA were inadequate because the experimental results should, but do not, confirm the finite element analysis. This opinion is based on Dr. Anderson's education and experience with using the results of experiments and finite element analyses in scientific problem-solving and in evaluating the structural integrity of objects. As such, Dr.

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<sup>1/</sup> LILCO's examination of the County's experts in discovery does not establish that they lack the qualifications to understand and apply finite element and fracture mechanics analyses, as distinct from performing such analyses themselves. The witnesses do in fact have sufficient training and experience to understand and use such analyses in scientific problem-solving and their qualifications to do so can be tested on voir dire if LILCO seriously believes they can be challenged. In any event, the record as it exists to date does not establish that they lack those qualifications and that is the issue here; not, as LILCO argues, whether they can perform the analyses themselves.

Anderson's testimony is not objectionable and should not be stricken.

LILCO also objects to the final sentence of this answer which states the witnesses' conclusion that greater weight should be given to the results of the finite element analysis than to the results of the experiments. As noted above, each of the County's expert witnesses, as materials or mechanical engineers, is knowledgeable by virtue of his education and experience with the uses and limitations of the investigative techniques of finite element and experimental analyses in problem-solving. Where, as here, the results of the experiments are suspect, the witnesses are competent and qualified in their professional judgment to place greater weight on the results of the finite element analysis.

(3) Pages 31-32, first full question and last sentence of the answer, sponsored by Anderson, Christensen, Eley and Bakshi.

Contrary to LILCO's claims (Supp. Motion at 6-7), it is not necessary that an expert witness be capable of performing a finite element analysis in order to testify that assumptions made in performing that analysis are incorrect and affect the accuracy of the results. In this testimony, the County's experts demonstrate, on the basis of their experience and their

review of the records of actual peak firing pressures in the EDGs, that the peak firing pressure assumed by FaAA in its finite element analysis of AE piston skirt crack initiation is too low. Because, as FaAA itself admits, "the most influential factor [concerning crack initiation]... is the peak firing pressure," (LILCO Piston Testimony at 10), it necessarily and logically follows that FaAA's analysis, which underestimates the peak firing pressure, will also underestimate the likelihood of crack initiation in the AE piston skirt. Thus, the County's witnesses need not be capable of reiterating the finite element results using a higher peak firing pressure to conclude that higher pressures will increase the likelihood of piston skirt cracking.

(4) Page 34, last sentence of the answer carried over from page 33, sponsored by all witnesses.

This testimony again concerns the impact of higher peak firing pressures on FaAA's conclusions regarding crack initiation. As LILCO's claims with respect to this testimony are identical to those shown to be without merit for the reasons discussed in (3) above, they are similarly without merit here.



(5) Pages 34-35, first full question and answer, sponsored by Anderson.

This testimony by Dr. Anderson again shows that FaAA's crack growth analysis is based upon a number of incorrect assumptions. As previously stated, Dr. Anderson is sufficiently familiar with the fields of finite element analysis and fracture mechanics analysis, and knows the uses of and limitations inherent in those analyses, to provide this testimony on the accuracy of the data on which those analyses are based.

(6) Page 36, last sentence and paragraph (1) of the answer carried over from page 35, sponsored by Anderson.

In this testimony, Dr. Anderson testifies as to the inaccuracy of FaAA's assumption of complete adherence to TDI drawing dimensions of the AE piston skirt and crown. Again, Dr. Anderson is sufficiently familiar with the use of finite element analysis and its inherent limitations to testify that incorrect assumptions made in the FaAA's analyses will affect the accuracy of the results.

(7) Page 39, first full question and answer, sponsored by Anderson.

In this testimony, Dr. Anderson testifies as to the limitations in FaAA's analysis based upon its failure to perform sensitivity analyses and to take into consideration actual properties of the AE piston skirts. As that testimony shows, such analyses would give a far better prediction of actual crack propagation than the idealized analysis performed by FaAA. Again, Dr. Anderson possesses the requisite knowledge, skill, training, education and experience with finite element analysis to comment on the inherent limitations in that analysis and the inaccuracies of that analysis when it fails to take into account relevant factors.

(8) Page 40, first full question and answer, sponsored by Anderson.

LILCO objects to the first and fifth sentences of this testimony for the same reasons as stated in (7) above. In this testimony, Dr. Anderson states that, in order to provide adequate confidence that the AE piston skirts are adequate for operation at Shoreham, the design deficiencies of the skirts should be considered, and an adequate crack initiation analysis should be performed using actual peak firing pressures and

properties of the AE skirts. Once again, Dr. Anderson's familiarity with the field of finite element analyses and his knowledge of the inherent limitations in its analysis are more than sufficient to permit him to offer expert opinion on the adequacy of the analysis performed by FaAA and the conclusions drawn therefrom.

(9) Page 47, first full question and answer, sponsored by all witnesses.

This testimony merely summarizes the previously stated conclusions of the County's expert witnesses on the probability of AE piston skirt cracking. For all the reasons previously set forth, the County's witnesses possess the necessary knowledge, skill, experience, training and education to express expert opinions on these matters, and LILCO's claims are without merit.

B. REPLACEMENT CYLINDER HEADS

(1) Page 62, paragraphs (a), (d) and (f), portions sponsored by Hubbard.

LILCO's objection to Mr. Hubbard's sponsoring of this testimony is without merit. Mr. Hubbard's sponsorship of this testimony is not premised upon any particular expertise in the

field of fracture mechanics or metallurgy but, instead, it is premised upon his broad engineering expertise and his concentrated experience in quality assurance, including engineering analyses of designs and failures.

(2) Page 68, sentence beginning "Fourth" in answer and continuing from page 67, portions sponsored by Hubbard.

Contrary to LILCO's claim (Supp. Motion at 9-10), this testimony requires no familiarity with the principles of fracture mechanics as it merely is introductory material describing how the County's cylinder head testimony is organized and, as such, requires no particular expertise.

(3) Page 74, answer to final question on page 73, portions sponsored by Hubbard.

In this testimony the County asserts that FaAA did not adequately review the design of the replacement cylinder heads because it did not address all of the functional attributes of the cylinder head as set forth in the Task Description for the cylinder head design review. LILCO's claim (Supp. Motion at 10) that the portions of this testimony sponsored by Mr. Hubbard should be stricken because he allegedly lacks expertise in the principles of fracture mechanics analysis is irrelevant.

Expertise in fracture mechanics analysis has nothing to do with evaluating the overall adequacy and comprehensiveness of the design review performed by FaAA. Mr. Hubbard's experience in quality assurance and engineering problem-solving provides ample qualifications for his sponsorship of this testimony.

(4) Page 78, first and second questions and answers, sponsored by Anderson.

In this testimony Dr. Anderson discusses the shortcomings in TDI's failure analyses of the cracked cylinder heads and casting defects which can result in such cracking. As his qualifications and deposition testimony demonstrate, Dr. Anderson has vast experience in metallurgy and failure analyses which more than adequately qualifies him to offer such testimony. Without even attempting to support its assertion with any facts or analysis, LILCO baldly asserts that this testimony requires expertise in foundry practices for large steel castings. LILCO offers no support for its position and dismisses without explanation Dr. Anderson's experience in performing consulting work for foundries dealing with small castings. More importantly, Dr. Anderson is a highly qualified metallurgist with extensive experience in failure analysis of metal products, including castings. LILCO's objection is tantamount to

asserting that Dr. Anderson is not competent to undertake or comment upon a failure analysis unless he is competent to manufacture the article which failed. As discussed above, that is simply not a proper test of an expert's qualifications. Dr. Anderson's education and experience adequately qualify him to offer this testimony, and LILCO's unsupported objections are without merit.

(5) Page 80, answer to second question, portions sponsored by Anderson, Hubbard.

Again, LILCO's objection to this testimony is invalid. The testimony clearly sets forth the facts that TDI has made numerous changes to its casting and foundry procedures, that many of these changes were not related to specific problems and often were made in response to production costs, and that the original and replacement cylinder head casting processes cannot be accurately compared because TDI had no detailed foundry procedure practices when the original heads at Shoreham were produced. As discussed above, Dr. Anderson is a highly qualified metallurgist with extensive experience in failure analysis of metal products and Mr. Hubbard is highly experienced in quality assurance and engineering problem-solving. Both are qualified to testify that an assessment of the total effects of

the process changes made by TDI is not possible due to the ad hoc nature of those changes.

(6) Pages 82-83, second question and answer, sponsored by Anderson.

Dr. Anderson's testimony concerns the significance of the various alleged casting improvements made by TDI and the relationship of those changes to the metallurgy of the cylinder heads. Dr. Anderson, by virtue of his education, training and experience as a metallurgist and as a consultant to foundries, is sufficiently familiar with casting methods to determine their effect on the metallurgical integrity of the heads.

C. CRANKSHAFT SHOTPEENING

(1) Page 133, second question and answer, portions sponsored by Christensen.

This testimony sets forth the general purpose of shotpeening the crank pin fillet area of crankshafts, an area which Professor Christensen indicates is generally the most critical for fatigue initiation. Contrary to LILCO's claims (Supp. Motion at 11), Professor Christensen's qualifications (Attachment 2 to the County's Testimony) indicate that he is adequately knowledgeable, as a result of his education,

experience and training in the areas of fatigue and stress analysis, to conclude that the fillet area is the most critical area for fatigue initiation. Professor Christensen's knowledge concerning the stresses operating on crankshafts is derived from his vast experience in the marine diesel engine field, including his examinations and stress analyses of failed crankshafts as a marine diesel engine surveyor. Furthermore, the courses taught by Professor Christensen at the U.S. Merchant Marine Academy encompass stress analyses of crankshafts, as does his book, Lamb's Questions and Answers on the Marine Diesel Engine. Professor Christensen also has studied numerous technical articles and attended numerous technical seminars on this subject. As for his testimony on the general purposes of shotpeening, Professor Christensen's knowledge is derived from his comprehensive experience and knowledge concerning design and manufacture of crankshafts as well as from reading various publications and textbooks, and attending technical seminars, on the subject of shotpeening. Accordingly, Professor Christensen is more than adequately qualified to testify to the matters in question.



(2) Page 134, first question and answer, second sentence, portions sponsored by Christensen.

As indicated in C(1) above, Professor Christensen's knowledge concerning shotpeening is derived from various courses he attended and technical publications he has read in the area. His testimony that the effectiveness of shotpeening is reduced when subject to appreciable heat is a principle basic to shotpeening. Professor Christensen's background adequately qualifies him to offer this testimony.

(3) Page 135, both questions and answers, portions sponsored by Christensen.

Again, Professor Christensen is qualified by knowledge, education and experience to testify as to the presence and effects of stress concentrations in fillet areas of crankshafts. Indeed, portions of Professor Christensen's book, Lamb's Questions and Answers on the Marine Diesel Engine, discuss these subjects in detail. Contrary to LILCO's claims (Supp. Motion at 12), Professor Christensen's testimony concerning shotpeening here concerns basic principles and does not require a detailed knowledge of metallurgy. His knowledge of the basic effects on the surface and subsurface effects of shotpeening is derived from his education and reading about

shotpeening together with his experience with the various processes used in the industry to increase the fatigue endurance limit of crankshafts and the effects caused by those processes. Professor Christensen's testimony relates to general principles and is not objectionable for lack of expertise.

(4) Page 138, first question and answer, first sentence, portions sponsored by Christensen, Eley and Bakshi.

In this testimony, Professor Christensen and Messrs. Eley and Bakshi testify that the lower third of the re-entrant fillet of the crankshaft pin generally is the most critical area with respect to crankshaft failure. This testimony is based on the witnesses' extensive knowledge of the stresses operating on a crankshaft derived from years of experience, training and education in this area as marine diesel engineers. Each of these diesel engine experts is intimately familiar with the stresses to which crankshafts are subjected as well as the areas of the crankshaft most susceptible to fatigue and why. Each possesses the necessary expertise to testify on this subject.

(5) Pages 138-139, second question and answer, beginning of second sentence, portions sponsored by Christensen and Bakshi.

This testimony relates to the witnesses' observations of photographs of the original shotpeening and the possible consequences of the deficiencies observed. LILCO raises no objection to the witnesses' observations from the photographs but objects to the opinions expressed therein as to the effects of the deficiencies in the shotpeening. As previously indicated, both Professor Christensen and Mr. Bakshi possess the requisite knowledge of the stresses to which crankshafts are subjected, and Professor Christensen is sufficiently knowledgeable about shotpeening and its effect on the surface and subsurface areas of the crankshaft to testify as to these matters. The County concedes that Mr. Bakshi lacks extensive expertise in shotpeening and agrees to strike his sponsorship of the testimony concerning the effects of defective shotpeening.

(6) Page 140, first and second question and answer, portions sponsored by Christensen.

This testimony merely restates and summarizes the conclusions discussed in the testimony preceding it and, for the reasons stated in C(4) and (5) above is not objectionable.

(7) Page 142, second question and answer, portions sponsored by Christensen.

Similarly, this testimony also restates and summarizes the testimony preceding it and, for the reasons discussed in C(4)-(6) above, is not objectionable.

D. CYLINDER BLOCKS

(1) Page 162, first question and answer, sponsored by Anderson, Christensen; all but last two sentences, Eley, Bakshi.

This testimony demonstrates how FaAA's analysis assumes "facts" which have no foundation in reality so that the analysis itself is suspect. Once again, LILCO incorrectly asserts that the County's witnesses must be capable of performing a finite element analysis in order to comment on the inaccuracy of the assumptions made by FaAA in performing that analysis. Here, the witnesses do not discuss the method of FaAA's finite element analysis as such but only the accuracy of certain technical assumptions used by FaAA in the analyses. The testimony merely lists the assumptions and shows that they are incorrect on the basis of reality. No expertise in modeling a finite element analysis is needed to demonstrate that the factual

predicates used in that analysis are wrong. The witnesses in question do possess the engineering and scientific expertise needed to understand the technical "facts" used in the analysis and how inaccuracies in those "facts" would impair the validity of the analysis.

(2) Page 163, first question and answer, sponsored by Anderson, Christensen, Eley, Bakshi.

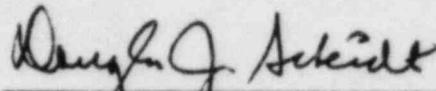
Again, LILCO erroneously states that the County's witnesses must be capable of re-modeling an entire computer program to perform a finite element analysis in order to testify as to certain variables not properly considered by FaAA. For the same reasons stated in connection with D(1) above, the County's witnesses are qualified to testify as to the significance of these variables and their testimony is not objectionable.

### III. CONCLUSION

For the reasons set forth above, LILCO's Supplemental Motion to Strike should be denied except for the limited testimony of Mr. Bakshi as agreed in C(5) above.

Respectfully submitted,

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September 5, 1984

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

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Docket No. 50-322 O.L.

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CERTIFICATE OF SERVICE

I hereby certify that copies of SUFFOLK COUNTY'S OPPOSITION TO LILCO'S SUPPLEMENTAL MOTION TO STRIKE PORTIONS OF THE JOINT DIRECT TESTIMONY OF DR. ROBERT N. ANDERSON, ET AL., dated September 5, 1984, have been sent to the following this 5th day of September, 1984 by U.S. mail, by hand when indicated by one asterisk, and by Federal Express when indicated by two asterisks.

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