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Board Panel
U.S. Nuclear Regulatory Commission
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Dr. Peter A. Morris
Administrative Judge
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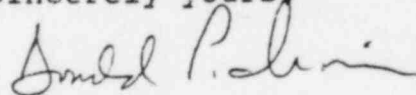
Dr. James H. Carpenter
Administrative Judge
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Long Island Lighting Company (Shoreham): Docket No. 50-322(OL)
Materials Cracking (SC-24)

Gentlemen:

The attached response, in which experts for LILCO, Suffolk County and the NRC Staff have concurred, attempts to respond to Dr. Morris' question, as clarified on December 22, 1982, concerning the derivation of Stress Rule Index error bands in the Resolution Agreement on Materials Cracking (SC-24). That Agreement is presently pending before the Board.

Sincerely yours,



Donald P. Irwin

91/867

Enclosure: "SRI Error Band Derivation"
cc w/enclosure: Attached Service List

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SRI ERROR BAND DERIVATION

Statements on December 22, 1982 by Dr. Morris (Tr. 17511-13, 17,516) and Dr. Carpenter (Tr. 17,513-14) evinced their dissatisfaction with the written answer presented by the parties to Dr. Morris' question with respect to how error bands involved in Stress Rule Index calculations under the Resolution Agreement on SC Contention 24 (Cracking of Materials) would be derived. That answer had been set out in a December 17, 1982 letter from Donald P. Irwin to the members of the Board. Dr. Morris stated his concern that the verbal formula used "could be terribly restrictive or it could have no meaning whatsoever" (Tr. 17,512) and that with a new method such as the SRI, the Board felt that it needed to understand better how it would be implemented (Tr. 17,516). Dr. Morris' observation was echoed by Dr. Carpenter (Tr. 17,513-14). Dr. Morris' original question had been stimulated by a statement in the Resolution Agreement, at 9:

The SRI acceptance criteria will require that the welds' SRI must be less than 1.0 assuming the most conservative use of the error bands.

The parties misinterpreted the original question by Dr. Morris and responded primarily with respect to the application of error bands.

The parties undertake this further answer to Dr. Morris' question as it relates to derivation of error bands in the SRI calculation:

1. The exact calculational method for development of error bands has not yet been determined. However, the parties do believe that the process is manageable and that the uncertainties are not such as to make the calculations meaningless. The basis for this belief is set forth below.
2. The general methodology for GE SRI calculation has been widely applied and is well understood. In 1978, for example, SRI's were calculated for a significant number of welds (approximately 60) in the recirculating water system at Shoreham.
3. The SRI is just one of a number of criteria applied in determining which of the 120 welds in the Shoreham recirculating water system to include in the program set out in the Resolution Agreement. In all likelihood, this criterion will be critical to the clarification of no more than about 10 of those welds. The reason is as follows: All but 22 of the 120 recirculating water system welds have received some form of post-weld treatment (24 have received Solution Heat Treatment and 74 have Induction Heat Stress Improvement), thus removing

them from consideration in the settlement program. Additional action for any of the 22 remaining welds requires that the weld in question meet additional criteria, namely: diameter greater than 4", inspectability less than 90%, and SRI equal to or greater than 1.0. LILCO has already determined that the number of welds remaining potentially eligible for further evaluation after application of the size and inspectability tests is approximately 10.

4. SRI calculations are performed for individual welds by GE. The calculation typically involves about 8 primary terms (see Attachment 1). The values for each term are unique to each calculation and cannot be ascertained in advance in the abstract, but can be determined on the facts of each weld whose SRI is being calculated. It is proposed to determine, upon examination of each weld, the range of uncertainty associated with each of its terms, and to carry the most unfavorable value within that range through the calculation. Although the parties are not aware of any previous derivations of error bands surrounding SRI calculations, they do not believe this calculation to be subject to unacceptable levels of uncertainty. Of the terms set out in the calculation on Attachment 1, for instance, the factor (Residual) is believed subject to some uncertainty. The range of variation for the other defined factors in the equation either is a function of the specific facts of the weld or can be determined by reference to equations in the ASME Code. In either case, it is believed to be relatively small.

Thus, the uncertainties associated with any given SRI calculation cannot be specified in advance. However, it is believed by the parties, on the basis of experience with these calculations, that the proposed use of these uncertainties will not affect the validity of the SRI calculations to be performed. Finally, even if the SRI calculations, as performed, obligated LILCO to take remedial steps as to every weld for which the SRI was critical to the screening process, the number of welds potentially affected is a small set. LILCO has recognized from the outset that use of the error band could introduce some additional conservatism into the SRI calculation, but felt (and feels) that this potential conservatism would not unacceptably affect the implementation of the Resolution Agreement.

6.5 GENERAL ELECTRIC DESIGN STRESS RULE

General Electric has established a criterion that identifies those stresses significant to IGSCC and establishes appropriate procedures for calculating these stresses. It would also place limits on the stresses so that IGSCC would not occur. (a) Table 6.3 describes the Design Stress Rule.

TABLE 6.3. General Electric Design Stress Rule
(Source: 6.1)

Premise: Stress corrosion can be avoided if stresses are maintained below 0.2% offset yield stress.

Rule:
$$\frac{P_M + P_B}{S_y} + \frac{Q + F + (\text{Residual})}{S_y + 0.002 E} < 1$$

Definitions: $P_M + P_B$ = Primary membrane and bending stresses

S_y = ASME code 0.2% yield stress at applicable temperature

Q = Secondary stress (includes thermal)

F = Peak stress

E = ASME code elastic modulus at applicable temperature

(Residual) = Sum of all sources of residual stress (including weld residual stress and stress resulting from compressive transients)

The Design Stress Rule might be used for in-service inspection of welds that, from a stress standpoint, would be susceptible to IGSCC. It might also be used to assess the potential benefit for methods of reducing stresses at welds; e.g., the heat-sink welding technique to reduce or eliminate tensile residual welding stresses on the inside surface near the weld.

Available information on field experience and laboratory data does not provide convincing evidence that satisfying the Design Stress Rule will necessarily assure that IGSCC will not occur. Further, Sherwood (6.1) points out that even for locations with the maximum incidents of cracking (Design Stress Rule Index between 1.8 and 1.9), only 15% of the welds have exhibited IGSCC. Accordingly, even if the Design Stress Rule is not satisfied, IGSCC will not necessarily occur. However, even if only qualitative in nature, the Design Stress Rule concept determines the piping or safe-end locations that could have a high potential for IGSCC.

6.6 CONCLUSIONS

1. Piping systems in BWRs are complex structures containing many welds. From a stress analysis standpoint, each weld is itself a complex structure. Piping design codes provide upper limits to calculated operation stresses but, because those stress bounds exceed the material yield strength, the code stress limits are not appropriate

(a) Watanabe (6.6) gives more detailed information on how the Design Stress Rule is being implemented by General Electric.

LILCO, January 17, 1983

CERTIFICATE OF SERVICE

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

I hereby certify that copies of the attached letter from Donald F. Irwin to the members of the Atomic Safety and Licensing Board dated January 17, 1983 and entitled "Materials Cracking (SC-24)" were served this date upon the following by first-class mail, postage prepaid.

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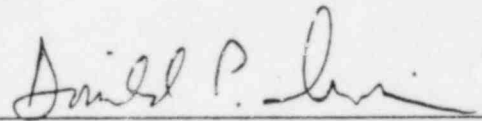
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DATED: January 17, 1982