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AUG 19 1981

Docket No. 50-261

Mr. J. A. Jones
Senior Executive Vice President
Carolina Power and Light Company
336 Fayetteville Street
Raleigh, North Carolina 27602

Dear Mr. Jones:

By letter dated February 25, 1980 we informed all licensee/users of Westinghouse low-pressure turbines that stress corrosion cracks were being found in the keyway and bore areas of low-pressure discs. Because these cracks were considered to increase the probability of disc failure we requested that you perform ultrasonic inspections on your low-pressure discs and justify that your plant could continue to operate safely.

All Westinghouse low-pressure turbines at operating nuclear power plants have now been inspected, at least once, for keyway and bore cracks. Indication of one or both types of these cracks has been found at 20 plants. Although all factors related to cracking have not been positively established, operating experience indicates that crack initiation and growth are related to disc temperature and material characteristics. Westinghouse is continuing to evaluate the effect of other manufacturing and operational variables.

Until a satisfactory solution can be found we believe that it would be prudent for you to continue inspecting your low-pressure turbine discs on a schedule designed to minimize the probability that a crack will form and grow to a depth that would cause a disc to rupture. Westinghouse has developed a method to determine safe inspection and re-inspection frequencies and has submitted this information in Memorandum MSTG-1-P, June 1981 (Proprietary) for review by the NRC staff.

Our appraisal of the Westinghouse approach is presented in the enclosed Safety Evaluation. We conclude that inspection schedules based on the recommendations in the Westinghouse Memorandum will provide an acceptably high degree of assurance that discs will be inspected before cracks can grow to a size that could cause disc failure at speeds up to design speed. In our Safety Evaluation we list four criteria for an acceptable inspection schedule. I request that you commit to use these criteria for future disc inspections. We believe that such a commitment will reduce the probability for a safety problem to such a degree that the NRC staff would no longer need to monitor your turbine inspections except through the normal activities of our Office of Inspection and Enforcement. Your commitment would also eliminate the need for you to report these inspection results to the staff or to transmit the computerized disc data sheets that are prepared by Westinghouse.

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Your response to this request should be submitted within 30 days of receipt of this letter.

I also take this opportunity to advise you that on June 11, 1981 Westinghouse transmitted two proprietary reports related to turbine missiles for NRC staff review and evaluation. We have been advised by Westinghouse that the methodology described in these reports was used to provide its customers with estimates of the probability of disc rupture from stress corrosion cracking and with analyses of potential missile energies. We shall provide Westinghouse with our evaluation of this methodology as soon as our resources permit.

Sincerely,

Original signed by:
S. A. Varga

Steven A. Varga, Chief
Operating Reactors Branch #1
Division of Licensing

Enclosure:
Safety Evaluation

cc w/enclosure
See next page

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Mr. J. A. Jones
Carolina Power and Light Company

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SAFETY EVALUATION REPORT

Criteria For Low Pressure Nuclear
Turbine Disc Inspection

Westinghouse has prepared a proprietary report covering their investigation and analysis of turbine disc cracking. This report includes a statistical analysis of all turbine disc cracks found to date and recommends criteria for scheduling disc inspections that provide a very low probability of disc failure prior to inspection.

We have evaluated each of the criteria presented in the report and are in agreement with either the Westinghouse position or with one of the positions in those cases where they suggest alternatives. These criteria and our evaluation of each is described below.

There are several major criteria involved in setting inspection schedules. Basically, the approach used is to make a conservative prediction of how fast a presumed or actual crack will grow and then schedule an inspection prior to the time the crack grows large enough to be of concern. Analytic components of this approach are:

A. Crack Growth Rate

B. Critical Crack Size

C. Fraction of Critical Crack Size Allowed.

The Westinghouse criterion for establishing each of these factors and our evaluation is discussed below.

A. Crack Growth Rate

Westinghouse has performed statistical studies using the field data on crack sizes and shapes as related to temperature of operation, location (bore or keyway), material strength, and environment. They have selected a conservative

upper bound basis and developed equations that define a conservative crack growth rate for each disc. We have reviewed the Westinghouse methodology and find the growth-rate equations to be acceptable.

B. Critical Crack Size

Westinghouse has used the usual LEFM model to calculate critical crack size, taking into consideration effects of crack shapes expected in different locations (bore or keyway). The fracture toughness values used in the calculations are determined from actual charpy V tests on each disc, using the common Rolf-Novak correlation. Westinghouse also presented test results, obtained from both fracture mechanics specimens and a spin test, to show that this correlation yields over-conservatively low values of the toughness related to actual disc cracks because the cracks are irregular and branched. We therefore prefer the alternative proposed; i.e., to increase the estimate of fracture toughness derived from the Rolf-Novak expression by 20% to reflect the effect of the irregular nature of actual service-induced disc cracks. This 20% increase is still very conservative, as all of the test data show even larger increases.

C. Fraction of Critical Size Allowed

Westinghouse has proposed two methods for applying this factor. One involves a very conservative critical crack size calculation using the Rolf-Novak value of toughness, and then permitting operation until a crack grows to a predicted maximum of 75% of the critical size. An alternative approach is to use the more realistic (but still conservative) augmented toughness value (discussed in B above) that gives a larger and more realistic crack

size and then permitting operation until a crack grows to a predicted maximum of 50% of critical crack size. We prefer this latter approach. A growth limit of 50% of critical crack size has been the NRC criterion; consequently, an acceptable inspection schedule criteria is maintained as follows:

1) New discs should be inspected at the first refueling outage, or before any postulated crack would grow to more than 1/2 the critical depth.

2) Discs previously inspected and found to be free of cracks or that have been repaired to eliminate all indications should be reinspected using the same criterion as for new discs, calculating crack growth from the time of the last inspection.

3) Discs operating with known and measured cracks should be reinspected before 1/2 the time calculated for any crack to grow to 1/2 the critical crack depth.

4) These inspection schedules may be varied to coincide with scheduled outages. Westinghouse recommendations in this regard should be followed.

Summary and Conclusions

A. We agree that the Westinghouse crack growth rate equations for bore and keyway cracks are acceptable.

B. We agree with the alternative Westinghouse critical crack size calculational method, using a value of fracture toughness increase of 20% above the Rolf-Novak value.

C. We will retain a criterion of relating allowable running time before inspections to the time to reach 1/2 of the critical crack depth.

D. The NRC staff will no longer monitor each turbine inspection except through the normal activities of the Office of Inspection and Enforcement.