June 30, 2003

Mr. Fred A. Emerson
Nuclear Energy Institute
1776 I street, NW., Suite 400
Washington, DC 20006-3708

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR PROPOSED INTERIM STAFF GUIDANCE (ISG)-11: RECOMMENDATIONS FOR FATIGUE ENVIRONMENTAL EFFECTS IN A LICENSE RENEWAL APPLICATION

Dear Mr. Emerson:

On January 17, 2003, Nuclear Energy Institute (NEI) submitted "Recommendations for Fatigue Environmental Effects in a License Renewal Application" for the Nuclear Regulatory Commission (NRC) staff review (See ADAMS Accession No. ML030300144) as an interim staff guidance (ISG). The proposed ISG is based on Electric Power Research Institute (EPRI) technical report, "Materials Reliability Program: Re-Evaluation of Results in NUREG/CR-6674 for Carbon and Low-Alloy Steel Components (MRP-74)." We have completed the review of NEI's submittal and identified, in the enclosure, areas in the technical report for which additional information is needed to complete our review of the proposed ISG.

As discussed, we plan to clarify the enclosed requests for additional information (RAI) in a July 24th public meeting. Please provide your response to the enclosed RAI within thirty (30) days. If you have any questions concerning this proposed ISG, please contact Peter J. Kang, at (301) 415-2779.

Sincerely,

/***RA***/

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Project 690

Enclosure: As stated

cc w/encl: See next page

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Project No. 690

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REQUEST FOR ADDITIONAL INFORMATION
FOR PROPOSED INTERIM STAFF GUIDANCE (ISG)
FOR FATIGUE ENVIRONMENTAL EFFECTS

1. The proposed ISG is based on re-evaluation of the carbon and low alloy steel components originally evaluated by Pacific Northwest National Laboratory (PNNL) and presented in NUREG/CR-6674, "Fatigue Analysis of Components for 60-Year Plant Life." This re-evaluation is presented in EPRI Report, "Materials Reliability Program: Re-Evaluation of Results in NUREG/CR-6674 for Carbon and Low-Alloy Steel Components (MRP-74)." EPRI claims that more realistic assumptions were used in the re-evaluation of these components and the use of these more realistic assumptions results in probabilities of crack initiation and leakage that are significantly less than indicated in NUREG/CR-6674. The most significant change made to the original study was in the standard deviation assumed for the endurance limit strain in the PNNL study. EPRI proposed to replace the standard deviation used in the PNNL study with a much smaller standard deviation. EPRI cites a typical value of fatigue data scatter proposed by Wirsching (Probabilistic Structural Mechanics Handbook, edited by C. Sundararajan, Chapman & Hall, New York, NY 1995, Chapter 7) as the basis for the change. This reference is general in nature and not directly applicable to carbon and low alloy steels used in nuclear power plants. The standard deviation for the endurance limit strain used in the PNNL study is based on a statistical evaluation of test data relevant to carbon and low alloy steels described in NUREG/CR-6335, "Fatigue Strain-Life Behavior of Carbon and Low-Alloy Steels, Austenitic Stainless Steels, and Alloy 600 in LWR Environments and NUREG/CR-6717, "Environmental Effects on Fatigue Crack Initiation in Piping and Pressure Vessel Steels." Provide the following additional information regarding the EPRI endurance limit strain and its standard deviation:

   A. The revised probabilistic fatigue curves do not appear consistent with the data for carbon and low alloy steels. For example, compare probabilistic curves developed using the EPRI assumption for the standard deviation of the endurance limit with the data presented in Figure 14 of Attachment 1 of the submittal.

   B. The study does not appear to adjust the endurance limit strain to account for the differences between smooth specimen data and actual components. The ANL correlation used by PNNL was developed to account for this difference. Provide the basis for not adjusting the endurance limit to account for the difference between the specimen data and actual components.

   C. The EPRI report indicates that a strain threshold was used in the evaluation but does show how the threshold was applied. The EPRI Report, page 3-11, references NUREG/CR-6717 for the strain threshold values used for the evaluation. As discussed in NUREG/CR-6717, the thresholds are strain levels at which environmental effects are considered moderate. These thresholds were proposed for use in the development of fatigue design curves. NUREG/CR-6717 also indicates that the threshold strain is approximately 20% higher than the fatigue limit (endurance limit) of the steel. Therefore, the threshold strain should be related to the endurance limit. Additionally, the proposed 0.07% threshold strain for the carbon and low alloy steel design curves has not been universally

accepted at this time. For example, some fatigue researchers have proposed using the endurance limit strain of 0.042% as the threshold value. As a consequence, the use of a fixed threshold strain in the probabilistic study is questionable. Explain how the strain threshold values were used in the evaluations presented in Chapter 4 of the EPRI report. Provide the results of the EPRI evaluations without using strain threshold values.

D. The strain thresholds are discussed on page 26 of NUREG/CR-6717. NUREG/CR-6717 indicates that after mean stress effects are taken into account, a threshold strain amplitude of 0.07% provides a 90% confidence level for both carbon and low alloy steels. As discussed previously, the threshold strain is approximately 20% higher than the endurance limit of the steel. Consequently, the 10 percent probabilistic fatigue curve should approach a strain amplitude of approximately 0.06% at 10E6 cycles. The 10 percent probability curve shown in Figure 3-11 of the EPRI report is not consistent with a strain of 0.06%. Discuss this discrepancy between Figure 3-11 of the EPRI report and the data assessment contained in NUREG/CR-6717.

2. The EPRI report, page 3-3, indicates that the ANL adjustment of ln(4), used to account for the differences between laboratory specimens and actual components, was included in the study in accordance with the discussion in the PNNL study. Section 4.7 of the PNNL study indicates that the ln(4) value was adjusted to account for the potential for multiple crack initiation sites. The PNNL study further indicates that the adjustment was calibrated against the data from the 9 inch diameter vessel tests described in the ANL report. Describe how this adjustment was applied in the EPRI study.

3. The EPRI report, page 3-11, provides a procedure to account for mean stress effects. Show how this procedure was implemented in the evaluations presented in Chapter 4 of the report. Discuss the consistency of the mean stress adjustment used in the Chapter 4 evaluations with the mean stress adjustment discussed in NUREG/CR-6717.

4. Several of the component evaluations presented in Chapter 4 of the EPRI report use stresses and cycle counts that are different than those used in the PNNL study. The changes affect the calculated environmental fatigue usage factors for these components. Provide the environmental fatigue usage factors based on the revised component stress and cycle assumptions. Discuss the actions that would be required by a license renewal applicant to address components with these usage factors.

5. The submittal references the evaluation of the component fatigue tests contained in EPRI Report MRP-49. The evaluation of the component fatigue test data is similar to the evaluation contained in EPRI Technical Report, “Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application (MRP-47),” Draft Revision G dated June 5, 2001. This report was submitted to the NRC by NEI letter dated July 31, 2001. The staff transmitted a request for additional information regarding the evaluation of the component fatigue tests by letter dated June 26, 2002. The staff has not received a response to its request for additional information. Indicate how the relevant June 26, 2002, staff comments have been addressed in the test data evaluation contained in EPRI Report MRP-49.