NUCLEAR ENERGY INSTITUTE

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Rules and Directives Branch
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: Transmittal of Comments on draft Regulatory Guide DG-1144 and Revision 1 of MRP-47

PROJECT NUMBER: 690

We appreciate the opportunity to comment on the subject draft regulatory guide concerning guidelines for evaluating fatigue analyses. On behalf of the Materials Reliability Program (MRP), NEI submits the attached comments in response to the Federal Register request for comments.

This letter transmits comments on draft Regulatory Guide DG-1144:

- "Guidelines For Evaluating Fatigue Analyses Incorporating The Life Reduction Of Metal Components Due To The Effects Of The Light-Water Reactor Environment For New Reactors," July 2006

These comments are provided as an enclosed document. The MRP believes that other referenced documents in these comments have already been made available to the NRC.

Additionally, this letter transmits revision 1 of the subject Report to the Nuclear Regulatory Commission (NRC) on behalf of the Materials Reliability Program (MRP):

- Materials Reliability Program: Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application (MRP-47 Revision 1), 1012017, September 2005

This report is Copyright Only and since it has been introduced to the public domain before, no affidavit has been prepared or is necessary.

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MRP-47 Revision 1 describes a fatigue environmental effect license renewal approach that can be applied by any license renewal applicant. It provides guidelines for performing environmental fatigue assessments using fatigue environmental factors from currently accepted F_{en} methodology. Using the guidance provided herein, the amount of effort needed to justify individual license renewal submittals and respond to NRC questions should be minimized, and a more unified, consistent approach should be achieved throughout the industry. More importantly, this revision provides "details of execution" for applying the environmental fatigue approach currently accepted by the NRC in the license renewal application process.

Again, we appreciate the opportunity to comment. If you have any questions regarding this letter, please contact me at 202-739-8137; jhr@nei.org.

Please contact Shannon Chu (650-855-2987; schu@eprisolutions.com) if copies of any document referenced in these comments need to be transmitted to the NRC.

Sincerely,

James H. Riley

Enclosures

c: Mr. Les Spain, Dominion Generation
Ms. Christine King, EPRI
Mr. David Steininger, EPRI
Ms. Shannon Chu, EPRI
Document Control Desk, NRC

**Comments on
DRAFT REGULATORY GUIDE DG-1144,
"GUIDELINES FOR EVALUATING FATIGUE ANALYSES
INCORPORATING THE LIFE REDUCTION OF METAL COMPONENTS
DUE TO THE EFFECTS OF THE LIGHT-WATER REACTOR
ENVIRONMENT FOR NEW REACTORS," JULY 2006.**

The methodology used by DG-1144 is an environmental fatigue multiplier (F_{en}) approach that is very similar to the approach being used by license renewal applicants, as documented in NUREG/CR-5704 (ANL-98/31), "Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels," April 1999, and NUREG/CR-6583 (ANL-97/18), "Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low-Alloy Steels," March 1998. The EPRI Materials Reliability Program (MRP) has previously provided guidance to utilities for performing plant specific environmental fatigue evaluations for plants pursuing license renewal in 'Materials Reliability Program: Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application (MRP-47 Revision 1), EPRI Product # 1012017, September 2005 (copy attached). The intent of MRP-47, Rev. 1 was to unify the process used by applicants to address environmental effects in the License Renewal Application, and provide specific guidance on the use of currently accepted environmental fatigue evaluation methodologies. As a result of industry application of the F_{en} relationships, MRP-47, Rev. 1 identified several practical issues associated with the application of the F_{en} methodology to typical industry fatigue evaluation problems. These issues have led to application of a variety of different solutions applied by analysts depending upon the analyst or the level of detail available in the existing fatigue evaluations. This varied approach has led to non-consistent application of the F_{en} approach between plants, and some amount of confusion amongst the industry.

Since DG-1144 utilizes a similar F_{en} methodology to that evaluated in MRP-47, Rev. 1, the issues identified in MRP-47, Rev. 1 are considered to be equally applicable to the DG-1144 methodology. Based on the foregoing, the EPRI MRP wishes to provide the following comments on draft Regulatory Guide DG-1144, with special emphasis on the relevant issues raised in MRP-47, Rev. 1.

Comment #1

Since DG-1144 utilizes a similar F_{en} methodology to that evaluated in MRP-47, Rev. 1, the issues identified in MRP-47, Rev. 1 are considered to be equally applicable to the DG-1144 methodology. Some, but not all, of the issues raised in MRP-47, Rev. 1 have been specifically addressed in DG-1144. Based on this, the MRP would like to see clarification on the remaining issues included in DG-1144 or the supporting document (DRAFT REPORT FOR COMMENT NUREG/CR-6909 (ANL 06/08), "Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials," July 2006.).

Please clarify the following specific issues:

a. "Linking" of transients pairs is not straight-forward and can lead to significant differences in results (refer to Figure 1). The MRP thinks that the recommendations made in Section 4.2.2 of MRP-47, Rev. 1 are an acceptable means of addressing linking of transients with respect to:
    - Situations where the starting and ending stress points between two linked transients are not equal.
    - Establishing the rate of change for the discontinuity between linked transients.
    - Computing the strain rate for linked transients.

    Please revise the text of DG-1144 to state that the recommendations made in Section 4.2.2 of MRP-47, Rev. 1 are an acceptable means of addressing linking of transients, or provide alternate recommendations.

b. Please revise the text of DG-1144 to state that cycle counting methods other than those typically employed in ASME Code Section III calculations, such as Rainflow Cycle Counting, are acceptable for use in fatigue analyses associated with DG-1144.

c. The MRP thinks that the recommendations made in Section 4.2.6 of MRP-47, Rev. 1 are an acceptable means for addressing the effect on strain rate from the elastic-plastic correction factor (K_e). Please revise the text of DG-1144 to state that the recommendations made in Section 4.2.6 of MRP-47, Rev. 1 are an acceptable means of addressing the effect on strain rate from K_e, or provide alternate recommendations.

d. The MRP thinks that the recommendations made in Section 4.2.6 of MRP-47, Rev. 1 are an acceptable means for addressing stratification loads. Please revise the text of DG-1144 to state that the recommendations made in Section 4.2.6 of MRP-47, Rev. 1 are an acceptable means of addressing stratification loads, or provide alternate recommendations.

e. The MRP thinks that the recommendations made in Section 4.2.6 of MRP-47, Rev. 1 are an acceptable means for addressing seismic loads. Please revise the text of DG-1144 to state that the recommendations made in Section 4.2.6 of MRP-47, Rev. 1 are an acceptable means of addressing seismic loads, or provide alternate recommendations.

f. The MRP thinks that the recommendations made in Section 4.2.6 of MRP-47, Rev. 1 are an acceptable means for addressing pressure and moment loads. Please revise the text of DG-1144 to state that the recommendations made in Section 4.2.6 of MRP-47, Rev. 1 are an acceptable means of addressing pressure and moment loads, or provide alternate recommendations.

g. Environmental fatigue is typically linked to dissolved oxygen. As noted in MRP-47, Rev. 1, this involves inappropriate over-simplification and ignores the key role of other water chemistry parameters such as conductivity (or more correctly, level of dissolved anionic impurities) and pH. NUREG/CR-6909 notes (for example, in Section 5.2.6) that water chemistry effects have been appropriately incorporated into the model except for off-normal water chemistry conditions. Please define off-normal water chemistry conditions and provide specific guidance on what should be done to evaluate such conditions.

h. NUREG/CR-6909 includes definitions for temperature for use with the F_{en} expressions. Please revise the text of DG-1144 to state which temperature (metal or fluid) is to be used in environmental fatigue evaluations. If it is the metal temperature, please provide guidance in DG-1144 on alternatives for cases when metal temperature is not available.

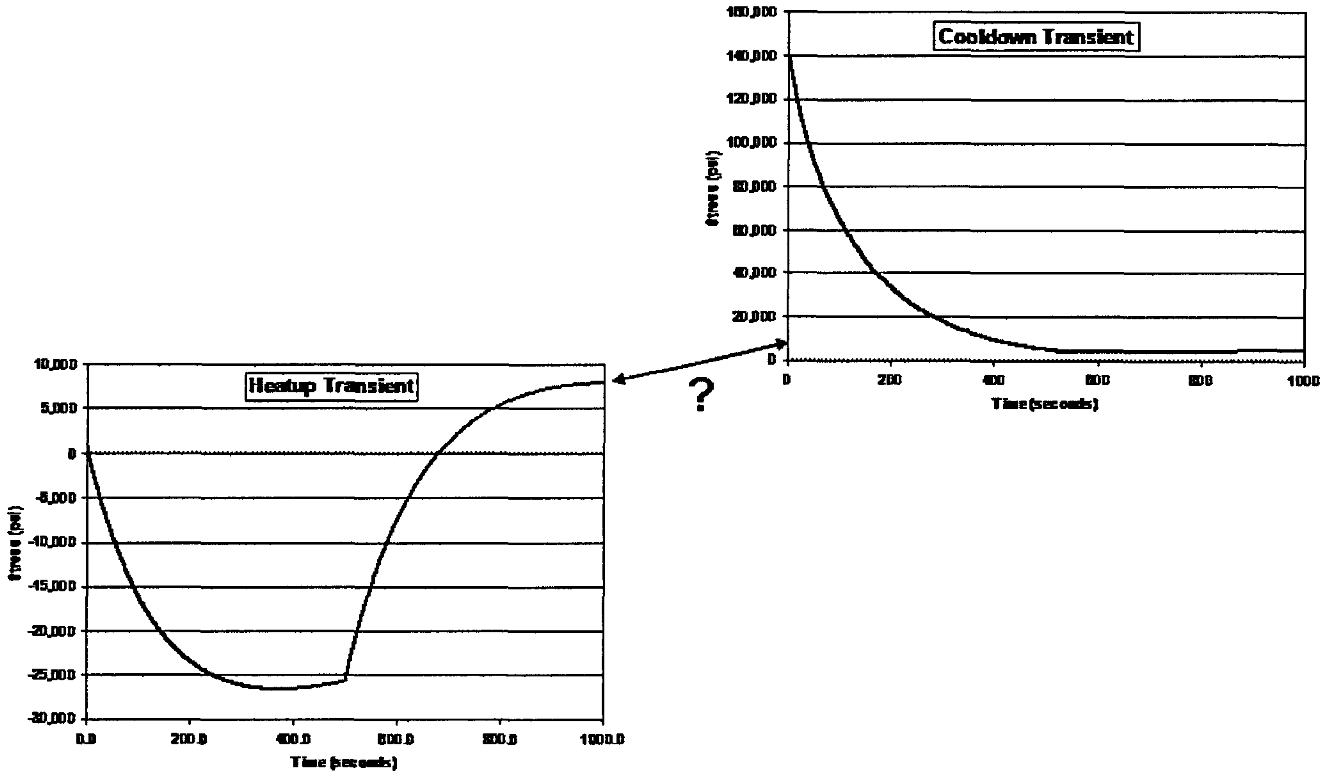

Figure 1. Issue of Transient Linking

Comment #2

In the Introduction of DG-1144, the NRC states:

> *"This draft regulatory guide provides guidance for use in determining the acceptable fatigue life of ASME pressure boundary components, with consideration of the light-water reactor (LWR) environment. In so doing, this guide describes a methodology that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable to support reviews of applications that the agency expects to receive for new nuclear reactor construction permits or operating licenses under 10 CFR Part 50, design certifications under 10 CFR Part 52, and combined licenses under 10 CFR Part 52 that do not reference a standard design. Because of significant conservatism in quantifying other plant -related variables (such as cyclic behavior, including stress and loading rates) involved in cumulative fatigue life calculations, the design of the current fleet of reactors is satisfactory, and the plants are safe to operate."*

The above text is not clear on what constitutes "new nuclear reactor construction." During the August 2006 meetings of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code in Henderson, NV, the NRC clarified that DG-1144 requirements will only apply to new plant construction, and that the requirements did not apply to repair or replacement component design for operating reactors. Please revise the text of DG-1144 to state that environmental fatigue rules do not apply to repair or replacement component design for operating reactors.

Comment #3

In Appendix A of NUREG/CR-6909, reference is made to two papers that may be used for guidance:

(1) Mehta, H. S., "An Update on the Consideration of Reactor Water Effects in Code Fatigue Initiation Evaluations for Pressure Vessels and Piping," Assessment Methodologies for Preventing Failure: Service Experience and Environmental Considerations, PVP Vol. 410-2, R. Mohan, ed., American Society of Mechanical Engineers, New York, pp. 45–51, 2000.

(2) Nakamura, T., M. Higuchi, T. Kusunoki, and Y. Sugie, "JSME Codes on Environmental Fatigue Evaluation," Proc. of the 2006 ASME Pressure Vessels and Piping Conf., July 23–27, 2006, Vancouver, BC, Canada, paper # PVP2006–ICPVT11–93305.

While both of these papers describe F_{en} methodologies and their application to fatigue analyses, the F_{en} formulas contained in these papers differ from those specified in DG-1144 and supporting document NUREG/CR-6909. Please revise the text of DG-1144 to state that the F_{en} methods and formulas specified in either of the above two documents are acceptable alternatives to the methodology specified in DG-1144.

Comment #4

DG-1144 does not provide any specific methods for evaluating Ni-Cr-Fe material. Alloy 600 and Alloy 690 materials, for example, have regularly been used in operating nuclear plants. It is assumed that this practice will continue for new reactors.

Ni-Cr-Fe rules that have previously been applied by some license renewal applicants are specified in the following documents:

- O. Chopra, "Status of Fatigue Issues at Argonne National Laboratory," Presented at EPRI Conference on Operating Nuclear Power Plant Fatigue Issues & Resolutions, Snowbird, UT, August 22-23, 1996
- EPRI TR-105759, "An Environmental Factor Approach to Account for Reactor Water Effects in Light Water Reactor Pressure Vessel and Piping Fatigue Evaluations," December 1995.

Please revise the text of DG-1144 to state that the rules defined in the above two documents are acceptable for use in evaluating Ni-Cr-Fe materials (including Alloy 690).

Comment #5

DG-1144 specifies rules for fatigue analysis for new reactor design. It is assumed that new reactors will need to be certified in accordance with ASME Code, Section III, in order to receive an N-stamp or similar certification prior to entry into service. The fatigue rules specified in DG-1144 currently differ from the fatigue rules specified in ASME Code, Section III. At this point in time, there is no reason to believe that the ASME Code will adopt methodology into Section III that is consistent with the methodology specified in DG-1144. Please revise the text of DG-1144 to state how these differences are to be reconciled to allow proper certification of nuclear components for new reactors.

Comment #6

Page A.3 of NUREG/CR-6909 states the following:

> *"When the results of detailed transient analyses are available an average temperature (i.e., average of the maximum and minimum temperatures for the transients) may be used to calculate F_{en}. The maximum temperature can be used to perform the most conservative evaluation."*

We are not clear on the definition of "average" temperature and how it would be used in each of the recommended methods of evaluation.

As an example, consider a fluid temperature transient that step changes from 550°F to 100°F and pairs with a Zeroload (zero stress at 70°F) transient . Based on the guidance in Appendix A of NUREG/CR-6909, we understand the following with respect to the use of an average temperature:

- The F_{en} would be computed based on the following for an "average strain rate" approach:
    - An average strain rate may be determined using the difference between the peak stress for the cooldown transient and zero, and the time from the beginning of the transient until the peak stress occurs.
    - An average transient temperature of 310°F (i.e., average of 70°F and 550°F) for this postulated transient pairing may be used.
- Alternatively, the F_{en} would be computed based on the following for a "modified rate approach" (as described in Section 4.2.14 of NUREG/CR-6909):
    - An integrated strain rate may be determined using Equation (28) of NUREG/CR-6909 for the tensile portion of the cooldown transient.
    - For each integration step, the average temperature during the integration step is used in Equation (28). Alternatively, as a simplification, the average transient temperature of 310°F(i.e., average of 70°F and 550°F for the two transients being evaluated) may be used for all integration steps.

Alternatively, for either of the above examples, the maximum temperature of 550°F could be used to provide a conservative assessment.

Please expand the text Appendix A of NUREG/CR-6909 to state that the above examples are an acceptable means of addressing average temperature, or provide alternate recommendations.

Comment #7

For cumulative usage factor (CUF) due to rapid thermal cycling, such as the cycling typically evaluated for boiling water reactor (BWR) feedwater nozzles, the MRP thinks that $F_{en} = 1.0$ is appropriate. Similar to dynamic loading practices, this approach is based on the premise that the cycling due to rapid thermal cycling occurs too quickly for environmental effects to be significant. Please revise the text of DG-1144 to state that the application of $F_{en} = 1.0$ is an appropriate treatment of rapid thermal cycling fatigue effects in environmental fatigue analyses, or provide alternate recommendations.

Comment #8

There is no guidance in DG-1144 regarding how to treat carbon steel or low alloy steel that is protected from the primary coolant environment by stainless steel (or Alloy 690) cladding. The MRP thinks it is reasonable to neglect the effects of the cladding and perform environmental fatigue assessment of the underlying base material, consistent with ASME Code, Section III methodology where the structural effects of cladding are neglected when the cladding is less than 10% of the component wall thickness. Please revise the text of DG-1144 to state that the cladding may be neglected in environmental fatigue analyses, or provide alternate recommendations