UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 6, 2012

Mr. Adam C. Heflin
Senior Vice President and Chief Nuclear Officer
Union Electric Company
P.O. Box 620
Fulton, MO 65251

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE CALLAWAY PLANT, UNIT 1, LICENSE RENEWAL APPLICATION, SET 9, METAL FATIGUE (TAC NO. ME7708)

Dear Mr. Heflin:

By letter dated December 15, 2011, Union Electric Company d/b/a Ameren Missouri (the applicant) submitted an application pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54) for renewal of Operating License No. NPF-30 for the Callaway Plant, Unit 1. The staff of the U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing this application in accordance with the guidance in NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants." During its review, the staff has identified areas where additional information is needed to complete the review. The staff's requests for additional information are included in the enclosure. Further requests for additional information may be issued in the future.

Items in the enclosure were discussed with Sarah G. Kovaleski, of your staff, and a mutually agreeable date for the response is within 30 days from the date of this letter. If you have any questions, please contact me by telephone at 301-415-2946 or by e-mail at Samuel.CuadradoDeJesus@nrc.gov.

Sincerely,

Samuel Cuadrado de Jesús, Project Manager
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosure:
As stated

cc w/encl: Listserv

CALLAWAY PLANT UNIT 1
LICENSE RENEWAL APPLICATION
REQUEST FOR ADDITIONAL INFORMATION, SET 9, METAL FATIGUE

RAI 4.3-1

Background:

License renewal application (LRA) Table 4.3-2 describes Transient 1b as "Plant Cooldown at 100 °F/hr, Pressurizer Cooldown at 200 °F/hr" and indicates that there are 29 occurrences of Transient 1b between 1983 and 2011.

Final Safety Analysis Report (FSAR) Table 3.9(N)-1A SP indicates that the "plant cooldown cycle at less than 100 °F/hr" is defined as "cooldown cycle T_{ave} from ≥ 550°F to ≤200 °F." FSAR Table 3.9(N)-1A SP also indicates that the "pressurizer cooldown cycle at less than 200 °F/hr" is defined as "pressurizer cooldown cycle temperature from ≥650 °F to ≤200 °F."

Issue:

It is not clear to the staff why the plant cooldown and pressurizer cooldown cycles are grouped together as a single transient (Transient 1b) in LRA Table 4.3-2 and whether Transient 1b should be considered separately based on the definition in the FSAR SP. In addition, it is not clear whether Transient 1b is considered to have occurred when either a (1) plant cooldown ***or*** pressurizer cooldown occurs or (2) when both plant cooldown ***and*** pressurizer cooldown occur.

Request:

a) Provide the basis for combining these two transients when they are being monitored by the Fatigue Monitoring Program.

b) Explain whether Transient 1b is considered to have occurred when either a (1) plant cooldown ***or*** pressurizer cooldown occurs or (2) when both plant cooldown ***and*** pressurizer cooldown occur.

c) With respect to the baseline value of 29 occurrences in LRA Table 4.3-2, clarify whether the two transients have been monitored separately or together since the beginning of power operations (considering that manual records and fatigue monitoring software have been used).

RAI 4.3-2

Background:

LRA Section 4.3.1.2 states the baseline cycle counting results were projected to a 60-year operating life based on the actual accumulation history since the start of plant life. A rate of future cycle accumulation is computed for each transient and the cycle projections are based on a long term rate and a short term rate of cycle accumulation. In addition, these accumulation rates are then combined based on a weighting factor of one for the long term and three for the short term.

Issue:

Since the applicant used the 60-year transient projections to support the disposition of the time-limited aging analyses (TLAAs) evaluated in LRA Sections 4.7.2 and 4.7.7, the staff requires additional information to determine whether the long-term and short-term weighting factors and the associated transient occurrences for these weighting factors used in the projection methodology is appropriate and conservative.

Request:

a) Identify the transients in LRA Table 4.3-2 in which the long-term and short-term weighting factors, described in LRA Section 4.3.1.2, are applicable and provide the short-term and long-term occurrence for each transient.

b) If any design transient in LRA Table 4.3-2 used a different 60-year projection methodology, other than the one discussed in LRA Section 4.3.1.2, describe and justify that this "alternative" 60-year projection methodology is conservative.

RAI 4.3-3

Background:

LRA Table 4.3-2 describes that for normal condition Transients Nos. 16a and b, the baseline results were judged to be conservative based on a review of instrumentation data available from 2000 to 2011.

Issue:

It is not clear to the staff whether the baseline numbers of 56 and 12, for normal condition Transient Nos. 16a and 16b, respectively, are the results of a review of instrumentation data available from 2000 to 2011 or whether they incorporate a backward-projection to include the years from 1983 to 2011.

The applicant also did not provide the technical basis why using the data from 2000 to 2011 was conservative and whether the 1:3 ratio for long term to short term weighting factor was used to calculate the 60-year projection for this transient.

Request:

a) Provide the number of occurrences for Transient Nos. 16a and 16b from 2000-2011 and the calculation performed to obtain the baseline values for 56 and 12 in LRA Table 4.3-2. Provide the technical justification that the data from 2000-2011 is conservative to represent the occurrences of these transients between 1983 and 2011.

b) Provide the short-term and long-term weighting factors used to calculate the 60-year projection and the associated transient occurrences for these weighting factors. In addition, provide the basis that the 60-year projection is conservative.

RAI 4.3-4

Background:

LRA Table 4.3-2 indicates that for Normal Transient 5b "Steady State Fluctuations, Random Fluctuations," the number of cycles is beyond the endurance limit of the fatigue curve and therefore this transient does not need to be counted.

Issue:

The staff noted that the endurance limit of the fatigue curve is typically referred to as the stress level below which it results in an infinite number of allowable cycles. Based on the information in the LRA, it may be interpreted that the endurance limit is based upon a certain number of cycles, thus, the applicant has not explained why the transient does not need to be counted when the number of cycles is greater than 10^6.

Request:

a) Clarify and explain the statement that "the number of cycles is beyond endurance limit of the fatigue curve."

b) Provide the basis for not counting this transient when the number of cycles is greater than 10^6.

RAI 4.3-5

Background:

LRA Table 4.3-2 indicates that there are 29 occurrences of the plant heat-up transient, 29 occurrences of the plant cool-down transient, 66 occurrences of the reactor trip transient, 2 occurrences of the inadvertent reactor coolant system (RCS) depressurization transient and one occurrence of the loss of power transient.

Issue:

Based on the baseline cycle occurrence data in LRA Table 4.3-2 it is not clear to the staff how there are an equal number of plant heat-up and cool-down transients when considering there have been occurrences of reactor trip, inadvertent RCS depressurization and loss of power transients. Thus, it is not clear to the staff whether there is a plant heat up recorded after each occurrence of the reactor trip, RCS depressurization, or loss of power.

Request:

a) Provide the basis that there are an equal number of plant heat-up and cool-down transients when considering there have been occurrences of reactor trip, inadvertent RCS depressurization and loss of power transient.

b) Clarify whether there is a recorded plant heat-up after each occurrence of an inadvertent RCS depressurization, loss of power, and reactor trip transient.

c) Identify the transient occurrences that would subsequently result in a recorded plant heat-up transient.

RAI 4.3-6

Background:

In the response to Question 11 in "Callaway Plant Application of Proprietary Leak-Before-Break Methodology Reports and Draft Regulatory Guide DG-1108," (non-Proprietary letter) dated December 9, 2003 (ADAMS Accession Number ML033530468), the applicant stated that the value of the maximum American Society of Mechanical Engineers (ASME) Code, Section III, Class 1, cumulative usage factor (CUF) of the pressurizer surge line previously calculated under the effects of thermal stratification is 0.4.

LRA Section 4.3.2.4 indicates that the fatigue results, including the effects of thermal stratification, for the 14-in. pressurizer surge nozzle on hot leg loop 4 and the 14-in. pressurizer surge line is 0.3 and 0.099, respectively. LRA Table 4.3-7, as amended by letter dated May 3, 2012, also indicates a CUF value of 0.3 for the surge line (hot leg surge nozzle).

Issue:

Based on the reported CUF values in the LRA, including LRA amendment 2 by letter dated May 3, 2012, and the applicant's response letter dated December 9, 2003, it is not clear to the staff if the CUF values are referring to the same or different locations of the pressurizer.

Request:

a) Clarify the specific locations that are represented by the CUF values of 0.099, 0.3, and 0.4.

b) If the CUF value of 0.4 refers to the same location as the 14-in pressurizer surge nozzle on hot leg loop 4, provide the basis for recording a lower CUF value in LRA Section 4.3.2.4 and LRA Table 4.3-7, as amended by letter dated May 3, 2012.

RAI 4.3-7

Background:

LRA Table 4.3-3 indicates that the CUF value for "RHR Nozzles, Hot Leg Loop 1 & 4" is 0.81, the CUF value for "Loop 1 Hot Leg Safety Injection Line" is 0.661 and the CUF value for "Loop 4 Hot Leg Safety Injection Line" is 0.110. In the response to residual heat removal (RHR) Line Question 1 in "Callaway Plant Application of Proprietary Leak-Before-Break Methodology Reports and Draft Regulatory Guide DG-1108," (non-Proprietary letter) dated December 9, 2003 (ADAMS Accession Number ML033530468), the applicant stated that the value of the ASME Code, Section III, Class 1, CUF of the RHR Line Loop 1 is not 0.81.

LRA Table 4.3-7, as amended by letter dated May 3, 2012, identifies the final locations, including the NUREG/CR-6260 locations that will be used as sentinel locations during the period of extended operation to manage environmentally-assisted fatigue (EAF).

Issue:

The staff noted that in some instances multiple loops on a particular line may have the same CUF value and in other instances they have different CUF values; thus, the basis for multiple loops having the same CUF value is not clear.

The LRA did not annotate or explain whether the CUF values, for entries of multi-loop systems in LRA Tables 4.3-3 to LRA Table 4.3-7, are intended to demonstrate that the CUF value of one loop bounds the "calculated" CUF value of another; or to demonstrate that the CUF value of one loop represents all other identical or less limiting loops.

Without a clear indication of the CUF values of multi-loop systems, the staff cannot verify the applicant's conclusion that LRA Table 4.3-7 identifies the final locations, including the NUREG/CR-6260 locations that will be used as sentinel locations during the period of extended operation to manage EAF.

Request:

a) Identify any components or locations in LRA Tables 4.3-3 to 4.3-7 for which the CUF value in the design-basis calculation is the same for each loop in a multi-loop system.

b) Identify any components or locations in LRA Tables 4.3-3 to 4.3-7 for which a CUF value of one loop was used to bound any "calculated" CUF values of another loop in a multi-loop system. Provide the basis for each circumstance discussed and provide the associated CUF values.

c) Identify any components or locations in LRA Tables 4.3-3 to 4.3-7 for which the CUF value of one loop represented all other identical or less limiting loops. Provide the basis for each circumstance discussed and provide the associated CUF values.

RAI 4.3-8

Background:

LRA Section 4.3.1.1 states that a benchmark was performed to demonstrate that the charging nozzle stress-based fatigue (SBF) algorithm produces a conservative CUF when compared to an independent ASME Section III, Division 1, Subsection NB, Subarticle NB-3200 fatigue calculation of the same component. The benchmarking consisted of inputting the temperature, pressure and flow rate time histories for the most severe transient pairs into the SBF algorithms. These time histories are the same as those assumed in the NB-3200 fatigue calculation and constitute about 88 percent of the NB-3200 CUF.

The LRA states that a comparison demonstrated that the CUF for those transient pairs as computed by the SBF algorithms is more conservative than the CUF calculated with all transient pairs as computed using the detailed NB-3200 methodology. Furthermore, the LRA states that for two of the transients, the SBF algorithms calculated stress ranges approximately one to two percent less than the NB-3200 analysis. The LRA also states that the small difference in results is within the accuracy of the analysis

Issue:

The LRA did not provide an explanation of how the CUF calculated by single-stress component SBF would be more conservative than that of the NB-3200 calculation. In addition, the LRA did not provide sufficient detail to support its statement that single-stress component SBF is more conservative than the NB-3200 calculation.

For the two transients that the SBF algorithms calculated stress ranges approximately one to two percent less than the NB-3200 analysis, the applicant did not explain or quantitatively define "the small difference in results" and "the accuracy of the analysis." The LRA also has not identified or compared the results between the single-stress component SBF and NB-3200 calculations; thus, without the information, the staff cannot verify the adequacy of the applicant's calculation to support the use of single-stress component SBF for the charging nozzle.

Request:

a) Identify those most severe transient pairs that "constitute about 88% of the NB-3200 CUF" and provide the associated CUF contribution for these "most severe transient pairs."

b) For the two transients that the SBF algorithms calculated stress ranges approximately one to two percent less than the NB-3200 analysis, clarify whether the term "results" is related to a stress value, CUF value, or some other parameter.

c) Explain what was meant by "the accuracy of the fatigue analysis" and explain how it was quantitatively determined.

d) Identify the CUF contributions (both in SBF and NB-3200 calculations) for these two transients. Demonstrate and justify that the defined "small difference in results" is within the "accuracy of the fatigue analysis."

e) Justify that the results calculated from the single-stress component SBF is conservative compared to the NB-3200 for the charging nozzle.

RAI 4.3-9

Background:

LRA Table 4.3-3 states that the CUF value for the Class 1 piping of "Normal/Alternate Charging-Loops 1 & 4" is 0.93. LRA Table 4.3-7, as amended by letter dated May 3, 2012, states the "Normal Charging Nozzles, Loop 1" and "Alternate Charging Nozzles, Loop 4" have CUF values of 0.90, which are the sentinel locations for EAF monitoring for the "Charging" thermal zone within the chemical and volume control system (CVCS).

Issue:

The applicant did not explain why the Normal and Alternate Charging nozzles would bound Class 1 piping of "Normal/Alternate Charging-Loops 1 & 4" given that the CUF values of the Class 1 piping of "Normal/Alternate Charging-Loops 1 & 4" is higher.

Request:

Justify that the Normal and Alternate Charging nozzles are sentinel locations for the "Charging" thermal zone within the CVCS. As part of justification, specifically include the materials, transient experienced, system configuration, water chemistry and other factors when comparing the Class 1 piping of "Normal/Alternate Charging-Loops 1 & 4" and the Normal and Alternate Charging nozzles.

RAI 4.3-10

Background:

LRA Section 4.3.5 states that piping in the scope of license renewal that is designed to American National Standards Institute (ANSI) B31.1 or ASME Section III Class 2 and 3 required the application of a stress range reduction factor to the allowable stress range (expansion and displacement) to account for thermal cyclic conditions.

In addition, the LRA provides a list of several systems and states that these systems are subject to thermal fatigue effects and were therefore included in the aging management review (AMR) results presented in LRA Section 3. Specifically, the main feedwater system and boron recycle system were included as part of this list of systems subject to thermal fatigue effects.

Issue:

Title 10 Section 54.21(a)(1) of the *Code of Federal Regulations* (10 CFR 54.21(a)(1)) requires, in part, that for those systems, structures, and components (SSCs) within the scope of license renewal as delineated in 10 CFR 54.4, the applicant identify and list those structures and components subject to an AMR. However, the staff noted that LRA Table 3.4.2-3, "Steam and

Power Conversion System – Summary of Aging Management Evaluation – Main Feedwater System" and LRA Table 3.3.2-28, "Auxiliary Systems – Summary of Aging Management Evaluation – Miscellaneous Systems in scope ONLY for Criterion 10 CFR 54.4(a)(2)" does not provide AMR results for components subject to "cumulative fatigue damage."

Request:

a) Provide the basis for the discrepancy between the LRA Section 4.3.5 and LRA Tables 3.3.2-28 and 3.4.2-3 or provide the appropriate AMR results for components subject to thermal fatigue effects for the main feedwater system and boron recycle system.

b) Confirm that there are no other components designed to ANSI B31.1 or ASME Section III Class 2 and 3, including reactor coolant sample lines, subject to thermal fatigue effects and subject to AMR for "cumulative fatigue damage" in accordance with 10 CFR 54.21(a)(1) or make appropriate revisions to the LRA to identify these additional components subject to AMR.

c) If components within the scope of license renewal designed to ANSI B31.1 or ASME Section III Class 2 and 3, including reactor sample lines that required the application of a stress range reduction factor, were excluded from the AMR results by the temperature screening criteria; provide the basis for excluding these components as AMR results that identify "cumulative fatigue damage" as an aging effect in accordance with 10 CFR 54.21(a)(1).

RAI 4.3-11

Background:

LRA Section 4.3.5 states that a review of FSAR Table 9.3-3 SP and Callaway Chemistry Schedule identified that the only sample piping in the scope of license renewal that meets the temperature screening criteria, and could possibly exceed 7,000 cycles, is the RCS hot leg sample piping. In addition, it states that a review of operating practice at Callaway indicates that RCS samples are taken weekly from the hot leg during operation. Therefore none of the lines associated with this sample location will exceed 7,000 cycles during the period of extended operation. FSAR Table 9.3-3 SP provides the "typical sampling frequency" for the primary sampling systems; specifically, it lists a frequency of 3 per week and/or 1 per week for the RCS hot legs sample (loop 1 or 3).

Issue:

Based on information presented in the LRA for the Callaway Chemistry Schedule and the operating practice at Callaway and FSAR Table 9.3-3 SP, the sampling frequency of the RCS hot legs sample (loop 1 or 3) is not clear to the staff. The FSAR indicates that the sampling frequency can be up to 3 per week and it appears that the Callaway Chemistry Schedule indicates a sampling frequency of once per week.

Request:

a) Provide the reason that the FSAR indicates the sampling frequency for the RCS hot legs sample (loop 1 or 3) may be 3 per week, while the LRA indicates that the sampling frequency is weekly. Describe any actions that are required to clarify this discrepancy between the LRA, site procedures, and FSAR.

b) If it is determined that the sampling frequency is or should be 3 per week, provide the reason that the disposition for the TLAA of reactor coolant sample lines in accordance with 10 CFR 54.21(c)(1)(i) is still appropriate.

c) Provide the reason that the RCS hot leg sample piping is only affected by the RCS samples taken weekly from the hot leg during operation and is not affected by the thermal cycles that are likely to produce full-range thermal cycles or other events that may contribute part-range cycles in ASME Class 2, 3, and B31.1 piping.

RAI 4.3-12

Background:

LRA Sections 4.3.2.2 and A3.2.1.2 state that for license renewal, Callaway has committed to monitor the CUF of the limiting location out of the pressurizer lower head, pressurizer surge line nozzle, and heater well nozzles using fatigue monitoring software consistent with RIS 2008-30. In addition, LRA Section 4.3.2.2 states that to mitigate pressurizer insurge-outsurge transients, Callaway has used modified operating procedures (MOPs) since 1996.

LRA Table A4-1 contains Commitment No. 36, which states the following, "[i]mplement SBF or CBF consistent with RIS 2008-30 to monitor the CUF of the limiting location out of the pressurizer lower head, surge nozzle and heater penetrations to accommodate the insurge-outsurge transient."

LRA Table A4-1 contains Commitment No. 37, which states in part that "[i]n order to determine if the pressurizer contains a limiting EAF location, the fatigue analyses will be revised to incorporate the affect effect of insurge-outsurge transients on the pressurizer lower head, surge nozzle, and heater well nozzles at plant specific conditions." LRA Amendment 2 dated May 3, 2012, revised Commitment No. 37 in LRA Table A4-1 to state that this portion of the commitment was completed. In addition, Commitment No. 37 was revised to state in part that "[t]he pressurizer contains a limiting EAF location. The fatigue analyses will be revised to incorporate the effect of insurge-outsurge transients in the pressurizer lower head."

Issue:

Based on this part of Commitment No. 37 that was completed and the addition to Commitment No. 37, both of which are described above, it is not clear to the staff whether the effects of insurge-outsurge transients has been incorporated into the fatigue analyses of the pressurizer. Furthermore, based on LRA Table 4.3-7, as amended by letter dated May 3, 2012, there are a total of seven sentinel locations for three different regions (pressurizer lower head, pressurizer spray, and pressurizer SRV/PORV) of the pressurizer. The staff noted that this is different from the revised Commitment No. 37 that the pressurizer contains a single limiting EAF location.

Considering the completion of this part of Commitment No. 37 described above, LRA Sections 4.3.2.2 and A3.2.1.2 were not revised to capture the incorporation of insurge-outsurge transients on the pressurizer lower head, surge nozzle, and heater well nozzles at plant-specific conditions. In addition, the staff noted that locations to be monitored are different between LRA Section A3.2.1.2 and Commitment No. 36; thus, it is not clear to the staff what the basis is for the discrepancy.

In addition, it is not clear how the effects of insurge-outsurge transients were incorporated into the fatigue analyses of the pressurizer prior to the implementation of MOPs in 1996.

Request:

a) Provide the basis for the discrepancy in Commitment No. 37, as revised by letter dated May 3, 2012, and explain whether the effects of insurge-outsurge transients has been incorporated into the fatigue analyses of the pressurizer.

b) Given that there are seven sentinel locations identified for the pressurizer, provide the basis for the discrepancy in Commitment No. 37, as revised by letter dated May 3, 2012, that the pressurizer contains a single limiting EAF location.

c) Provide the basis that LRA Sections 4.3.2.2 and A3.2.1.2 were not revised to capture the incorporation of insurge-outsurge transients on the pressurizer lower head, surge nozzle, and heater well nozzles at plant specific conditions, considering the part of Commitment No. 37 that was identified as completed by letter dated May 3, 2012.

d) Clarify the locations to be monitored for CUF using fatigue monitoring software. Revise LRA Section A3.2.1.2 and Commitment No. 36 to address discrepancy in monitored locations. Or provide the reason that the locations discussed in Commitment No. 36 are different from those in LRA Section A3.2.1.2.

e) Describe how the effects of insurge-outsurge transients were incorporated into the fatigue analyses of the pressurizer prior to the implementation of MOPs in 1996. If actual plant data at Callaway was not used to incorporate the effects of insurge-outsurge transients, provide the reason that the methods used are bounding to capture the plant-specific condition prior to implementing MOPs to ensure an accurate baseline to manage fatigue through the period of extended operation.

RAI 4.3-13

Background:

LRA Section 4.3.2.1 describes that the fatigue analysis for the thermal barrier flange at the component cooling water (CCW) connection has a CUF of 0.9334. Furthermore, the transients used in the design of the CCW connection are 200 cycles of elevated CCW injection temperature; 40 cycles of seasonal temperature change; and 200 cycles of loss of CCW flow.

The LRA states that the seasonal temperature change is the only transient not counted; thus, its usage contribution during the period of extended operation can be estimated by multiplying its 40-year usage contribution by 1.5, which results in the CUF exceeding the Code allowable of 1.0. It also states that the transient that contributes most significantly to fatigue is the 200 cycles of elevated CCW injection temperature. In order to account for the increase in usage described above caused by the 20 additional years of operation and to keep the usage below the Code allowable of 1.0, the LRA describes that the number of the most severe transient will be limited to 75 percent of its design value (i.e., limited to 150 elevated CCW injection temperature) and this will keep the CUF less than 0.9. Therefore, the LRA states that the fatigue analysis will be managed for the period of extended operation, and the TLAAs are dispositioned in accordance with 10 CFR 54.21(c)(1)(iii).

Issue:

Additional information regarding the CUF contribution for each of the transients in the original fatigue analysis for this component is required for the staff to verify the adequacy of the TLAA disposition. Furthermore, ASME Code Section III Paragraph NB-3224(e)(5) Step 1 indicates that transients shall be paired in order to produce a total stress difference range greater than the stress difference range of the individual cycles.

It is not clear to the staff whether the applicant has performed a CUF "re-calculation" consistent with ASME Code NB-3224(e)(5) Step 1, to arrive at the conclusion that restricting elevated CCW injection temperature transients to 75 percent of its design occurrences will keep the CUF less than 0.9. Furthermore, the technical basis that supports the statement that the CUF value can be kept less than 0.9 is not clear, considering that the number of past and future occurrences of the seasonal temperature change transient was not accounted for and shown to be bounding through the period of extended operation.

Request:

a) Provide the CUF contribution, as documented in the original fatigue evaluation, for each of the transient pairing (including number of cycles used in each pairing) consistent with Code NB-3224(e)(5).

b) Clarify whether the CUF value has been recalculated consistent with ASME Code Section III NB-3224(e)(5) to reach the conclusion that restricting the occurrence of the elevated CCW injection temperature to 75 percent of the design limit will result in a CUF of less than 0.9.

    i. If yes, provide the CUF contribution for each transient pair (including number of cycles used in each pairing) and demonstrate that this restriction results in a CUF of less than 0.9.

    ii. If not, justify that the determination in using this 75 percent restriction on the elevated CCW injection temperature transient is based on an evaluation consistent with requirements in ASME Code Section III NB-3200.

c) Justify that the accumulated fatigue usage will remain less than 0.9 without monitoring and/or confirmation that the number of occurrences of the seasonal temperature change transient will not exceed the design limit.

RAI 4.3-14

Background:

LRA Section 4.3.8 states that the fatigue analysis for the letdown heat exchanger indicated a maximum CUF of 1.84 for the flange that accounts for a recent reanalysis to account for operation (1993-2011) with a letdown flow of 140 gpm. The LRA states that the CUF is driven mainly by the "charging flow step decreased and return to normal" transient, which is a load-following transient. Furthermore, the LRA states that Callaway does not practice load-following operation and the number expected to be experienced is a small fraction of the number of assumed transients. The LRA states that the assumed number of this transient was dropped by an order of magnitude, which is about equal to 3 transients a month for 60 years and is more consistent with Callaway's operation, and the CUF dropped to 0.894.

The applicant dispositioned the TLAA for the letdown heat exchanger flange in accordance with 10 CFR 54.21(c)(1)(ii) to demonstrate that the analysis was projected to be valid through the period of extended operation.

Issue:

The staff noted that the "charging flow step decreased and return to normal" transient with a design limit of 24,000 cycles was based on load-following operation; thus, it may be reasonable to conclude that because the applicant's site does not practice load-following operation there will be margin between the design limit and the expected number of cycles for this transient through the period of extended operation. However, since the applicant reduced the number of cycles for this transient from 24,000 by an order of magnitude (i.e., 2,400), it is not clear to the staff whether there is still margin between the design number and expected number of cycles through the period of extended operation (i.e., approximately [3 cycles per month] x [12 months per year] x [60 years of operation] = 2,160 cycles). Thus, the staff requires additional information to verify the adequacy of the applicant's disposition in accordance with 10 CFR 54.21(c)(1)(ii), that the CUF of 0.894 for the letdown heat exchanger flange has been projected to be valid through the period of extended operation.

Request:

Given that the CUF value of 0.894 may no longer be valid if the 3-occurrence-per-month assumption through the period of extended operation is exceeded, provide the reason that there is sufficient margin to conclude that the TLAA has been projected to remain valid through the period of extended operation (i.e., 10 CFR 54.21(c)(1)(ii)).

RAI 4.3-15

Background:

LRA Section 4.3.8 states that the fatigue analyses of the letdown heat exchanger also include the tubesheet, tube side nozzles, and the studs, with CUF values of 0.910, 0.843, and 0.635, respectively.

The LRA discusses the transients that were included in the fatigue analyses for these components, the transients that will be monitored by the Fatigue Monitoring Program and the transients that will not be monitored. Specifically, for the "letdown flow step decrease and return to normal" transient with a design limit of 2,000 cycles, the LRA states that it is not a normal operating event with the plant at power but was included in the analysis for conservatism. Furthermore, it states that this transient was assumed to occur approximately once a week for 40 years and if this assumption is extended through the period of extended operation, then 3,000 events will be assumed to occur and the CUF will increase to 0.995, 0.880, and 0.696.

The applicant dispositioned the TLAA for these letdown heat changer components in accordance with 10 CFR 54.21(c)(1)(ii) to demonstrate that these analyses were projected to be valid through the period of extended operation.

Issue:

Additional information regarding the CUF contribution for each of the transients in the original fatigue analysis for this component is required for the staff to verify the adequacy of the TLAA disposition. ASME Code Section III Paragraph NB-3224(e)(5) Step 1 indicates that transients shall be paired in order to produce a total stress difference range greater than the stress difference range of the individual cycles. It is not clear to the staff whether the applicant has performed a CUF re-calculation, consistent with ASME Code NB-3224(e)(5) Step 1, to arrive at the conclusion that through the period of extended operation with 3,000 cycles of this transient assumed to occur, the CUF values will increase to 0.995, 0.880, and 0.696.

Furthermore, the technical basis to support the assumptions that this transient occurs approximately once a week for 40 years and can be extended to 3,000 cycles for 60 years is not clear to the staff. In addition, it is not clear whether these assumptions are conservative.

Request:

a) Provide the CUF contribution, as documented in the original fatigue evaluation, for each transient pairing (including number of cycles used in each pairing) consistent with Code NB-3224(e)(5).

b) Clarify whether the CUF value has been recalculated consistent with ASME Code Section III NB-3224(e)(5) to reach the conclusion that through the period of extended operation with 3,000 cycles of this transient assumed to occur, the CUF values will increase to 0.995, 0.880, and 0.696 for these components.

    i. If yes, provide the CUF contribution for each transient pair (including number of cycles used in each pairing) and demonstrate that the assumption of 3000 cycles results in CUF values of 0.995, 0.880, and 0.696 for the letdown heat exchanger tubesheet, tube side nozzles, and the studs, respectively.

ii. If not, justify that the determination in using the assumption of 3000 cycles for the "letdown flow step decrease and return to normal" transient is based on an evaluation consistent with requirements in ASME Code Section III NB-3200.

c) Justify the assumptions that the "letdown flow step decrease and return to normal" transient occurs approximately once a week for 40 years and can be extended to 3,000 cycles for 60 years. In addition, provide the reason that these assumptions are conservative and support the disposition of 10 CFR 54.21(c)(1)(ii).

RAI 4.3-16

Background:

LRA Section 4.3.8 states that the fatigue analysis for the letdown reheat heat exchanger indicated a maximum CUF of 4.431 for the studs that accounts for a recent reanalysis to account for operation (1993-2011) with a letdown flow of 140 gpm. The LRA states that the CUF is driven mainly by the "letdown flow step increase and return to normal" and "load follow boration" transients, which are load-following transients. Furthermore, the LRA states that Callaway does not practice load-following operation and the assumed number of these transients was dropped by an order of magnitude and the CUF dropped to about 0.503.

The applicant dispositioned the TLAA for the letdown reheat exchanger studs in accordance with 10 CFR 54.21(c)(1)(ii) to demonstrate that the analysis was projected to be valid through the period of extended operation.

Issue:

The staff noted that the "letdown flow step increase and return to normal" and "load follow boration" transients, each with a design limit of 24,000 cycles, were based on load-following operation; thus, it may be reasonable to conclude that because the applicant's site does not practice load-following operation there will be margin between the design limit and the expected number of cycles for these transients. However, since the applicant reduced the number of cycles for these transients from 24,000 by an order of magnitude (i.e., 2,400); it is not clear to the staff whether there is still margin between the design number and expected number of cycles through the period of extended operation. Thus, the staff requires additional information to verify the adequacy of the applicant's disposition in accordance with 10 CFR 54.21(c)(1)(ii), that the CUF of 0.503 for the letdown heat exchanger studs has been projected to be valid through the period of extended operation.

Request:

Given that the CUF value of 0.503 may no longer be valid if, for each transient ("letdown flow step increase and return to normal" and "load follow boration"), a 3-occurrence-per-month assumption through the period of extended operation is exceeded, provide the basis that there is sufficient margin to conclude that the TLAA has been projected to remain valid through the period of extended operation (i.e., 10 CFR 54.21(c)(1)(ii)).

RAI 4.3-17

Background:

LRA Section 4.3.8 states that the fatigue analyses of the letdown reheat heat exchanger also include the shell and tube side nozzles and tubesheet, with CUF values of 0.054 and 0.47, respectively.

The LRA discusses the transients that were included in the fatigue analyses for these components, the transients that will be monitored by the Fatigue Monitoring Program and the transients that will not be monitored. Specifically, for the "letdown flow step decrease and return to normal" transient with a design limit of 2,000 cycles, if the number of events is extended through the period of extended operation, then 3,000 events will be assumed to occur and the CUFs will increase to 0.57 for the tubesheet and 0.0563 for the tube side nozzles. The LRA states that the nozzles CUFs are not affected by this increase.

The applicant dispositioned the TLAA for these letdown reheat heat exchanger components in accordance with 10 CFR 54.21(c)(1)(ii) to demonstrate that the analysis was projected to be valid through the period of extended operation.

Issue:

Additional information regarding the CUF contribution for each of the transients in the original fatigue analysis for this component is required for the staff to verify the adequacy of the TLAA disposition. ASME Code Section III Paragraph NB-3224(e)(5) Step 1 indicates that transients shall be paired in order to produce a total stress difference range greater than the stress difference range of the individual cycles. It is not clear to the staff whether the applicant has performed a CUF re-calculation, consistent with ASME Code NB-3224(e)(5) Step 1, to arrive at the conclusion that through the period of extended operation with 3,000 cycles of this transient assumed to occur, the CUF values will increase to 0.57 for the tubesheet and 0.0563 for the tube side nozzles.

Furthermore, the technical basis to support the assumption that this transient can be extended to 3,000 cycles for 60 years is not clear to the staff. In addition, it is not clear whether this assumption is conservative.

Request:

a) Provide the CUF contribution, as documented in the original fatigue evaluation, for each transient pairing (including number of cycles used in each pairing) consistent with Code NB-3224(e)(5).

b) Clarify whether the CUF value has been recalculated consistent with ASME Code Section III NB-3224(e)(5) to reach the conclusion that through the period of extended operation with

3,000 cycles of this transient assumed to occur, the CUF values will increase to 0.57 for the tubesheet and 0.0563 for the tube side nozzles.

i. If yes, provide the CUF contribution for each transient pair (including number of cycles used in each pairing) and demonstrate that the assumption of 3000 cycles results in CUF values of 0.57 for the tubesheet and 0.0563 for the tube side nozzles.

ii. If not, justify that the determination in using this assumption of 3000 cycles for the "letdown flow step decrease and return to normal" transient is based on an evaluation consistent with requirements in ASME Code Section III NB-3200.

c) Justify the assumption that the "letdown flow step decrease and return to normal" transient can be extended to 3,000 cycles for 60 years. In addition, provide the basis that this assumption is conservative and supports the disposition of 10 CFR 54.2 (c)(1)(ii).

d) Clarify the nozzles CUFs that are not affected by this increase in the "letdown flow step decrease and return to normal" transient described in LRA Section 4.3.8, considering the LRA states that the CUF value increased to 0.0563 for the tube side nozzles.

RAI 4.3-18

Background:

LRA Section 4.3.8 provides a list of transients that were in the design specification for RHR heat exchanger and states that all of these transients except "pressurization" are monitored by the Fatigue Monitoring Program. The LRA states that the design specification describes the "pressurization" event as pressurization to the design pressure, at the design temperature and ***can*** occur coincidentally with plant cooldown and plant heatup.

Issue:

It is not clear to the staff whether it is only possible for the "pressurization" transient to occur coincidentally with plant cooldown and plant heatup and will not occur coincident with any other transient.

Request:

a) Confirm that the "pressurization" transient can only occur coincident with plant cooldowns and plant heatups and cannot occur coincident with any other transient. Based on this response, clarify whether the "pressurization" transient ***will*** occur coincident with each and every occurrence of the identified transient(s).

b) If it is possible for the "pressurization" transient to occur coincident with any other transient other than plant cooldowns and plant heatups, provide the reason that the Fatigue Monitoring Program will ensure that this fatigue waiver remains valid during the period of extended operation.

RAI 4.3-19

Background:

LRA Table A4-1 contains Commitment No. 38, which states that the number of the most severe reactor coolant pump (RCP) CCW transient, elevated CCW inlet temperature transients, will be limited to 75 percent of its design value (i.e., limited to 150) in order to accommodate the seasonal temperature change transient in the RCP thermal barrier flange fatigue analysis.

LRA Section 4.3.2.1 states that the Seasonal Temperature Change is the only transient not counted.

LRA Section A3.2.1.1 states that the transients used in the fatigue analysis of the thermal barrier flange at the CCW connection will be tracked by the Fatigue Monitoring Program, summarized in Section A2.1.

Issue:

LRA Section A3.2.1.1 does not identify that elevated CCW injection temperature transients will be limited to 75 percent of its design value (i.e., limited to 150). Furthermore, the staff noted that A3.2.1.1 does not clearly indicate that, with the exception of the seasonal temperature change transient, the transients used in the fatigue analysis of the thermal barrier flange at the CCW connection will be tracked by the Fatigue Monitoring Program.

10 CFR 54.21(d) requires that the FSAR supplement contain a summary description of the program and activities for managing the effects of aging. Without an explicit reference to the 75 percent limit of the design value of the elevated CCW inlet temperature transients, the proposed FSAR supplement in LRA Section A3.2.1.1 does not reflect an accurate summary description of the program and activities to manage the effects of aging.

Request:

a) Revise LRA Section A3.2.1.1 to indicate that elevated CCW injection temperature transient will be limited to 75 percent of its design value (i.e., limited to 150) in order to accommodate the seasonal temperature change transient in the RCP thermal barrier flange fatigue analysis. In lieu of this revision, identify the section of the current FSAR that references this limitation for the elevated CCW injection temperature transient.

b) Revise LRA Section A3.2.1.1 to indicate that, with the exception of the seasonal temperature change transient, the transients used in the fatigue analysis of the thermal barrier flange at the component cooling water connection will be tracked by the Fatigue Monitoring Program.

RAI 4.3-20

Background:

LRA Section 4.3.4, as amended by letter dated May 3, 2012, states that the CUF for wetted reactor coolant pressure boundary (RCPB) locations were categorized based on the strain rate of the dominant transient, which was determined with a qualitative assessment based on experience and not a quantitative stress analysis. In addition, this estimated strain rate was used to calculate an estimated environmental fatigue effect multiplier (F_{en}.)

It further states that this estimated F_{en} was then averaged with the maximum F_{en} for that material type to calculate the average F_{en}, which was used with the design basis CUFs to calculate the estimated EAF CUF. The estimated F_{en} value was based on NUREG/CR-5704 for austenitic stainless steels, NUREG/CR-6583 for carbon and low alloy steels and NUREG/CR-6909 for Ni-Cr-Fe steels. These estimated EAF CUFs were then organized according to their system, thermal zone and material type.

LRA Section 4.3.4, as amended by letter dated May 3, 2012, defines a thermal zone as a collection of piping and/or vessel components which undergo essentially the same group of thermal and pressure transients during plant operations.

Issue:

Since the estimated strain rate was determined based on a qualitative assessment, judgment of the appropriate strain rate must be made based on knowledge of, at a minimum, the transient, system and/or thermal zone in question. However, the applicant did not provide the details of how this qualitative assessment was performed for its plant nor was it justified that this approach was appropriate or conservative for the Callaway plant.

Since the estimated EAF CUFs were organized according to their system, thermal zone and material type, the staff noted that to have a meaningful comparison of the EAF CUFs, it is important that the CUFs were assessed similarly (e.g., amount of rigor in calculating CUF) and used the same fatigue curves in ASME Code, Section III, Appendix I.

In addition, since the LRA states that NUREG/CR-6909 was used for Ni-Cr-Fe steels, it is not clear whether the fatigue curve in Appendix A, Figure A.3, of NUREG/CR-6909 was used when using the F_{en} expression for Ni-Cr-Fe steels.

Request:

a) Describe the qualitative assessment that was used to categorize the CUF for wetted RCPB locations based on the strain rate of the dominant transient and provide the basis that this assessment is appropriate or conservative for the Callaway plant. As part of this description and justification, specifically include the criteria of the qualitative assessment to determine the appropriate strain rate to use in the categorization of EAF CUF.

b) Provide the reason that the method for calculating the average F_{en} (i.e., average of the estimated F_{en} and the maximum F_{en} for the material type) is appropriate and conservative for the plant-specific conditions.

c) Confirm that the EAF CUFs that were organized according to their system, thermal zone and material type were assessed similarly (e.g., amount of rigor in calculating CUF) and used the same fatigue curves in ASME Code Section III Appendix I to provide a meaningful comparison. If not, provide the basis for ranking or comparing the EAF CUFs to one another to provide an appropriate method for screening and determining a "sentinel" location.

d) Since NUREG/CR-6909 was used for Ni-Cr-Fe steels, confirm that the fatigue curve in Appendix A, Figure A.3, of NUREG/CR-6909 was used for determining the F_{en} of Ni-Cr-Fe steels and EAF CUFs for Ni-Cr-Fe components. If not, provide the basis for not considering Figure A.3 of NUREG/CR-6909 for screening and determining a "sentinel" location.

RAI 4.3-21

Background:

LRA Section 4.3.4, as amended by letter dated May 3, 2012, indicates that an initial screening list may have been reduced by using one of the following methods:

- *One Thermal Zone can bound another Thermal Zone in a System*
- *One material in a Thermal Zone can bound other materials in the same Thermal Zone*
- *One material in a Thermal Zone can bound other materials in another Thermal Zone*

LRA Section 4.3.4, as amended by letter dated May 3, 2012, defines a thermal zone as a collection of piping and/or vessel components which undergo essentially the same group of thermal and pressure transients during plant operations.

Issue:

Since the initial screening list may have been reduced by using one of the methods described above, which is based on the CUF, F_{en}, thermal zone and material type, the staff noted that in order to have a meaningful comparison to screen EAF CUFs it is important that the CUFs were assessed similarly (i.e., amount of rigor in calculating CUF) and used the same fatigue curves in ASME Code, Section III, Appendix I. In addition, the applicant did not provide specific examples of how/when these methods were used to reduce the initial screening list; therefore, it is not clear how each method was applied and a basis was not provided to support that these methods are appropriate and conservative.

In addition, since the LRA states that NUREG/CR-6909 was used for Ni-Cr-Fe steels, it is not clear whether the fatigue curve in Appendix A, Figure A.3, of NUREG/CR-6909 was used when using the F_{en} expression for Ni-Cr-Fe steels.

Specifically for the "One Thermal Zone can bound another Thermal Zone in a System" method, it is not clear that a higher CUF and F_{en} in one thermal zone bounds a lower CUF and F_{en} from a different thermal zone. Factors such as the following should be considered, at a minimum: (1) the CUF values having been assessed similarly in both thermal zones (i.e., amount of rigor in calculating CUF), (2) use of the same fatigue curves in ASME Code, Section III, Appendix I when comparing CUF, and (3) the thermal zone being considered "bounding" should experience thermal and pressure transients that are more severe compared to the other thermal zone.

Specifically for the "One material in a Thermal Zone can bound other materials in the same Thermal Zone" method, it is not clear that a higher CUF and F_{en} for one material in one thermal zone will always bound a lower CUF and F_{en} of all other materials in the same thermal zone. Factors such as the following should be considered, at a minimum: (1) the CUF values having been assessed similarly for all materials (i.e., amount of rigor in calculating CUF) and (2) the material properties of the components in question, which can affect CUF and F_{en}.

Finally, the "One material in a Thermal Zone can bound other materials in another Thermal Zone" method is a combination of the two methods described above. Thus, the staff's concern about those methods is also applicable.

Request:

For the "One Thermal Zone can bound another Thermal Zone in a System" method:

a) Provide two examples of when this method was used to reduce the initial screening list, including a reason that this method was appropriate and conservative for each situation.

b) Provide the reason that a higher CUF and F_{en} in one thermal zone will bound a lower CUF and F_{en} from a different thermal zone. As part of the justification, specifically address any factors or criteria that are applicable when implementing this method.

c) If the following factors and criteria were not included, as part of the response above, provide the reason that they are not appropriate and do not need to be considered: (1) CUF values being assessed similarly in both thermal zones (i.e., amount of rigor in calculating CUF), (2) use of the same fatigue curves in ASME Code, Section III, Appendix I when comparing CUF, and (3) the thermal zone being considered "bounding" should experience thermal and pressure transients that are more severe compared to the other thermal zone.

For the "One material in a Thermal Zone can bound other materials in the same Thermal Zone" method:

d) Provide two examples of when this method was used to reduce the initial screening list, including a reason that this method was appropriate and conservative for each situation.

e) Provide the reason that a higher CUF and F_{en} for one material in one thermal zone will bound a lower CUF and F_{en} of all other materials in the same thermal zone. As part of the justification, specifically address any factors or criteria that are applicable when implementing this method.

f) If the following factors and criteria were not included, as part of the response above, provide the reason that they are not appropriate and do not need to be considered: (1) CUF values being assessed similarly for all materials (i.e., amount of rigor in calculating CUF) and (2) the material properties of the components in question, which can affect CUF and F_{en}.

For the "One material in a Thermal Zone can bound other materials in another Thermal Zone" method:

g) Provide two examples of when this method was used to reduce the initial screening list, including a reason that this method was appropriate and conservative for each situation.

h) Provide the reason that one material in a thermal zone can bound other materials in another thermal zone. As part of the justification, specifically address any factors or criteria that are applicable when implementing this method.

i) If the following factors and criteria were not included, as part of the response above, provide the reason that they are not appropriate and do not need to be considered: (1) CUF values being assessed similarly in both thermal zones for the different materials (i.e., amount of rigor in calculating CUF), (2) the material properties of the components in question, which can affect CUF and F_{en}, and (3) the thermal zone being considering "bounding" should experience thermal and pressure transients that are more severe compared to the other thermal zone.

September 6, 2012

Mr. Adam C. Heflin
Senior Vice President and Chief Nuclear Officer
Union Electric Company
P.O. Box 620
Fulton, MO 65251

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE CALLAWAY PLANT, UNIT 1, LICENSE RENEWAL APPLICATION, SET 9, METAL FATIGUE (TAC NO. ME7708)

Dear Mr. Heflin:

By letter dated December 15, 2011, Union Electric Company d/b/a Ameren Missouri (the applicant) submitted an application pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54) for renewal of Operating License No. NPF-30 for the Callaway Plant, Unit 1. The staff of the U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing this application in accordance with the guidance in NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants." During its review, the staff has identified areas where additional information is needed to complete the review. The staff's requests for additional information are included in the enclosure. Further requests for additional information may be issued in the future.

Items in the enclosure were discussed with Sarah G. Kovaleski, of your staff, and a mutually agreeable date for the response is within 30 days from the date of this letter. If you have any questions, please contact me by telephone at 301-415-2946 or by e-mail at Samuel.CuadradoDeJesus@nrc.gov.

Sincerely,
/RA/
Samuel Cuadrado de Jesús, Project Manager
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosure:
As stated

cc w/encl: Listserv
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NAME	IKing	SCuadrado	DMorey	SCuadrado
DATE	8/29/2012	8/29/2012	9/5/2012	9/6/2012

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Letter to A. Heflin from S. Cuadrado DeJesus dated September 6, 2012

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE CALLAWAY PLANT, UNIT 1, LICENSE RENEWAL APPLICATION, SET 9, METAL FATIGUE (TAC NO. ME7708)

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