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

March 26, 2013

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 23 (TAC NO. ME7708)

Dear Mr. Heflin:

By letter dated December 15, 2011, Union Electric Company (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 (Callaway). The staff of the U.S. Nuclear Regulatory Commission 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

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/RA/

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

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CALLAWAY PLANT UNIT 1
LICENSE RENEWAL APPLICATION
REQUEST FOR ADDITIONAL INFORMATION, SET 23

RAI B2.1.3-1b

Background:

By letter dated November 20, 2012, the applicant responded to RAI B2.1.3-1a, and stated that the threads for stud No. 18 and its stud hole were inspected immediately prior to installation of the stud. The applicant also stated that when the stud became stuck, excessive force was not used in an attempt to free the stud, and therefore no threads were damaged by installation of the stud. The applicant further stated that although the threads of stud No. 18 have not been inspected for damage due to wear or corrosion, the other 53 reactor vessel studs and stud holes have been inspected. The applicant also stated that since 1992, no damage to the threads of the other studs and stud holes has been observed. The applicant further stated that since stud No. 18 is exposed to the same environment as the other studs, except during refueling, it is reasonable to conclude that damage to the threads due to corrosion or wear has not occurred. The applicant stated that the ultrasonic test (UT) examination is capable of identifying cracking and severe corrosion of the threads.

In addition, the applicant provided a sketch of the stuck stud and the stud hole to demonstrate its basis that with the stud 2 5/8 inches from the bottom of the stud hole, the stuck stud still has 6.505 inches of thread engagement. The applicant also provided the basis for stating that only 6.31 inches of thread engagement is required to meet the ASME code limits.

Issue:

The staff finds that the applicant's response still did not address the possibility of thread damage to the vessel flange or stud threads as a result of the stud getting stuck. In addition, in its response to RAI B2.1.3-1, the applicant had stated that stud No. 18 had two locations on threads 10 and 11 which were reworked just prior to the stud getting stuck (burrs which were removed).

The staff noted that the applicant is assuming that conditions for the stuck stud are the same as the others without providing any technical basis. The staff noted that at the location of the stuck stud, the stresses would be higher than at the other locations due to less thread engagement. Furthermore, the staff noted that the applicant is assuming that future tensioning and de-tensioning operations will not cause any wear, and that there will be no loss of material due to corrosion. The staff finds that this reasoning is nonconservative and contrary to the engineering evaluations performed in 1987 and 1989, which the applicant has relied on to justify the continued the use of stud No. 18 in its current stuck position. Specifically, the 1989 evaluation recommended that if damage approaches the limiting value (6.3 inches of engagement or 19.5 threads missing), or if the vessel is operated with a missing stud, vessel hydrotest should be avoided, and the plant heat up rate should be limited to half the design value in order to minimize the risk of localized plastic deformation.

The staff also noted that, as stated by the applicant in its response, the current UT examinations performed on the stuck stud and its flange hole would only be able to detect cracking or severe thread corrosion. Since the number of fully engaged threads for this location is near the acceptance level, a marginal reduction in the number of properly engaged threads may bring the effective number of engaged threads below the acceptance criteria. Furthermore, the staff does not agree with the applicant's assertion that the conditions at this location are typical of the remaining 53 locations. Specifically, since the stud at No. 18 is stuck 2 5/8 inches from the bottom of the flange hole and has fewer threads engaged, it has higher stresses than those that have no thread damage or more threads engaged. As stated earlier, this location would be more susceptible to localized plastic deformation.

Since the applicant's stated acceptance criteria for the minimum allowable thread engagement (6.31 inches) is very close to the acceptable calculated thread engagement for stud No. 18 (6.505 inches). The staff does not have reasonable assurance that the applicant's current UT examinations will detect thread degradation prior to exceeding the acceptance criteria.

Request:

Clarify how the applicant's aging management program will detect thread damage on the stud and vessel flange hole threads at locations with stuck studs, as the future condition of these threads cannot be deterministically verified given the applicant's current assumption and inspection methodology if a stud remains in place.

RAI B2.1.3-2b

Background:

By letter dated November 20, 2012, the applicant responded to RAI B2.1.3-2a, stated that review of plant records confirmed that reactor vessel stud No. 15 was replaced in June of 1984, and stud No. 35 was replaced in the spring of 1989. The applicant also stated that these studs were replaced due to thread damage. The applicant further stated that no other repair or replacement activities were discovered in the review of plant records.

In addition, the applicant provided a brief summary of two engineering evaluations which were performed on its RV closure head studs in 1987 and 1989. The applicant stated that the two evaluations were related to the problems the applicant has experienced with the reactor vessel studs and flange threads. The applicant stated that both of the evaluations addressed minimum thread engagement, and based on those evaluations the value of 6.31 inches has been used by the applicant to determine acceptability of the reactor vessel stud thread engagement. The applicant further stated that the 1989 evaluation provided criteria for taking partial credit for damaged threads, however all damaged threads were removed from the stud holes in 1989 and 1992, and all studs with damaged threads were replaced.

The applicant stated that the first evaluation was performed in 1987, when in refueling outage (RFO) 2, five reactor vessel studs became stuck. The applicant also stated that the evaluation provided justification for operation in the subsequent cycle with one stud untensioned and the other four studs with partial engagement. The applicant further stated that the evaluation provided three recommendations in addition to the conclusion that the plant could operate with stud No. 2 untensioned. The applicant stated that all three recommendations were satisfied.

In addition, the applicant stated that the purpose of the 1989 report was to develop criteria to accept or reject reactor vessel thread degradation on a generic basis. The applicant also stated that the report provided five recommendations. The applicant further stated that it has met all five recommendations.

Issue:

During its review, the staff noted that both evaluations (1987 and 1989) assumed that, with the exception of the five studs hole locations (Nos. 2, 4, 5, 7, and 9) all the other remaining studs and stud hole threads had no degradation. Furthermore, the 1989 report also anticipated that a laser inspection technique would be used to accurately evaluate thread damage at the facility, noting that the laser inspection technique would yield high quality profile of damaged threads; the report further stated that care should be exercised in the evaluation of areas with uniform wear, because they may appear intact but may in fact be out of tolerance. It is not clear to the staff whether the applicant has employed this specific technique in evaluating thread damage.

In contrast to the conditions assumed in the 1987 and 1989 evaluations, additional stud hole locations have known thread damage (i.e., 13, 25, 39, 53, and 54). Furthermore, stud No. 18 has been stuck since 1996, with partial thread engagement. The staff also noted that the affected locations are mostly on one side of the RPV flange periphery.

In addition, during review of the applicant's reply, the staff noted that recommendation 2 (from the 1989 report), stated in part that studs used in vessel flange holes with degraded threads should be free from damage. Since the applicant stated that two threads on the No. 18 stud were re-worked, it is not clear to the staff that recommendation 2 from the 1989 report will be met for this location. Furthermore, recommendation 4 (also from the 1989 report) states in part that if damage approaches the limiting values, or if the vessel is operated with a missing stud, vessel hyrdotests should be avoided, and the plant heat-up rate limited to 50 °F/hr in order to minimize the risk of localized plastic deformation. It is not clear to the staff that this aspect of recommendation 4 is met.

Request:

a) Clarify if the thread inspections for the vessel flange hole and stud threads include a laser inspection method referenced in the 1989 report, which can accurately gauge thread degradation so that there is assurance that any damage which is present does not exceed the acceptance criteria prior to the next inspection.

b) The evaluations performed in 1987 and 1989 assumed that with the exception of location Nos. 2, 4, 5, 7, and 9, there were no other damaged locations. Since additional damage has occurred, provide justification that the evaluations and the acceptance criteria provided by these reports will be valid during the period of extended operation and that the overall adequacy of the entire RPV flange assembly will be adequately managed during the period of extended operation.

Follow-up RAI 4.3-22:

Background:

In its response dated October 11, 2012, to Part (c) of RAI 4.3-20, the applicant made the following assumptions:

- The applicant stated that "it is assumed that the same fatigue curves for each material were used for the analyses relied upon for the screening." It is not clear to the staff how the applicant justified or verified that the assumption is valid for its components.

- The applicant also stated that "the level of analytical rigor has not been specially reviewed." It is not clear how the applicant can draw conclusions from a comparison of its fatigue analyses for the Environmentally Assisted Fatigue (EAF) screening. The applicant has not substantiated its conclusion that the cumulative usage factor (CUF) values are expected to have been performed using the same level of rigor.

- The applicant also claimed that "[b]ased on analytical experience and engineering judgment, the relative design report CUF values of the components indicate that any transient lumping used in the various analyses have not skewed the screening and ranking results." However, the applicant did not further elaborate or discuss the specific "engineering judgment" it used and any associated actions to come to the conclusion that transient lumping did not skew the EAF screening and ranking results.

In its response dated October 11, 2012, to Part (a) of RAI 4.3-21, as revised by letter dated December 13, 2012, the applicant made the following assumption:

- The applicant assumed that the comparison of CUF including the effects of the environment (U_{en}) calculations across multiple thermal zones is valid. The applicant provided an example supporting one of its principles for removing "sentinel locations" that one thermal zone can bound another thermal zone is conservative. The staff noted that the original design reports may have been performed by different vendors, which may result in different fatigue analyses performed at different times. The applicant has not demonstrated that the level of rigor is comparable across these different design reports. Three examples of this are whether the transients are consistently bundled or not bundled in the calculation of different CUF values, whether consistent material properties are used, and whether the American Society of Mechanical Engineers (ASME) Code editions are consistent.

Issue:

In essence, the staff noted that the applicant has not demonstrated that the U_{en} values of the applicant's systems were calculated with the same level of rigor or conservatism. Without demonstrating that the U_{en} values share a common calculational basis, the resulting ranking and comparisons may not appropriately determine the "sentinel" locations to be monitored by the Fatigue Monitoring Program.

Request:

For each of the four assumptions identified above and any other assumptions made, provide plant-specific situations that are based on the applicant's data and analyses to further justify that these assumptions would allow meaningful and valid comparisons among calculated U_{en} values at the applicant's facility.

Follow-up RAI 4.3-23

Background:

In its letter dated December 13, 2012, the applicant revised LRA Section 4.3.4 stating that a location that can be shown to be bounded by another location on a "common basis stress evaluation" may be removed from the "sentinel location" list. The applicant provided a qualitative explanation that this judgment relies upon the comparison of transients in terms of severity and/or number of occurrences.

Issue:

In order for the staff to determine whether the "common basis stress evaluation" is appropriate or valid for the applicant's facility, additional information is needed related to the scope, parameters considered, and assumptions involved.

Request:

(a) Clarify whether the "common basis stress evaluation" performed the comparison of only the transient severity and the number of transient occurrences.

    1. If yes, justify why comparing only severity and the number of occurrences would result in a valid evaluation to eliminate a sentinel location.

    2. If not, identify all other parameters that were used in the comparison and justify that those parameters are sufficient to evaluate the elimination of a sentinel location.

(b) Justify why the geometry of the locations (whether it is a straight pipe, a nozzle, a tee, or a 90-degree bend) being compared does not need to be considered for the charging nozzle/chemical and volume control (CVCS) system.

(c) Clarify whether the locations being compared must be the same type of materials. If not, justify that the "common basis stress evaluation" is valid when comparing different types of materials.

(d) Clarify whether the stress, CUF, or U_{en} values of the locations has been used in the "common basis stress evaluation." Clarify whether the stress, CUF, or U_{en} values have been reviewed to confirm that the results of the common basis stress evaluation are valid for the applicant's site.

(e) Clarify whether the charging nozzle/CVCS system is the only example where a "common basis stress evaluation" was performed. If not, identify all systems in the applicant's site that a "common basis stress evaluation" was performed to remove location(s) from the "sentinel location" list and justify that the common basis stress evaluation is valid.

Follow-up RAI 4.3-24:

Background:

In its response dated October 11, 2012 to Part (d) of RAI 4.3-21, as revised by letter dated December 13, 2012, the applicant provided an example supporting one of its principles that one material can bound other materials in the same thermal zone. The applicant also stated in its revised LRA dated December 13, 2012, that a location that can be shown to be bounded by another location on a common basis stress evaluation may be removed from the "sentinel location" list. The applicant indicated that those plant-specific locations, in LRA Table 4.3-6, with U_{en} greater than 1.0 will be evaluated further using the same methods as those to remove conservatisms for NUREG/CR-6260 locations described in LRA Section 4.3.4.

Issue:

The staff noted that the U_{en} value of different materials may respond differently when the EAF is being refined in the future. Using the information in Part (d) of RAI 4.3-21 as an example, the action to refine the U_{en} of the stainless steel Pressurizer Instrument Nozzle will not always proportionally refine the U_{en} of the low alloy steel for the Pressurizer Upper Head/Upper Shell. The applicant has not justified that the low alloy steel components would remain bounded by the stainless steel components after the EAF has been refined to reduce the U_{en} of the stainless steel components. The applicant has not explained how nor justified that the refinement of a higher U_{en}, in LRA Table 4.3-6, of one material would ensure the reduction of U_{en} for a bounded location of another material.

Request:

(a) Justify that the refinement of a higher U_{en}, in LRA Table 4.3-6, of one material would ensure the reduction of the U_{en} for a bounded location of another material, such that the conclusion that one material bounds other materials in the same thermal zone will remain valid.

(b) Justify that the refinement of a higher U_{en}, in LRA Table 4.3-6, of one location would ensure the reduction of the U_{en} for a bounded location, such that the conclusion from the common basis stress evaluation will remain valid.

Follow-up RAI 4.3-25

Background:

The elastic modulus, E, to be used for the austenitic stainless steel fatigue curve in Figure I-9.2 in the ASME Code Section III Appendix I, has changed from 26 $\times 10^6$ psi in the 1980 edition to 28.3$\times 10^6$ psi in the 1983 edition.

Issue:

It is not clear to the staff whether the change in the stainless steel material property in the aforementioned ASME Code editions has been considered in the U_{en} comparison.

Request:

Identify all the stainless steel components that were designed to the ASME Code editions that were after the 1980 edition. For each of these components, clarify whether the corresponding thermal zone bounded another stainless steel component that was designed to the 1980 ASME Code edition or earlier. Justify that the comparison of U_{en} values that were calculated with different code editions is appropriate when the values of the elastic modulus are different.

Follow-up RAI 4.3-26

Background:

In its response dated October 11, 2012, to Parts (d) of RAI 4.3-21, as revised by letter dated December 13, 2012, the applicant stated that the EAF screening was revised to not use the equation in NUREG/CR-6909 for the F_{en} of Ni-Cr-Fe; instead, the revised calculation used NUREG/CR-5704 to compute F_{en} values for Ni-Cr-Fe material. The applicant also revised LRA Table 4.3-7 indicating two Ni-Cr-Fe components (RPV Bottom Head Instrument tubes and RSG Tube-to-tubesheet connection) as the "sentinel locations."

Issue:

The staff noted that in LRA Table 3.1.2.3, there are nickel alloy pressurizer safe ends that are exposed to the reactor coolant environment with the aging effects of cumulative fatigue damage. The staff noted that given the F_{en} value calculated using NUREG/CR-5704 is typically greater than 10, there is a high probability that nickel alloy components would be identified as "sentinel locations." The staff did not find any reference related to these nickel alloy components as "sentinel locations" from the list in LRA Table 4.3-7. It is not clear to the staff how this component has been bounded by the three stainless steel pressurizer locations identified in LRA Table 4.3-7.

Request:

Identify the nickel alloy component(s) in the pressurizer safe ends and the associated CUF and F_{en} values. Demonstrate how the nickel alloy locations have been bounded by the three stainless steel pressurizer locations identified in LRA Table 4.3-7.

Follow-up RAI 4.3-27

Background:

The applicant stated in its Fatigue Monitoring Program that, for the Cycle-Based Fatigue (CBF) monitoring method, the fatigue accumulation is tracked to determine the approach to the ASME Code allowable fatigue limit of 1.0. Enhancement 6 of the program stated that procedures will be enhanced to include additional "cycle-count action limits" and "fatigue usage action limits," which will allow adequate time for completion of corrective actions if the "design limits" are projected to be exceeded within the next three fuel cycles.

Issue:

In its letter dated December 13, 2012, the applicant revised LRA Section 4.3.4, indicating that the 60-year projected U_{en} is 0.74 for the safety injection nozzle. The staff noted that the 60-year projected cycle counts are the same as the numbers of cycles to-date for three transients assumed in the safety injection nozzle EAF analysis.

The staff noted that the premise of CBF is that the incremental fatigue usage of each transient can be accumulated to provide a fatigue usage as the components are being monitored during the period of extended operation. Furthermore, the fatigue accumulation is calculated in accordance with the ASME Code because the incremental fatigue usage for each transient was supported by a fatigue analysis with an assumed number of occurrences for each transient.

However, the staff noted the incremental fatigue usage may change after the number of occurrences of a transient had exceeded that assumed in the fatigue analysis. This happens because of the transient-pairing provision delineated in ASME Code Section III Paragraph NB-3222.4(e)(5).

Request:

(a) Clarify how the incremental fatigue usage and fatigue accumulation will be tracked when the cycle count is beyond those assumed in the fatigue analysis. Justify that, prior to reaching the "fatigue-usage action limit," incremental fatigue usage for additional occurrences beyond those assumed in the fatigue analysis will be calculated in accordance with the ASME Code.

(b) Justify that, for the safety injection nozzle, the implementation of a "fatigue-usage action limit" would ensure that corrective action will be initiated before exceeding the design limit.

(c) For all the locations monitored by CBF, clarify whether the safety injection nozzle is the only location that was analyzed for the number of transient cycles to-date. If not, identify all the locations that were analyzed for their respective number of cycles to-date and justify that the implementation of "fatigue-usage action limits" would ensure that corrective action will be initiated before a location exceeds its design limit.

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