CALLAWAY PLANT UNIT 1
LICENSE RENEWAL APPLICATION

REQUEST FOR ADDITIONAL INFORMATION (RAI) SET #26 RESPONSES

RAI B2.1.3-1c

Background:

By letter dated April 26, 2013, the applicant responded to RAI B2.1.3-1b, and stated in part that detensioning of stud No. 18 during each refueling outage (RFO) confirms its intended function will be maintained. The applicant also stated that normal reactor pressure vessel (RPV) head stud tensioning and detensioning operations performed during each RFO are a form of "proof test" of the adequacy of the threaded connection to support in-service RPV head stud loads. The applicant further stated that the minimum RPV head stud load experienced by RPV head stud No. 18 during detensioning is a 113 percent proof test of the maximum in-service primary plus secondary RPV head stud loading during heatup.

The applicant stated that the 1987 evaluation which calculated the RPV head stud minimum thread engagement (6.31 inches) was based on a conservative methodology. The applicant also stated that an evaluation performed in 2013 demonstrates that the minimum RPV head stud engagement required to resist all primary loads is 4.77 inches. The applicant further stated that the stuck stud No. 18 nominally has in excess of 35 percent more thread engagement than is required to meet American Society of Mechanical Engineers (ASME) Code limits, and that the margin is sufficiently large that the comments related to plastic deformation in the 1989 evaluations do not apply to RPV stud No. 18.

The applicant stated that although the condition of the threads on the inside of the RPV head stud hole No. 18 cannot be observed through direct visual examination, the 2013 evaluation performed a bounding estimate based on the amount of force used during efforts to remove stud No. 18 and concluded that the effective damage could be no more than 20 percent of a single thread, which would result in less than 0.025 inches of lost effective thread engagement. The applicant also stated that stud No. 18 is protected from boric acid corrosion by encapsulation during refueling to prevent exposure to the boric acid in the refueling pool. The applicant further stated that most wear occurs when an RPV head stud is threaded in and out of the RPV head stud hole, since stud No. 18 is stuck, it is not removed or installed, therefore essentially there is no wear (loss of material).

In addition, the applicant stated that the existing RPV head stud handling procedures and practices do not damage threads. The applicant stated that with the exception of minor maintenance on RPV head stud No. 18 (burr removal in 1996) and RPV head stud No. 20 (chasing lead threads), no threads have been damaged in over 20 years. The applicant also stated that it has not destructively removed an RPV head stud since 1989, when five stuck studs were removed due to their interference with the fuel transfer path and to restore functionality to RPV head stud No.2. The applicant further stated that at that time the risks associated with destructive removal, which included possible introduction of foreign material, worker safety, dose exposure, possibility of additional damage during the repair process, technical challenges associated with the RPV head stud removal tooling, and failure to restore the normal fuel transfer path, were acceptable in order to repair the RPV.

Finally, the applicant stated that given the above considerations, it is considered appropriate to monitor and manage the continued use of RPV head stud No. 18 rather than pursue its removal.

Issue:

The staff finds that the applicant's response still did not fully address how the condition of the threads for the RPV head stud and stud hole No.18 would be monitored during the period of extended operation. In its response the applicant stated that normal RPV head stud tensioning and detensioning operations performed during each RFO is a form of "proof test" of the adequacy of the threaded connection to support in-service RPV head stud loads for the subsequent cycle. The staff does not agree that successful tensioning and detensioning provides adequate assurance that the threads will withstand all in-service loads in the subsequent operating cycle. Specifically, the tensioning and detensioning is usually performed at ambient temperatures. In addition, during tensioning and detensioning, some of the stresses may be distributed or shared by the adjacent studs and flange ligaments, while during in-service transients the adjacent areas may not be able to share as much of the stresses.

Furthermore, the staff noted that the applicant is essentially assuming zero corrosion at the location of the stuck stud, because the stuck stud is encapsulated during RFOs. The staff noted that leakage past the encapsulation may occur along with leakage past the inner o-ring, and therefore loss of material at this location is an aging effect which requires management during the period of extended operation.

Request:

Explain how the current aging management program (AMP) will monitor the condition of the threads on the stud and vessel flange hole threads, so that there is reasonable assurance that the known degradation and any postulated degradation along with the number of unengaged threads will not exceed the acceptance criteria during the period of extended operation.

Callaway Response

Based on the clarification call held with the Staff on July 30, 2013, Callaway understands that this request specifically pertains to reactor pressure vessel (RPV) stud and stud hole #18.

Callaway manages cracking and loss of material in the RPV stud and stud hole #18 consistent with the Reactor Head Closure Stud Bolting program. Callaway performs volumetric examinations of the threads of RPV stud and stud hole #18 in accordance with ASME Section XI. Any discontinuities or flaws that have not been documented previously would be entered in the Corrective Action Program for evaluation and corrective action. Callaway follows the recommendations of Regulatory Guide 1.65, *Materials and Inspections for Reactor Vessel Closure Studs*, to prevent degradation of the studs. In addition, RPV stud and stud hole #18 are protected from exposure to the borated water of the refueling pool to prevent loss of material due to corrosion.

To allow for monitoring of the condition of the threads on the RPV stud and vessel flange hole threads relative to aging, Callaway commits to remove RPV stud #18 through non-destructive or destructive means. If RPV stud hole repair is required following removal of stud #18, the repair plan will include inspecting the RPV stud hole prior to the repair to assess the as-found condition and an inspection after the repair is complete to assess the results of the repair. This commitment will be completed no later than 6 months prior to the period of extended operation or the refueling outage prior to the period of extended operation, whichever occurs later. Note that removal of RPV stud #18 is not scheduled earlier than Refueling Outage 21.

The Reactor Head Closure Stud Bolting program and the additional commitment will manage the aging of RPV stud and vessel flange hole threads for RPV stud #18 and provide reasonable assurance that aging effects will be managed such that the RPV stud and vessel flange hole threads will continue to perform their intended functions consistent with the current license basis for the period of extended operation. LRA Table A4-1 item 41 has been added as shown in Amendment 26 in Enclosure 2.

Corresponding Amendment Changes

Refer to the Enclosure 2 Summary Table "Amendment 26, LRA Changes" for a description of LRA changes with this response.

RAI B2.1.3-2c

Background:

By letter dated April 26, 2013, the applicant responded to RAI B2.1.3-2b, and stated that during the 1989 and 1992 repairs, a tool especially designed for inspection of RPV stud holes was used which produced a high quality video of the stud hole threads by using a laser to illuminate and map the profile of the threads. The applicant stated that the laser inspection tool was used before and after the repairs. The applicant also stated that since 1992, due to improved RPV head stud handling procedures, only one minor indication was found on RPV stud hole No. 20 threads. The applicant further stated that the laser inspection device has not been used since 1992.

In addition the applicant stated that the 1989 evaluation was intended to apply to the remainder of the "RPV design life" and includes a discussion on the pattern of the degraded RPV head at that time, however the thread damage existing at that time was used only to support the discussions estimating the effective thread engagement in hole locations 2, 4, 5, 7, and 9. The applicant also stated that thread damage to RPV stud hole Nos. 13, 25, 39, 53 and 54, subsequent to the 1989 evaluations do not invalidate past evaluations as long as the minimum thread engagement criteria are met. The applicant further stated that the thread degradation evaluation criteria developed in the 1989 report was analyzed such that each RPV stud engagement region fully meets applicable ASME Code rules, provided that the thread degradation evaluation criteria are met for each vessel stud hole. The applicant stated that using this evaluation, the RPV flange as a whole would fully meet ASME Code rules even if the effective thread engagement of all 54 RPV head stud locations were at a minimum. The applicant stated that there is no interaction mechanism between adjacent RPV stud hole locations, provided that each one meets the acceptance criteria established in the 1989 evaluation.

The applicant also stated that Recommendation 2 from the 1989 evaluation which stated that "studs used in vessel flange holes with degraded threads should be free from damage," was based on the assumption that the vessel threads would engage with RPV head stud threads that were each fully intact. The applicant stated that use of RPV head stud No. 18 after removing a small burr was not in conflict with the recommendation that "studs used in vessel flange holes with degraded threads should be free of damage." The applicant further stated that the recommendations of the 1989 evaluations are considered to be optional since the language used was "should" rather than "must" or "shall."

The applicant stated that the 1987 evaluation calculated a 6.31 inch minimum vessel/stud thread engagement length based on a conservative calculation methodology. However a 2013 evaluation demonstrates that the minimum vessel/stud engagement required to resist all primary loads is 4.77 inches. The applicant also stated that the stuck RPV head stud No. 18 has in excess of 35 percent more thread engagement than is required to meet ASME Code limits. The applicant further stated that this margin is sufficiently large that the comments related to localized plastic deformation do not apply to stuck stud No. 18.

Issue:

During its review, the staff noted that the evaluations (1987 and 1989), essentially used similar language such as "should" rather than "must" or "shall." This is because at the time these evaluations were performed the applicant had other options, such as the option to repair the RPV stud hole locations with stud hole inserts. However, in perusing the continued use of the 1987 and 1989 evaluations to justify the use of the RPV closure bolting in its current condition (i.e., with multiple locations with less than full thread engagement), the use of the recommendations should not be considered as "optional" by the applicant. In addition, since these evaluations are only valid if the acceptance criteria are still being met, the staff still seeks assurance that for locations Nos. 2, 4, 5, 7, 9, 13, 18, 25, 39, 53, and 54 the minimum thread engagement criteria will continue to be met during the term of the renewed license, with sufficient margin such that there is an extremely low probability of abnormal leakage, rapidly propagating failure, and gross rupture.

The staff noted that the applicant in its response stated that the 1989 evaluation was intended to apply to the remainder of the RPV design life. The staff reviewed the license renewal application (LRA) and did not note that the 1989 evaluation was identified as time-limited aging analyses (TLAA), the applicant's response did not provide additional information for the staff to determine whether this evaluation should have been identified as a TLAA in the LRA.

Request:

a) Explain what is meant by the term "remainder of the RPV design life," as discussed above. In addition, clarify whether the 1987 and/or 1989 evaluations should be identified as a TLAA in accordance with 10 CFR 54.3. If the evaluations are identified as TLAAs, revise the LRA accordingly and provide TLAA disposition in accordance with 10 CFR 54.21(c)(1). If not, provide the justifications why these evaluations are not considered as TLAAs.

b) Explain how the current AMP will monitor the condition of the threads such that there is adequate assurance that the acceptance criteria will continue to be met at repaired RPV stud hole location Nos. 2, 4, 5, 7, 9, 13, 25, 39, 53, and 54 during the period of extended operation.

Callaway Response

a) An analysis, calculation, or evaluation is a “Time-Limited Aging Analysis” (TLAA) under the 10 CFR 54 License Renewal Rule, only if it meets all six of the 10 CFR 54.3(a) criteria:

   (1) Involve systems, structures, and components within the scope of license renewal, as delineated in §54.4(a);

   (2) Consider the effects of aging;

   (3) Involve time-limited assumptions defined by the current operating term, for example, 40 years;

   (4) Were determined to be relevant by the licensee in making a safety determination;

   (5) Involve conclusions or provide the basis for conclusions related to the capability of the system, structure, and component to perform its intended functions, as delineated in §54.4(b); and

(6) Are contained or incorporated by reference in the current licensing basis (CLB).

The 1987 evaluation addresses questions relating to plant operation with RPV Stud #2 not tensioned and unknown thread conditions in RPV stud holes 4, 5, 7 and 9. The 1987 evaluation discussed a number of different issues that were germane to the circumstances of the contemporaneous fall 1987 refueling outage, and this report was very specific to the pattern of stuck studs and any other known thread degradation that existed at that particular point in time. This calculation provided the basis for Callaway to operate during Cycle 3 and was communicated to the NRC by letter ULNRC-1663 dated October 29, 1987. The stud and flange conditions described in the 1987 evaluation have been repaired and are no longer representative of the current stud and flange conditions.

Since the 1987 evaluation does not provide the basis for today's conclusions related to the capability of the reactor vessel studs, stud holes, or flange to perform its intended functions, the evaluation is not a TLAA in accordance with 10 CFR 54.3(a), criterion 5.

The 1989 evaluation provides acceptance criteria for thread degradation. The starting point of the evaluation acknowledges the reactor vessel flange condition as it was known in 1989. The evaluation itself contains no time-limited assumptions. Callaway's response to RAI B2.1.3-2b introduced the statement that the 1989 evaluation was "intended to apply to the remainder of the RPV design life." This descriptive phrase was meant to convey that the 1989 evaluation was forward-looking rather than a snapshot in time and could be used to evaluate similar future conditions that might arise.

Since the analyses contained within the 1989 evaluation are not time-dependent, this analysis is not a TLAA in accordance with 10 CFR 54.3(a), criterion 3.

b) It is noted that Callaway experienced problems with the reactor vessel head closure studs and stud holes early in plant life (1986 – 1992), and that multiple RPV stud holes required ASME Section XI repairs to remove damaged threads. To supplement the monitoring that is accomplished through regular volumetric inspections and to confirm that additional thread degradation is not occurring in the RPV stud holes, Callaway commits to perform a one-time inspection of select RPV stud holes using a method consistent with the Babcock and Wilcox laser inspection that was applied following stud hole repair in 1989 and 1992. RPV stud hole locations 2, 4, 5, 7, 9, and 53 have had more than one thread removed and will be inspected. If inspection of these RPV stud holes confirms that there was minimal or no additional degradation since the prior video inspection was performed, then it is a reasonable conclusion that there will be minimal additional degradation in the period of extended operation. If additional degradation is observed in any of the repaired stud holes where more than one thread has been removed, the condition will be entered in the Corrective Action Program for evaluation and corrective action, and the remaining repaired RPV stud hole locations 13, 25, 39 and 54 will be inspected. The inspection is expected to confirm that further degradation is not occurring in the repaired stud holes, and will provide a basis for the conclusion that acceptance criteria for thread engagement will continue to be met through the period of extended operation. This commitment will be completed no later than 6 months prior to the period of extended operation or the refueling outage prior to the period of extended operation, whichever occurs later.

The Reactor Head Closure Stud Bolting program and a supplemental one-time inspection will manage the aging of the threads at RPV stud hole locations 2, 4, 5, 7, 9, 13, 25, 39, 53, and 54, and provides reasonable assurance that aging effects will be managed such that the threads at RPV stud hole locations 2, 4, 5, 7, 9, 13, 25, 39, 53, and 54 will continue to perform their intended functions consistent with the current license basis for the period of extended operation. LRA Table A4-1 item 42 has been added as shown in Amendment 26 in Enclosure 2 to perform the supplemental one-time inspection.

Corresponding Amendment Changes

Refer to the Enclosure 2 Summary Table "Amendment 26, LRA Changes" for a description of LRA changes with this response.