August 27, 2001

MEMORANDUM TO: File

FROM: Jack N. Donohew, Senior Project Manager, Section 2
Project Directorate IV ***/RA/***
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SUBJECT: POTENTIAL REQUEST FOR ADDITIONAL INFORMATION FOR ELECTROSLEEVE APPLICATION DATED FEBRUARY 15, 2001, FOR CALLAWAY PLANT, UNIT 1 (TAC NO. MB1214)

By letter of February 15, 2001 (ULNRC-4391), Union Electric Company (the licensee) submitted a request to amend the Callaway Plant, Unit 1 Technical Specifications (TSs). In the application, the licensee proposed to remove the two-cycle restriction in Paragraph d.1.j)2) of TS 5.5.9, "Steam Generator (SG) Tube Surveillance Program," that requires all SG tubes containing an Electrosleeve, a Framatome proprietary process, to be removed from service within two operating cycles following installation of the first Electrosleeve. This requirement was incorporated in TS 5.5.9 in Amendment No. 132 issued May 21, 1999. The first Electrosleeve was installed in the Fall of 1999 and the two operating cycles in TS 5.5.9 will expire in the Fall of 2002. A meeting with the licensee was held on June 6, 2001, for the licensee to explain its application. The meeting summary was issued July 18, 2001 (ADAMS Accession No. ML011630355).

Attached is a request for additional information (RAI) on the application. The RAI was provided to the licensee by e-mail on July 16, 2001, to expedite the staff's review of the licensee's application. The RAI will allow (1) the licensee to review and understand the questions before the RAI is sent by letter, and (2) the staff to discuss with the licensee the date when the licensee could submit its responses to the RAI. The licensee's review of the questions will permit the licensee to understand what is being requested by the staff and the staff to understand the licensee's submittal. Based on the discussions, if any, with the licensee on the attached questions, the questions may be revised. The goal is for the staff to complete its review within one year of the date of the application.

The attached RAI was discussed with the licensee by phone on August 15, 2001. In that call, Framatome ANP, which owns the proprietary information in report BAW-10219P that was submitted with the licensee's application dated February 15, 2001, stated that the RAI contained no proprietary information. The Framatome ANP affidavit dated February 9, 2001, for BAW-10219P was also submitted in the application.

Question 6 in the RAI was clarified for the licensee. The staff stated that it understood that providing data on detecting electro discharge machining (EDM) notches on the inside diameter (ID) of SG tubes would provide information on the ability to detect flaws on the ID. Also the staff stated that information requested by the RAI can be provided by referencing letters on the Callaway docket that already contain that information.

In the phone call, to expedite the staff's review of the application, the licensee agreed that it would provide draft responses to the staff by August 31, 2001, and the staff agreed that it would have a meeting with the licensee on the responses on September 12-13, 2001. The licensee would then submit its responses to the RAI by letter.

The email from the technical branch providing the RAI, and the RAI provided, is given in the email from the branch dated July 5, 2001.

Docket No. 50-483

Attachment: 1. Request for Additional Information
2. Email From Technical Branch dated July 5, 2001

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REQUEST FOR ADDITIONAL INFORMATION

REVIEW OF THE CALLAWAY PLANT APPLICATION

FOR REVISION TO TECHNICAL SPECIFICATION 3/4.4

TAC NUMBER: MB1214

On May 21, 1999, the NRC granted a limited, two-cycle approval to Union Electric [Company] (UE) for Electrosleeve repairs at Callaway Plant, based on some unresolved technical issues that restricted the period of approval. The staff expected that UE would address the remaining technical issues, discussed below, in order to seek approval without limitations during the two-cycle period. These issues were discussed in detail in a letter from the NRC staff to UE dated May 20, 1998. Some of the technical issues pertained to weaknesses in the UT qualification data and lack of experience with nanocrystalline nickel material in the steam generator (SG). The staff also had concerns about the UT technique's ability to inspect dented intersections. To remove the two-cycle restriction, the staff was expecting UE to provide additional technical basis to show that the UT technique could reliably size stress corrosion cracks. UE was also asked to provide additional UT data on pits and disbonds. Based on the staff's evaluation of data that had been previously submitted by UE, the staff was concerned that a safety significant flaw could be undersized.

The staff also told UE that for a permanent approval, the licensee needed to provide additional details on the exclusion of tubes due to locked tube effects and propose specific text to incorporate exclusion requirements into the license for the Callaway Plant. In addition, the staff requested additional data to support the equivalency of a one-directional approach to sizing flaws by UT examinations, as compared to the two-directional UT approach. The staff indicated that the depth to which theses issues would need to be addressed is dependent on how the licensee addresses the UT depth sizing of the SCC issued described above.

The NRC staff held a public meeting on June 7, 2001, with UE and Framatome Technologies Inc. (FTI) to discuss a UE license amendment request dated February 15, 2001. This proposed license amendment would revise TS 5.5.9 to remove the two cycle operating limit and allow all SG tubes repaired with Electrosleeved tubes to remain in service. The proposed change is based on the evaluations and justifications presented in a FTI topical report, (TR) BAW-10219P, Revision 4, "Electrosleeving Qualification for PWR Recirculating SG Tube Repair."

The NRC staff indicated at the meeting that they would develop request for additional information questions, based on the material presented and discussed at the June 7, 2001, meeting and from their review of the FTI TR. The letter from UE to the NRC, dated February 15, 2001, conveying the FTI TR, requested that the NRC staff focus their review on Section 11.0 of the report and the Appendix J qualified NDE techniques for examination of the Electrosleeves that will remain in service. The staff acknowledges that Section 11.0 pertains to the technical justifications of the NDE techniques requested by the NRC, and accordingly, has focused most of its review on this section. However, a few questions regarding changes to repair limits, discussed in Section 12.0, have been included. In addition, the staff noted in it's review of the report that some issues, such as the one-directional versus two-directional UT

approach to sizing flaws, were addressed. Others, such as the specific details on tubes that would be included in an exclusion zone due to locked tube effects, were not explicitly addressed.

The staff developed a set of questions, which are presented below. Some general themes emerged while developing the questions. These themes include concerns about the qualification data set, detecting and sizing primary water stress corrosion cracking (PWSCC)/outside diameter stress corrosion cracking (ODSCC)/pits/disbonds, specifics about the use of UT techniques and data analysis, and cited repair limits. In the current revision to the TR, the PWSCC flaws from the previously submitted data sets have been removed. The staff has continuing concerns about UE's ability to detect PWSCC flaws, due to issues raised during the previous license amendment review about the UT technique undersizing PWSCC flaws. Based on the past review, the staff was expecting additional data and analysis on detection of ID flaws to support the current license amendment review, which was not provided.

Additionally, the FTI report often provides summaries of the data, without providing the actual analyst data sets. This prevents the staff from making an independent review and finding that the techniques are adequate to detect and size the range of possible flaws before they result in reductions of required margins. In a similar manner, different factors and values are presented throughout the report without discussing how they were derived.

The staff noted that a number of the data sets have been changed since the last revision of the TR, and some data has been deleted. For example, new data sets have been added for dent detection and sizing, combined wall thickness measurements, and ODSCC detection and sizing to Revision 4 of BAW-10210P. The staff would like to understand the basis for selecting the data sets and the applicability of the data sets to Callaway. The content of the data sets was discussed briefly in the June 7, 2001, meeting and is also discussed in the questions below. The staff also has concerns about the applicability of the data sets to the field conditions at Callaway. The basis for the staff concerns is that the qualification of the examination technique needs to demonstrate the ability to detect and size flaws that are representative of those that are expected to be in tubes that are sleeved at Callaway.

Data Sets Used for Qualification

1. In reviewing the qualification program described in Section 11.9, the staff had overlying concerns about how well the sample set represented the conditions at Callaway. The staff identified the following concerns about the data set used in Section 11.9.1:

   A "thin Electrosleeve repair" that was "typically 0.012 inch" was applied for the tubes used in the qualification program sample set, rather than the nominal thickness used at Callaway. How does the use of a thinner sleeve impact the qualification, and how is this demonstration representative of the actual conditions at Callaway? (Page 11-59, BAW-10219P, Rev. 4)

   Section 11.8.5 states that inner diameter profilometry is used to detect and size dented regions located in the parent tube to sufficient accuracy to determine if the Electrosleeve operation can be performed. The staff believes it is also necessary to demonstrate that

dents do not affect the ability of the UT technique to detect and size flaws. What was the range of dent sizes in the sample set presented in Section 11.9.1? Are they representative of the full range of dents sizes that could be Electrosleeved? (Pages 11-57 to 11-63, BAW-10219P, Rev. 4)

What were the maximum depths for the axial and circumferential cracks listed in Tables 11.9.1 to 11.9.4? Relatively long flaws were used in this data set. Are these flaw lengths representative of those that would be sleeved at Callaway? Are there a range of flaw depths, similar to what you would identify at Callaway? (Pages 11-57 to 11-63, BAW-10219P, Rev. 4)

2. Prior to the June 7, 2001, meeting the staff compared the UT data sets from the current proposed license amendment request with the UT data sets provided for the license amendment review for the May 21, 1999, safety evaluation (SE). The staff noted that the new data sets appeared to contain only a portion of the data from the old data sets. During the June 07, 2001, meeting the Framatome discussed the differences in the data sets. They indicated that the UT data collection procedures had become more proceduralized over time, so they did not feel it was appropriate to utilize the old data that may have been collected using different procedures (and was no longer available because it had been destructively examined.)

   However, following the meeting the staff further reviewed the data sets and it appears that some of the old data (which was also destructively examined) was included in the new data sets. For example, flaw designations A1-A5, A8-A11, and C1 which are listed in Table Q2.1, provided to the staff in a letter dated February 24, 1998, from [UE] to the NRC, are also listed in Table 11.8.15 of BAW-10219P, Rev. 4, provided to the staff by letter dated February 15, 2001. In both tables, the flaws have been destructively analyzed. This appears to negate the explanation provided by the licensee at the June 07, 2001, meeting. Please clarify this discrepancy (e.g., does this indicate that the numbering scheme is not unique?)

   In addition to the above information, please provide the list of all flaws removed from each of the data sets, and a detailed explanation as to why the data from the prior and current sets could not be combined. (Question from the June 07, 2001, meeting held with UE, FTI, and the NRC staff.)

3. The staff did not identify any dents included in the sample set discussed in Section 11.9.2. The staff is just as interested in the effect denting has on the ability to reliably depth size flaws, as only dented intersections were used for the probability of detection data set. Discuss the impact of not including dents in the ODSCC depth sizing data set, as it pertains to the expected field conditions of Callaway's SG tubes. (Pages 11-64 to 11-69, BAW-10219P, Rev. 4)

4. Please provide the associated flaw lengths in Tables 11.9.5 - 11.9.8, and discuss whether the flaw morphology and sizes are consistent with what is found in Callaway's SG tubes. (Pages 11-64 to 11-69, BAW-10219P, Rev. 4)

5. How does the sample set in Section 11.9.2 achieve the stated objective of UT demonstrating a high probability of detection of service induced cracks that have depths of penetration exceeding 40 percent through-wall of the parent tube, when the sample set contains just 4 flaws (out of 20) that are less than 60percent through wall? (Pages 11-64 to 11-69, BAW-10219P, Rev. 4)

PWSCC

6. During the meeting, FTI indicated that PWSCC detectability in the sleeve could be inferred from the ID notches in the UT calibration standards and the data sets containing pits. It is not clear to the staff how detecting EDM notches in the calibration standards or another degradation morphology such as pits would infer an ability to detect tight flaws such as PWSCC. Explain the basis for the statement that sleeve PWSCC ID defects will be detected, and the resulting sensitivity and POD, since the peer review (ETSS # 98404) only covers volumetric defects. Please provide additional discussion or, preferably, additional data to support the claims of the capability of the technique to detect PWSCC in the sleeve. (Question from the June 07, 2001, meeting held with UE, FTI, and the NRC staff)

7. In the June 07, 2001, meeting UE stated that they only need to detect, not size, ID flaws in the Electrosleeve, because the tubes would be plugged upon detection of ID flaws in the Electrosleeve. This provision is not currently included in the Callaway TSs. Include in the TSs a requirement that tubes with sleeve ID flaws will be taken out of service. (Question from the June 07, 2001, meeting held with UE, FTI, and the NRC staff)

8. The TR does not discuss the detectability of PWSCC in the original tube once the tube defect has been sleeved. During the meeting on June 07, 2001, the licensee indicated that this is because shallow PWSCC flaws are not detectable once the sleeve was installed, and additionally, further degradation of these flaws are not expected. In response to a staff question at this meeting, the licensee stated that if the PWSCC flaw did, unexpectedly, continue to degrade, it would be expected to grow towards the outside diameter (OD) of the parent tube and not towards the sleeve. As the PWSCC flaw approached the parent tube OD, it would be detectable, and the UT depth sizing technique would be utilized to monitor the flaw. (Question from the June 07, 2001, meeting held with UE, FTI, and the NRC staff)

   A. Explain the basis and level of confidence for why the tube PWSCC flaw would grow towards the tube OD, versus into the sleeve.

   B. During the license amendment review for the safety evaluation report approving electrosleeving for Callaway in May 1999, the staff noted that the largest depth sizing NDE uncertainties (undersizing) were associated with through-wall PWSCC flaws that were electrosleeved. The TR for the current proposed amendment does not include flaws of this type. Therefore, given the potential situation proposed above (i.e., parent tube PWSCC flaws that continue to degrade after sleeving) the staff believes no information has been provided in the TR to support the licensee's stated actions (i.e., depth size the flaw using the ODSCC technique). Explain why it would be acceptable to

take this action given the previous experience and the lack of supporting data in the current TR. Otherwise, provide supporting data for this action.

ODSCC

9. Rev. 3 of BAW-10219P contained typical full skip normalization (FSN) values that were obtained by using various EDM notch depths. Were any actual crack data used to develop the regression equation mentioned in Rev. 4 that would be used to correlate the FSN value to a crack depth, rather than just the EDM notch data as in Rev. 3? Is the regression equation based on the data from Table 11.7.1 in Rev. 3 (page 11-34 of Rev. 3)? (Page 11-30, BAW-10219P, Rev. 4)

10. The report discusses an 0.8 inch ODSCC length in the parent tube that was established for repair using a minimal Electrosleeve thickness. What is this thickness? Does this also assume a 100 percent throughwall depth through the parent tube? Is there a structural integrity graph of ODSCC length in parent tube versus minimum Electrosleeve thickness? Please discuss the statement "axial cracks of extent 0.8 to 1.5 inches are of interest to the structural Electrosleeve for certain adverse plant operational conditions," especially covering the significance of the crack length range of 0.8 to 1.5 inches. (Page 11-58, BAW-10219P, Rev. 4)

11. The report states that "three analysts performed the analysis of the data." Yet, in Tables 11.9.1 through 11.9.8, data is only provided for 2 of the 3 analysts. Please provide the data in Tables 11.9.1 through 11.9.8 for all three analysts. (Pages 11-59 to 11-63, 11-64 to 11-69, BAW-10219P, Rev. 4)

12. The report states that the accuracy to which UT can measure crack depth determines the ability of the technique to determine if the crack has propagated into the sleeve material. The goal of the qualification was to demonstrate that the combination of the three depth sizing techniques (tip sizing, shear wave Mode Converted Signal, and Full Skip Normalization) could accurately determine the crack depth of penetration to 0.011 inch. Please discuss how the stated crack depth accuracy for ODSCC depth sizing of 0.011 inch was determined. (Page 11-64, BAW-10219P, Rev. 4)

Pits

13. Please provide the data from analysts 1 and 2 in their pit sizing for the pits listed in Table 11.8.1, as well as the destructive analysis results. You have provided the summary information in Table 11.8.2, but not the actual analyst data or destructive analysis results. (Page 11-33, BAW-10219P, Rev. 4)

14. Confirm that there is a typographical error on page 11-36, first paragraph. The last sentence reads, "Although dip pits...", and we assume that it should read, "Although deep pits ..." (Page 11-36, BAW-10219P, Rev. 4)

15. The report states that "when the signals merge, the UT analyst makes a call that indicates that the pit is deep but an accurate measurement of the pit depth is beyond the

capability of the system." When the signals merge, does the analyst detect the signals saturating or does the data provide erroneous depth values (or some other phenomena)? (Page 11-36, BAW-10219P, Rev. 4)

16. In Table 11.8.3, would subtracting the "UT Parent Tube Thickness" from the "UT Combined Thickness at Pit Center Line" give the thickness of the Electrosleeve at each pit location? (Page 11-37, BAW-10219P, Rev. 4)

17. The staff notes that the data from two tubes were removed from Table 11.8.3 (samples 081897-02M and 082597-085) in revising report BAW-10219P from Rev. 3 to Rev. 4. However, the staff noticed that Tables 11.8.4 and 11.8.5 that summarized the sleeve OD pit sizing analysis results for the data set as presented in Table 11.8.3 were identical from Rev. 3 to Rev. 4, even after deleting data from the two tubes. The staff does not understand how deleting data from an analysis would result in the same numerical results as including the same data. Please discuss this apparent discrepancy. (Pages 11-37, 11-38, 11-39, BAW-10219P, Rev. 4)

18. Please provide the UT data for the depth sizing for each pit listed in Table 11.8.3, and any destructive examination data, if performed. Since the remaining wall resolution of the UT system restricts the measurement of pits with 0.012 inch or less of remaining wall, the staff assumes that measurements for pit depths over 0.026" for a nominal sleeve thickness of 0.038" for a 7/8" tube or measurements for pit depths over 0.022" for a nominal sleeve thickness of 0.034" for a 3/4" tube could not be measured. This would potentially affect pit C in tube 041897-06 and pit C in tube 082297-01S for the 7/8" tubes as well as pit C in tube 081897-04M, pits A and C in tube 081897-07M, and pit B in tube 082597-02M for the 3/4" tubes. Please confirm if the previously mentioned tubes were those excluded from Tables 11.8.4 and 11.8.5. (Pages 11-37, 11-38, BAW-10219P, Rev. 4)

19. The report states that UT is required to detect ID pits with diameters in excess of 0.050 inch - why a threshold of 0.050 inch? The staff noted that the technique cannot detect a pit sized at 0.016 inch actual pit diameter (see Table 11.8.11, page 11-49). Why is it not significant that the technique cannot detect ID pits in service that are 0.016 inch in diameter or greater, especially since they cannot be depth sized on the ID. (Page 11-45, BAW-10219P, Rev. 4)

20. The report states that because ID pits are conservatively assumed to be 100 percent through the sleeve, no depth sizing is required. However, the report states that UT can detect the ID pits. The report states that "ID pits with a depth greater than one wavelength" which is approximately 0.006 inches for a 10MHz transducer and a 0.058 inch/μs speed of sound in water can be detected because there should be at least two distinct surface reflections. Please provide UT data to support your ability to detect ID pits. (Page 11-45, BAW-10219P, Rev. 4)

21. The report states that the set of tubes with ID pits was selected from the process pre-qualification and training runs. What size pits are normally left in service as a result of the field deposition process (diameter and depth)? (Page 11-46, BAW-10219P, Rev. 4)

Disbond

22. Please provide the UT data for analysts 1 and 2 that is summarized in Tables 11.8.8 and 11.8.9. (Pages 11-43, 44, BAW-10219P, Rev. 4)

UT techniques/data analysis

23. Please provide the "UT Examination Technique Specification Sheets" for the EPRI peer reviews: ETSS # 98300, 98201,98302,98303,98400,98401, 98402, 98403,98404, and 98405. (Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

24. The staff would like to understand the capability of the UT to detect flaws relative to the structural integrity limits. It is the staff's understanding that this information was contained in the viewgraph presented in the June 07, 2001, meeting that derived from Table 12.4.4. Please clarify the conclusions to be drawn from the viewgraph derived from Table 12.4.4 presented at the meeting. (Question from the June 07, 2001, meeting held with UE, FTI, and the NRC staff)

25. Please provide details on the data collected during your RF-11 inspection of 26 Electrosleeves. In particular, please provide the parameters inspected and a summary of the data collected from using the seven following techniques: UT-360 Electrosleeve Disbond Analysis Procedure, UT-360 Inner Diameter Profilometry Analysis Procedure, UT-360 Outer Diameter Pit Analysis Procedure, UT-360 Electrosleeve Inner Diameter Pit Analysis Procedure, UT-360 Outside Diameter Pit Analysis Procedure, UT-360 Crack Detection and Extent Sizing Analysis Procedure, UT-360 Crack Depth Sizing Analysis Procedure. (Question from the June 07, 2001, meeting held with UE, FTI, and the NRC staff)

    The meeting handout from the June 7, 2001, meeting states that based on the April 2001 RF-11 inspection of the Electrosleeves, there were "no detectable changes." Please expand on this statement (e.g., was there any change in sleeve/tube thickness, were any new flaws or indications detected (regardless of whether they were in the pressure boundary or non-pressure boundary portion of the sleeve or tube), did any of the original parent tube flaws change with respect to length, depth, etc.). If any of the above changes were identified, identify how these indications were dispositioned and the basis for the disposition. (Question from the June 07, 2001, meeting held with UE, FTI, and the NRC staff)

26. Since the May 21, 1999, NRC SE was based on Rev. 3 of BAW-10219P, explain in detail how shifting the criteria to EPRI Appendix J for Rev. 4 affects the conclusions made in Rev. 3.

27. Appendix J (PWR SG Examination Guidelines: Revision 5) only contains minimum acceptance criteria for flaws that are $\geq$60 percent through-wall for both performance demonstration detection and sizing. What acceptance criteria was assumed for the

20-59 percent through-wall flaws, considering that the TSss contain a plugging limit of 20 percent through wall, which is much less than 60 percent through wall?

28. How was the correction factor of 1.6 for the mode conversion method determined? Is the correction factor of 1.6 the same for the full range of crack depths? If not, how would the correction factor be determined on a crack depth basis? (Page 11-27, BAW-10219P, Rev. 4)

29. What is the basis for computing the crack depth by using the regression and averaging with the tip and mode converted signal depth values to determine the reported crack depth? Why would this averaging process provide the optimum crack depth? (Page 11-30, BAW-10219P, Rev. 4)

30. The report states that "UT techniques have been shown to be effective in the detection and sizing of fatigue cracks propagated into the sleeve material." Please provide data to support this assertion. (Page 11-57, BAW-10219P, Rev. 4)

31. In Table 11.8.12, how was the "actual dent" measured for each tube? (Page 11-51, BAW-10219P, Rev. 4)

32. The report states that the "results listed in Table 11.8.15 show that the maximum error and the RMSE are sufficient to meet the requirements for sleeve thickness examination." Table 11.8.15 provides error measurements specific to the combined wall thickness, and doesn't contain any sleeve thickness measurements. Is it reasonable to infer that the error for measuring sleeve thickness would be identical to that of the combined wall thickness? Provide the basis for why the values would be the same. (Page 11-56, BAW-10219P, Rev. 4)

Repair Limit

33. The Rev. 4 to BAW-10219P states that the "Electrosleeve plugging limit is conservatively set at 30 percent through-wall of the sleeve nominal thickness." Rev. 3 to BAW-10219P states that the "Electrosleeve plugging limit is 20 percent through-wall of the sleeve nominal thickness." However, the Callaway TSs provided with the February 15, 2001, UE submittal state that "[t]he plugging or repair limit for the pressure boundary portion of Electrosleeves is determined to be 20 percent through wall of the nominal sleeve wall thickness (as determined by NDE)." Please resolve this apparent discrepancy. (Page 11-64 and Section 12, beginning on 12.1, BAW-10219P, Rev. 4)

34. The tube repair limit with respect to sleeve OD pitting is discussed in this report. The report states that the structural limit calculations defined a maximum allowed structural degradation of 88.0 percent of the sleeve nominal thickness for a sleeve OD pit degradation mechanism. What pit diameter is assumed? (Pages 12-3, 12-4, BAW-10219P, Rev. 4)

Editorial remarks:

35. Editorial remark - Rev. 3 of BAW-10219P contained a section discussing D-Scan Maps, that was subsequently removed in Rev. 4 of the TR. However, even though it is no longer discussed in the following sections, the reference to D-scans still exists on page 11-17 of Rev. 4. (Page 11-17, BAW-10219P, Rev. 4)

36. Editorial remark - On page 3 of ULNRC-4391, which is Attachment 2 to the February 15, 2001, letter from UE conveying the FTI report, a typographical error exists. In the 4th full paragraph from the top of the page, the first and last sentences refer to Section 10.1.5. However, in the last sentence, the numbers are transposed, so that the Section is listed as 10.5.1. Section 10.5.1 does not exist in the FTI report.

EMAIL FROM TECHNICAL BRANCH DATED JULY 5, 2001

From: Louise Lund
To: Jack Donohew
Date: 7/5/01 4:59PM
Subject: Electrosleeve RAI

Jack,

I think we have the RAIs in a form we can discuss them with the licensee and FTI. Ted has reviewed, and asked that I send them to you. Please set up a phone call with the licensee for us. I will be on travel until Thursday of next week.

Thanks!

Louise

CC: Cheryl Khan; Edmund Sullivan; Herbert Conrad

REQUEST FOR ADDITIONAL INFORMATION
REVIEW OF THE CALLAWAY PLANT APPLICATION
FOR REVISION TO TECHNICAL SPECIFICATION 3/4.4
TAC NUMBER: MB1214

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The NRC staff indicated at the meeting that they would develop request for additional information questions, based on the material presented and discussed at the June 7, 2001 meeting and from their review of the FTI topical report. The letter from UE to the NRC, dated February 15, 2001, conveying the FTI topical report, requested that the NRC staff focus their review on Section 11.0 of the report and the Appendix J qualified NDE techniques for examination of the Electrosleeves that will remain in service. The staff acknowledges that Section 11.0 pertains to the technical justifications of the NDE techniques requested by the NRC, and accordingly, has focused most of its review on this section. However, a few questions regarding changes to repair limits, discussed in Section 12.0, have been included. In addition, the staff noted in it's review of the report that some issues, such as the one-directional versus two-directional UT approach to sizing flaws, were addressed. Others, such as the specific details on tubes that would be included in an exclusion zone due to locked tube effects, were not explicitly addressed.

The staff developed a set of questions, which are presented below. Some general themes emerged while developing the questions. These themes include concerns about the qualification data set, detecting and sizing primary water stress corrosion cracking (PWSCC)/outside diameter stress corrosion cracking (ODSCC)/pits/disbonds, specifics about the use of UT techniques and data analysis, and cited repair limits. In the current revision to the topical report, the PWSCC flaws from the previously submitted data sets have been removed. The staff has continuing concerns about UE's ability to detect PWSCC flaws, due to issues raised during the previous license amendment review about the UT technique undersizing PWSCC flaws. Based on the past review, the staff was expecting additional data and analysis on detection of ID flaws to support the current license amendment review, which was not provided.

Additionally, the FTI report often provides summaries of the data, without providing the actual analyst data sets. This prevents the staff from making an independent review and finding that the techniques are adequate to detect and size the range of possible flaws before they result in reductions of required margins. In a similar manner, different factors and values are presented throughout the report without discussing how they were derived.

The staff noted that a number of the data sets have been changed since the last revision of the topical report, and some data has been deleted. For example, new data sets have been added for dent detection and sizing, combined wall thickness measurements, and ODSCC detection and sizing to Revision 4 of BAW-10210P. The staff would like to understand the basis for selecting the data sets and the applicability of the data sets to Callaway. The content of the data sets was discussed briefly in the June 7, 2001 meeting, and is also discussed in the questions below. The staff also has concerns about the applicability of the data sets to the field conditions at Callaway. The basis for the staff concerns is that the qualification of the

examination technique needs to demonstrate the ability to detect and size flaws that are representative of those that are expected to be in tubes that are sleeved at Callaway.

Data Sets Used for Qualification

1. In reviewing the qualification program described in Section 11.9, the staff had overlying concerns about how well the sample set represented the conditions at Callaway. The staff identified the following concerns about the data set used in Section 11.9.1:

   A "thin Electrosleeve repair" that was "typically 0.012 inch" was applied for the tubes used in the qualification program sample set, rather than the nominal thickness used at Callaway. How does the use of a thinner sleeve impact the qualification, and how is this demonstration representative of the actual conditions at Callaway? (Page 11-59, BAW-10219P, Rev. 4)

   Section 11.8.5 states that inner diameter profilometry is used to detect and size dented regions located in the parent tube to sufficient accuracy to determine if the Electrosleeve operation can be performed. The staff believes it is also necessary to demonstrate that dents do not affect the ability of the UT technique to detect and size flaws. What was the range of dent sizes in the sample set presented in Section 11.9.1? Are they representative of the full range of dents sizes that could be Electrosleeved? (Pages 11-57 to 11-63, BAW-10219P, Rev. 4)

   What were the maximum depths for the axial and circumferential cracks listed in Tables 11.9.1 to 11.9.4? Relatively long flaws were used in this data set. Are these flaw lengths representative of those that would be sleeved at Callaway? Are there a range of flaw depths, similar to what you would identify at Callaway? (Pages 11-57 to 11-63, BAW-10219P, Rev. 4)

2. Prior to the June 7, 2001 meeting, the staff compared the UT data sets from the current proposed license amendment request with the UT data sets provided for the license amendment review for the 5/21/99 safety evaluation. The staff noted that the new data sets appeared to contain only a portion of the data from the old data sets. During the 6/7/01 meeting, the Framatome discussed the differences in the data sets. They indicated that the UT data collection procedures had become more proceduralized over time, so they did not feel it was appropriate to utilize the old data that may have been collected using different procedures (and was no longer available because it had been destructively examined).

   However, following the meeting the staff further reviewed the data sets and it appears that some of the old data (which was also destructively examined) was included in the new data sets. For example, flaw designations A1-A5, A8-A11, and C1 which are listed in Table Q2.1, provided to the staff in a letter dated 2/24/98 from Ameren UE to the NRC, are also listed in Table 11.8.15 of BAW-10219P, Rev. 4, provided to the staff by letter dated 2/15/01. In both tables,

the flaws have been destructively analyzed. This appears to negate the explanation provided by the licensee at the 6/7/01 meeting. Please clarify this discrepancy (e.g., does this indicate that the numbering scheme is not unique?).

In addition to the above information, please provide the list of all flaws removed from each of the data sets, and a detailed explanation as to why the data from the prior and current sets could not be combined. (Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

3. The staff did not identify any dents included in the sample set discussed in Section 11.9.2. The staff is just as interested in the effect denting has on the ability to reliably depth size flaws, as only dented intersections were used for the probability of detection data set. Discuss the impact of not including dents in the ODSCC depth sizing data set, as it pertains to the expected field conditions of Callaway's SG tubes. (Pages 11-64 to 11-69, BAW-10219P, Rev. 4)

4. Please provide the associated flaw lengths in Tables 11.9.5 - 11.9.8, and discuss whether the flaw morphology and sizes are consistent with what is found in Callaway's SG tubes. (Pages 11-64 to 11-69, BAW-10219P, Rev. 4)

5. How does the sample set in Section 11.9.2 achieve the stated objective of UT demonstrating a high probability of detection of service induced cracks that have depths of penetration exceeding 40% through-wall of the parent tube, when the sample set contains just 4 flaws (out of 20) that are less than 60% through wall? (Pages 11-64 to 11-69, BAW-10219P, Rev. 4)

PWSCC

6. During the meeting, FTI indicated that PWSCC detectability in the sleeve could be inferred from the ID notches in the UT calibration standards and the data sets containing pits. It is not clear to the staff how detecting EDM notches in the calibration standards or another degradation morphology such as pits would infer an ability to detect tight flaws such as PWSCC. Explain the basis for the statement that sleeve PWSCC ID defects will be detected, and the resulting sensitivity and POD, since the peer review (ETSS # 98404) only covers volumetric defects. Please provide additional discussion or, preferably, additional data to support the claims of the capability of the technique to detect PWSCC in the sleeve. (Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

7. In the 6/7/01 meeting, UE stated that they only need to detect, not size, ID flaws in the Electrosleeve, because the tubes would be plugged upon detection of ID flaws in the Electrosleeve. This provision is not currently included in the Callaway Technical Specifications. Include in the Technical Specification a requirement that tubes with sleeve ID flaws will be taken out of service. (Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

8. The topical report does not discuss the detectability of PWSCC in the original tube once the tube defect has been sleeved. During the meeting on 6/7/01, the licensee indicated that this is because shallow PWSCC flaws are not detectable once the sleeve was installed, and additionally, further degradation of these flaws are not expected. In response to a staff question at this meeting, the licensee stated that if the PWSCC flaw did, unexpectedly, continue to degrade, it would be expected to grow towards the OD of the parent tube and not towards the sleeve. As the PWSCC flaw approached the parent tube OD, it would be detectable, and the UT depth sizing technique would be utilized to monitor the flaw. (Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

   A. Explain the basis and level of confidence for why the tube PWSCC flaw would grow towards the tube OD, versus into the sleeve.

   B. During the license amendment review for the safety evaluation report approving electrosleeving for Callaway in May 1999, the staff noted that the largest depth sizing NDE uncertainties (undersizing) were associated with through-wall PWSCC flaws that were electrosleeved. The topical report for the current proposed amendment does not include flaws of this type. Therefore, given the potential situation proposed above (i.e., parent tube PWSCC flaws that continue to degrade after sleeving) the staff believes no information has been provided in the topical report to support the licensee's stated actions (i.e., depth size the flaw using the ODSCC technique). Explain why it would be acceptable to take this action given the previous experience and the lack of supporting data in the current topical report. Otherwise, provide supporting data for this action.

ODSCC

9. Rev. 3 of BAW-10219P contained typical full skip normalization (FSN) values that were obtained by using various EDM notch depths. Were any actual crack data used to develop the regression equation mentioned in Rev. 4 that would be used to correlate the FSN value to a crack depth, rather than just the EDM notch data as in Rev. 3? Is the regression equation based on the data from Table 11.7.1 in Rev. 3 (page 11-34 of Rev. 3)? (Page 11-30, BAW-10219P, Rev. 4)

10. The report discusses an 0.8 inch ODSCC length in the parent tube that was established for repair using a minimal Electrosleeve thickness. What is this thickness? Does this also assume a 100% throughwall depth through the parent tube? Is there a structural integrity graph of ODSCC length in parent tube versus minimum Electrosleeve thickness? Please discuss the statement "axial cracks of extent 0.8 to 1.5 inches are of interest to the structural Electrosleeve for certain adverse plant operational conditions," especially covering the significance of the crack length range of 0.8 to 1.5 inches. (Page 11-58, BAW-10219P, Rev. 4)

11. The report states that “three analysts performed the analysis of the data.” Yet, in Tables 11.9.1 through 11.9.8, data is only provided for 2 of the 3 analysts. Please provide the data in Tables 11.9.1 through 11.9.8 for all three analysts. (Pages 11-59 to 11-63, 11-64 to 11-69, BAW-10219P, Rev. 4)

12. The report states that the accuracy to which UT can measure crack depth determines the ability of the technique to determine if the crack has propagated into the sleeve material. The goal of the qualification was to demonstrate that the combination of the three depth sizing techniques (tip sizing, shear wave Mode Converted Signal, and Full Skip Normalization) could accurately determine the crack depth of penetration to 0.011 inch. Please discuss how the stated crack depth accuracy for ODSCC depth sizing of 0.011 inch was determined. (Page 11-64, BAW-10219P, Rev. 4)

Pits

13. Please provide the data from analysts 1 and 2 in their pit sizing for the pits listed in Table 11.8.1, as well as the destructive analysis results. You have provided the summary information in Table 11.8.2, but not the actual analyst data or destructive analysis results. (Page 11-33, BAW-10219P, Rev. 4)

14. Confirm that there is a typographical error on page 11-36, first paragraph. The last sentence reads, “Although dip pits...”, and we assume that it should read, “Although deep pits ...” (Page 11-36, BAW-10219P, Rev. 4)

15. The report states that “when the signals merge, the UT analyst makes a call that indicates that the pit is deep but an accurate measurement of the pit depth is beyond the capability of the system.” When the signals merge, does the analyst detect the signals saturating or does the data provide erroneous depth values (or some other phenomena)? (Page 11-36, BAW-10219P, Rev. 4)

16. In Table 11.8.3, would subtracting the “UT Parent Tube Thickness” from the “UT Combined Thickness at Pit Center Line” give the thickness of the Electrosleeve at each pit location? (Page 11-37, BAW-10219P, Rev. 4)

17. The staff notes that the data from two tubes were removed from Table 11.8.3 (samples 081897-02M and 082597-085) in revising report BAW-10219P from Rev. 3 to Rev. 4. However, the staff noticed that Tables 11.8.4 and 11.8.5 that summarized the sleeve OD pit sizing analysis results for the data set as presented in Table 11.8.3 were identical from Rev. 3 to Rev. 4, even after deleting data from the two tubes. The staff does not understand how deleting data from an analysis would result in the same numerical results as including the same data. Please discuss this apparent discrepancy. (Pages 11-37, 11-38, 11-39, BAW-10219P, Rev. 4)

18. Please provide the UT data for the depth sizing for each pit listed in Table 11.8.3, and any destructive examination data, if performed. Since the

remaining wall resolution of the UT system restricts the measurement of pits with 0.012 inch or less of remaining wall, the staff assumes that measurements for pit depths over 0.026" for a nominal sleeve thickness of 0.038" for a 7/8" tube or measurements for pit depths over 0.022" for a nominal sleeve thickness of 0.034" for a 3/4" tube could not be measured. This would potentially affect pit C in tube 041897-06 and pit C in tube 082297-01S for the 7/8" tubes as well as pit C in tube 081897-04M, pits A and C in tube 081897-07M, and pit B in tube 082597-02M for the 3/4" tubes. Please confirm if the previously mentioned tubes were those excluded from Tables 11.8.4 and 11.8.5. (Pages 11-37, 11-38, BAW-10219P, Rev. 4)

19. The report states that UT is required to detect ID pits with diameters in excess of 0.050 inch - why a threshold of 0.050 inch? The staff noted that the technique cannot detect a pit sized at 0.016 inch actual pit diameter (see Table 11.8.11, page 11-49). Why is it not significant that the technique cannot detect ID pits in service that are 0.016 inch in diameter or greater, especially since they cannot be depth sized on the ID. (Page 11-45, BAW-10219P, Rev. 4)

20. The report states that because ID pits are conservatively assumed to be 100% through the sleeve, no depth sizing is required. However, the report states that UT can detect the ID pits. The report states that "ID pits with a depth greater than one wavelength" which is approximately 0.006 inches for a 10MHz transducer and a 0.058 inch/μs speed of sound in water can be detected because there should be at least two distinct surface reflections. Please provide UT data to support your ability to detect ID pits. (Page 11-45, BAW-10219P, Rev. 4)

21. The report states that the set of tubes with ID pits was selected from the process pre-qualification and training runs. What size pits are normally left in service as a result of the field deposition process (diameter and depth)? (Page 11-46, BAW-10219P, Rev. 4)

Disbond

22. Please provide the UT data for analysts 1 and 2 that is summarized in Tables 11.8.8 and 11.8.9. (Pages 11-43, 44, BAW-10219P, Rev. 4)

UT techniques/data analysis

23. Please provide the "UT Examination Technique Specification Sheets" for the EPRI peer reviews:
ETSS # 98300, 98201,98302,98303,98400,98401, 98402, 98403,98404, and 98405.
(Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

24. The staff would like to understand the capability of the UT to detect flaws relative to the structural integrity limits. It is the staff's understanding that this information was contained in the viewgraph presented in the 6/7/01 meeting

that derived from Table 12.4.4. Please clarify the conclusions to be drawn from the viewgraph derived from Table 12.4.4 presented at the meeting. (Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

25. Please provide details on the data collected during your RF-11 inspection of 26 Electrosleeves. In particular, please provide the parameters inspected and a summary of the data collected from using the seven following techniques: UT-360 Electrosleeve Disbond Analysis Procedure, UT-360 Inner Diameter Profilometry Analysis Procedure, UT-360 Outer Diameter Pit Analysis Procedure, UT-360 Electrosleeve Inner Diameter Pit Analysis Procedure, UT-360 Outside Diameter Pit Analysis Procedure, UT-360 Crack Detection and Extent Sizing Analysis Procedure, UT-360 Crack Depth Sizing Analysis Procedure. (Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

The meeting handout from the June 7, 2001 meeting states that based on the April 2001 RF-11 inspection of the Electrosleeves, there were "no detectable changes." Please expand on this statement (e.g., was there any change in sleeve/tube thickness, were any new flaws or indications detected (regardless of whether they were in the pressure boundary or non-pressure boundary portion of the sleeve or tube), did any of the original parent tube flaws change with respect to length, depth, etc.). If any of the above changes were identified, identify how these indications were dispositioned and the basis for the disposition. (Question from the 6/7/01 meeting held with UE, FTI, and the NRC staff)

26. Since the 5/21/99 NRC safety evaluation was based on Rev. 3 of BAW-10219P, explain in detail how shifting the criteria to EPRI Appendix J for Rev. 4 affects the conclusions made in Rev. 3.

27. Appendix J (PWR Steam Generator Examination Guidelines: Revision 5) only contains minimum acceptance criteria for flaws that are $\geq$60% through-wall for both performance demonstration detection and sizing. What acceptance criteria was assumed for the 20-59% through-wall flaws, considering that the Technical Specifications contain a plugging limit of 20% through wall, which is much less than 60% through wall?

28. How was the correction factor of 1.6 for the mode conversion method determined? Is the correction factor of 1.6 the same for the full range of crack depths? If not, how would the correction factor be determined on a crack depth basis? (Page 11-27, BAW-10219P, Rev. 4)

29. What is the basis for computing the crack depth by using the regression and averaging with the tip and mode converted signal depth values to determine the reported crack depth? Why would this averaging process provide the optimum crack depth? (Page 11-30, BAW-10219P, Rev. 4)

30. The report states that "UT techniques have been shown to be effective in the detection and sizing of fatigue cracks propagated into the sleeve material."

Please provide data to support this assertion. (Page 11-57, BAW-10219P, Rev. 4)

31. In Table 11.8.12, how was the "actual dent" measured for each tube? (Page 11-51, BAW-10219P, Rev. 4)

32. The report states that the "results listed in Table 11.8.15 show that the maximum error and the RMSE are sufficient to meet the requirements for sleeve thickness examination." Table 11.8.15 provides error measurements specific to the combined wall thickness, and doesn't contain any sleeve thickness measurements. Is it reasonable to infer that the error for measuring sleeve thickness would be identical to that of the combined wall thickness? Provide the basis for why the values would be the same. (Page 11-56, BAW-10219P, Rev. 4)

Repair Limit

33. The Rev. 4 to BAW-10219P states that the "Electrosleeve plugging limit is conservatively set at 30% through-wall of the sleeve nominal thickness." Rev. 3 to BAW-10219P states that the "Electrosleeve plugging limit is 20% through-wall of the sleeve nominal thickness." However, the Callaway Technical Specifications provided with the 2/15/01 UE submittal state that "[t]he plugging or repair limit for the pressure boundary portion of Electrosleeves is determined to be 20% through wall of the nominal sleeve wall thickness (as determined by NDE)." Please resolve this apparent discrepancy. (Page 11-64 and Section 12, beginning on 12.1, BAW-10219P, Rev. 4)

34. The tube repair limit with respect to sleeve OD pitting is discussed in this report. The report states that the structural limit calculations defined a maximum allowed structural degradation of 88.0% of the sleeve nominal thickness for a sleeve OD pit degradation mechanism. What pit diameter is assumed? (Pages 12-3, 12-4, BAW-10219P, Rev. 4)

Editorial remarks:

35. Editorial remark - Rev. 3 of BAW-10219P contained a section discussing D-Scan Maps, that was subsequently removed in Rev. 4 of the topical report. However, even though it is no longer discussed in the following sections, the reference to D-scans still exists on page 11-17 of Rev. 4. (Page 11-17, BAW-10219P, Rev. 4)

36. Editorial remark - On page 3 of ULNRC-4391, which is Attachment 2 to the February 15, 2001 letter from UE conveying the FTI report, a typographical error exists. In the 4th full paragraph from the top of the page, the first and last sentences refer to Section 10.1.5. However, in the last sentence, the numbers are transposed, so that the Section is listed as 10.5.1. Section 10.5.1 does not exist in the FTI report.