50-302

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

October 24, 1995

Mr. Percy M. Beard, Jr.
Senior Vice President,
Nuclear Operations (SA2A)
Florida Power Corporation
ATTN: Manager, Nuclear
Licensing (SA2A)
15760 W Power Line Street
Crystal River, Florida 34428-6708

SUBJECT: CRYSTAL RIVER NUCLEAR GENERATING PLANT UNIT 3 - CR-3 TECHNICAL SPECIFICATION CHANGE REQUEST PROPOSING AN ALTERNATE METHODOLOGY FOR DISPOSITIONING SMALL VOLUME EDDY CURRENT INDICATIONS IN THE ONCE THROUGH STEAM GENERATOR TUBES (TAC NO. M92548)

Dear Mr. Beard:

By letter dated May 31, 1995, you submitted an application to amend the Technical Specifications (TS) to utilize an alternate methodology for dispositioning small volume, low signal-to-noise (S/N) eddy current indications in the once through steam generators (OTSGs). Our review of your request is in progress. To continue our review, we require additional information. The enclosure contains a list of questions and remarks which require clarification.

The proposed alternate repair criteria is a voltage- and dimensional-based approach, which would apply only to certain steam generator indications. Based on available tube pull data at that time, in 1993 you concluded that the low S/N eddy current indications were due to pit-like intergranular attack (IGA) and you had intended to use the proposed methodology for addressing these IGAs. Recent additional tube pulls during Refuel 9 revealed that the wear indications at the tube support plates may also exhibit a similar eddy current response (i.e., low S/N ratio). A low S/N ratio is a product of the inspection process and is not a characteristic intrinsic to a particular mode of degradation. As currently proposed, the repair criteria could apply to volumetric indications located throughout the CR-3 steam generators.

It should be noted that the voltage-based repair criteria approved for certain Westinghouse-designed steam generators (see Generic Letter 95-05) is specifically aimed at addressing a particular mode of degradation occurring at known locations within the steam generators. Your proposed amendment differs from the approved voltage-based criteria in that it could apply to all volumetric indications and locations within the steam generators. We believe that it would be appropriate for you to revise your amendment to focus on the limited population of IGA S/N indications.

On August 30, 1995, we discussed our general concerns in a phone call with your staff relating to these issues. The enclosure includes issues that we discussed with your staff as well as other questions which were not discussed during the August 30, 1995, phone call.

We request your response within 60 days from the date of this letter. If you have any questions regarding this matter, please call me at (301) 415-1471.

This requirement affects nine or fewer respondents, and therefore, it is not subject to Office of Management and Budget review under P.L. 96-511.

Sincerely,

L. Raghavan, Project Manager
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Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosure: As Stated

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Enclosure

Request for Additional Information

Degradation Specific Management

1. Describe your long term plans to monitor the morphology of low signal-to-noise (S/N) indications (e.g., tube pulls, destructive examinations, etc.). Reference 3 states that the B&W Owners Group Steam Generator Committee recommended pulling tubes from Oconee Units 1 and 3 in addition to those at Crystal River Unit 3 (CR-3). Describe how the results available to date from these other tube pulls support the conclusions developed based on the data from the CR-3 tube pulls. If the Oconee tube pull data are not currently available, discuss your schedule and plans for incorporating the data into your analyses. Provide a schedule of when the tube pull nondestructive examination comparison study cited on pages 2-2 and 3-6 in Reference 3 will be available.

2. Appendix B to Reference 3 discusses sizing of wear indications. Is a wear scar standard used at CR-3 for sizing these indications? If so, discuss the basis for applying the proposed voltage-based repair criteria to wear indications.

3. The proposed voltage-based repair criteria applies only to volumetric indications located outside the tubesheet regions. Describe the eddy-current inspection procedures and quantitative data analysis criteria to distinguish between volumetric and crack-like indications.

4. The eddy current signals generated by wear and IGA pitting may be significantly different due to the different morphologies for each type of degradation. The larger and more easily detectable signals from wear can bias the statistics for the IGA pits if they are used together. Discuss the potential bias from the use of both IGA and wear data in the correlations incorporating eddy current voltages.

Signal-to-Noise

5. What actions have been taken to decrease the noise or increase the defect response signal during eddy-current inspections at CR-3? Discuss the use of alternate probes (size and type), inspection frequencies, assessments of noise origin, and other potential signal improvement measures. What alternative inspection techniques have been used in the past or been considered for the next inspection of S/N indications?

6. Appendix G to Reference 5 provided a simplified description of how noise is quantified. However, it is unclear how noise associated with an indication is measured when the signals are superimposed. Describe the procedures used at CR-3 to quantify the signal-to-noise ratio of an indication where the contribution due to noise is not easily separated from that of the indication.

7. Appendix A of Reference 2 lists the eddy current voltage amplitude for all identified S/N indications in the CR-3 steam generators. However, the table does not include quantitative data for the level of noise measured for each indication. Provide the data recorded during eddy current inspections quantifying the level of noise associated with

each indication. For indications inspected in more than one outage, provide noise measurements recorded during each inspection.

8. The last paragraph in Section 2.3.1.3 in Reference 3 states that "the 0.540 inch HF bobbin coil exhibited slightly better detection performance than the 0.510 inch HF bobbin coil." This section also indicated that the 0.540-inch high frequency bobbin coil gave cleaner (higher signal-to-noise ratio) and more repeatable data. Do you plan to use the 0.540 inch high frequency bobbin coil probe for upcoming inspections of CR-3 steam generator tubes? if you plan on using a bobbin coil probe with a diameter other than 0.540 inches discuss your basis for doing so in light of the above.

9. If all indications are recorded regardless of voltage amplitude and the growth mechanism is dormant, only a small number of new indications should be detected during any outage (i.e., small voltage indications at the threshold of detection). What steps has the licensee taken to address the root cause for indications which have faded in and out from inspection to inspection?

10. New S/Ns are defined as those that have voltages greater than 0.9 volts and that have not been identified in any outage since 1987. Discuss the basis for considering only indications identified during inspections since 1987 in light of the fact that some indications were first identified many years earlier.

Growth

11. Appendix B of Appendix A to Reference 5 assessed the growth of intergranular attack (IGA) patches for three tubes examined in 1989, 1990, and 1992 outages. The study concluded that there was no evidence of growth of the observed IGA patches included in the study. While past growth assessments may support your assumption of zero growth for IGA S/N indications, the basis for assuming no growth for tube wear indications is unclear. Provide the basis for this assumption.

12. How frequently will each S/N indication be inspected in future outages?

13. A number of growth studies have been cited in the various submittals supporting this TS amendment. Discuss how differences in probes, calibration procedures, cable lengths, calibration standards (including the use of transfer standards), probe wear, and other related factors have been accounted for in each of these studies. Indicate whether the data used in each of the studies are based on Vmax voltages or peak-to-peak voltages. It would be sufficient to address the more recent outages since they most likely used similar techniques and analysis criteria.

14. Has a growth rate study of S/N indications been performed based on rotating pancake coil (RPC) sizes (i.e., axial and circumferential length)? If so, provide the results. If not, discuss the usefulness of such a study.

15. An S/N indication is considered to have grown if it exhibits a 0.5 volt increase from the previous inspection and has a measured voltage in excess of 0.9 volts. The basis for the 0.5 volt increase resides in the fact that this criterion was used in the previous inspections of S/N indications. Provide technical justification for not performing a subsequent RPC examination of indications previously RPC examined unless the bobbin voltage increases by 0.5 volts. If an indication was identified as having an eddy current response of 0.4 volts and was later reexamined and found to exhibit a 0.8 volt response, discuss why this indication is not considered to have grown. The staff notes that since the degradation mechanism is considered dormant and no allowance for flaw growth was used in the development of the tube repair criteria, there should be essentially no change in voltage with the exception of variations arising from nondestructive examination uncertainty. Since the probe wear model and analyst variability model being proposed have a total uncertainty of approximately 24% at an upper 95% confidence level, it seems like a much lower threshold than 0.5 volts should be used. Please discuss. Is the 0.5 volt increase determined from the most recent inspection of the indication or from the original inspection in which the indication was identified?

Leakage

16. The basis for the 0.9 volt cutoff for determining when RPC examinations should be performed and the length based limits applied is not clear in light of past inspection data which indicates that voltages of about 0.8 volts can have an axial extent in excess of 0.5 inches (Figure 28 in Reference 5). Has a systematic review of all available CR-3 data as well as any pulled tube data from other plants been performed which supports the assumption that the 0.9 volt criteria will ensure that the proposed dimensional limits will not be exceeded? Since the 0.9 volt cutoff is presumably based on experience to date, discuss your plans for random RPC sampling below the appropriate voltage threshold (0.9 volts is being proposed).

17. Independent staff calculations determined that leakage integrity is not assured at a 95% confidence level for indications with a bobbin coil signal of 0.9 volts. Discuss the 0.9 volt lower limit in light of this staff finding. Consider the response to Question 18 below.

18. The data in Figures 5-1 through 5-5 in Reference 1 illustrates the relationship between eddy current voltage measurements and the dimensions of S/N indications. However, these relationships are based on nominal correlations without consideration to the scatter in the data. Plot conservative 95% prediction intervals for each of these figures and determine the volume and corresponding bobbin coil voltage associated with an 87% through-wall indication evaluated at the 95% prediction interval.

19. Clarify what material properties were used to determine the proposed dimensional limits. Reference 7 indicates that the "probable" values are the 95% probability/95% confidence values as does page 4-1 of Reference 1. However, the calculations provided in the appendices to Reference 7 indicate both "actual" and "average" values were considered.

20. In Reference 5 (Section 8.2), a correction was made to account for the lower voltage response when using the mix frequency channel for sizing tube support plate indications. Is a similar correction needed with the current approach? Discuss how the proposed depth/volume/bobbin voltage approach accounts for the lower voltages from indications located at the tube support plate intersections. Also, discuss the basis for combining the data from tube support plate and freespan indications given that the voltages may not be comparable.

Inservice Inspection

21. The proposed dimensional requirements do not specify limits for indications exhibiting geometries with the maximum linear dimension inclined at an intermediate angle with respect to the steam generator tube axis (i.e., neither axial nor circumferential). Staff calculations indicate that consideration of only defect axial or circumferential lengths may be nonconservative for certain defect geometries. Discuss how the proposed dimensional limits will be applied to an S/N indication with its major axis not aligned to either the tube axial or circumferential directions.

22. Reference 1 provided limited details of the testing performed to support the nondestructive examination uncertainty allowance of 13.05% (pg 3-17). Discuss how many analysts were used, clarify if 10 different probes were used, discuss the need for considering additional data since the study was based on an examination of only six indications. Discuss the similarities and differences in the morphology between the indications in the NDE study and those in the population of S/N indications examined from pulled tubes at CR-3?

23. The error allowance for acquisition variability is assumed to be equal to that determined in EPRI report TR-100407, Revision 1, "PWR Steam Generator Tube Repair Limits - Technical Support Document For Outside Diameter Stress Corrosion Cracking at Tube Support Plates," dated August 1993. However, the NDE error quantified in the EPRI report uses different probe sizes, inspection frequencies, and procedures from those used at CR-3. Provide a basis for assuming a 7% error for acquisition variability considering these factors. In addition, acquisition variability is closely related to the amount of probe wear during inspections. Discuss the need to limit the amount of probe wear in future CR-3 inspections to ensure that the probe wear allowance used in the determination of the repair limits is conservative.

24. Provide a comparison of the sizing error being proposed (Section 3.2 of Reference 1) and that provided in EPRI report NP-6864-L Revision 2, "PWR Steam Generator Tube Repair Limits: Technical Support Document For Expansion Zone PWSCC in Roll Transitions - Rev. 2" dated August 1993.

Provide the field procedure for length sizing S/Ns. Describe any differences between the field procedures and the procedures used to support your length sizing uncertainty estimate. Discuss how these procedures compare to those in the EPRI report NP-6864-L.

25. In order to demonstrate RPC sizing capability for S/N indications, CR-3 pulled tube data were combined with data from IGA samples obtained from the B&W Owners Group NDE Committee. Discuss the applicability of combining eddy current data obtained from these two sources. Consider the differences in voltage response for the laboratory grown flaws and the sulfur-induced IGA indications found at CR-3.

26. In Reference 3 it is stated that the probability of detection (POD) for the RPC was somewhat less than for the bobbin coil (page 1-2). This is supported by Section 3.2 of Reference 6; however, the study documented in Appendix B of Reference 6 (i.e., page B-4 of Appendix B to Reference 6) states that the IGA patches were better detected with the RPC. Please clarify these observations.

27. What is the general shape of the free-span IGA? For example, is the shape cone-like or similar to a flat-bottomed hole?

<u>Other Issues</u>

28. It is not apparent from the data presented, what data were used in the various correlations. The staff is having difficulty comparing the results from one section of a report to another and from one report to another. In addition, it appears that some correlations have more data than others although they should apparently be coming from the same database. For example, the number of data points used in Table 3-2 of Reference 6 does not match the number of data points used in Appendix D to Attachment 2 of Reference 4. Another example is the number of specimens cited in Table 3-1 of Reference 1 compared to the number of data points in Appendix B to Reference 6. In order to clarify the data presented in the various correlations, provide the following information.

    a. Provide the pulled tube data points (1992 and 1994) used throughout your submittals. Identify the tube number, defect location, defect identification, defect classification (circular wear, IGA, etc.) field bobbin and RPC call, field and laboratory bobbin voltage, field and laboratory RPC voltage, field and laboratory percent through-wall call, laboratory reanalyzed voltages (if applicable), length, width, depth, volume, and other relevant parameters. Since several different probes were used during the inspections, provide the information for the probe and inspection parameters (frequencies/calibration) to be used during the upcoming inspection, if available, or the "probe of record."

    b. Identify which specimens were included in each correlation. For specimens with multiple discontinuities that were too close to be distinguished in the field non-destructive examination (i.e., within the proposed 0.2" band), provide details on what dimensions were used in the various correlations and/or analyses, annotate specimens that were combined, provide the data used for the combined data point, and indicate in which correlation this combined data point was used (e.g., the depth used in the probability of detection study). For example, if an "indication" was missed, was the largest, smallest, or a combination of the defect dimensions used in the POD curve, voltage versus volume correlation, etc. For specimens excluded from any correlation, discuss the reason for excluding them. Discuss if any significant indications were not included in a correlation since they were not destructively examined. For example, in the POD correlation, were any large laboratory detected indications which were not detected in the field not included in the analysis since they were not destructively examined.

c. The above information should specifically identify the data used in the development of Figures 3-4, 3-5, 3-6, and 3-7 of Reference 1.

29. On page 2-5 of Reference 3, it indicates that a small amplitude low S/N indication was observed in the field for the 75% through-wall defect in the lower tubesheet region of tube 68-46; however, in other portions of Reference 3 (e.g., Table 2-3, page 1-4) it appears that the indication was not identified in the field (i.e., called an NDD). Please clarify whether this indication was detected in the field or not. If hindsight was used to identify this indication, discuss any improvements made to the eddy current data analysis guidelines to prevent missing such indications in the future. What is the threshold for reporting S/N indications during eddy current inspections?

30. 600 kHz is stated to be the best frequency for sizing S/N indications but correlations of through-wall depth to voltage (Vmax) were developed at 400 kHz (Section 7.1 of Reference 5) justifying a 2.7 volt limit corresponding to a 100% through-wall flaw. Staff calculations using the data in Table B2 of Appendix D to Reference 5 indicate that a reduction in the voltage limit corresponding to a 100% through-wall flaw from approximately 2.7 volts to 2.2 volts is obtained when using the 600 kHz channel (presumably the channel used to size indications in the field). The staff notes that the licensee is not currently proposing this correlation. Discuss the calibration procedure used in the development of Table B2. Discuss whether the voltages measured and recorded in the field are peak-to-peak voltages or Vmax. If peak-to-peak voltages are recorded in the field, provide a correlation based on peak-to-peak voltages developed with the frequency used to size these indications. These correlations should use all of the data (not just the 10 data points to support the 2.7 volt limit).

31. Discuss how the burst pressure of specimen 68-46-3A was adjusted to account for the brass shim. If discussed in the Electric Power Research Institute (EPRI) Burst Testing Guidelines (Reference 2 of Reference 3), submitting a copy per Question 35 below is acceptable.

32. Quantify the level of error associated with the estimation of defect volume from a metallographic analysis.

33. On page 2-3 of Reference 3, item 3 indicates that tapered wear marks were identified at two adjacent tube support plate lands. However, Table 2-3

does not identify the indications referred to in the text. Was one of the specimens not destructively examined? Please clarify.

34. Clarify the reason for the difference in the number of metallurgical indications reported in Appendix B to Reference 6 and the number reported in Table 3-1 of Reference 6. Furthermore, clarify the reason for the discrepancy between the previously cited data and the data (number of indications) reported in Tables B1/B2 of Appendix D to Attachment 2 to Reference 4. If the reasons for these discrepancies are a result of different analysts/analysis criteria, have the eddy current data analysis guidelines been improved to incorporate the best aspects of each analysis criteria?

35. The numerous documents submitted in support of the proposed Technical Specification (TS) amendment refer to several supporting references. The NRC staff requests that the licensee forward the following references in support of this license amendment application.

    A. Reference 2 of Reference 3: Robert F. Keating memo to D. Steininger (EPRI) dated October 25, 1993, "EPRI Guidelines for Leak & Burst Testing of SG Tubes," NSD-EPRI-0545.

    B. Reference 15 of Reference 3: S.D. Brown, "Crystal River 3 8R/9R Bobbin Voltage (S/N) Growth Rate Calculations," Packer Engineering Report B51956-R1, Dated May 1995.

    C. Reference 14 of Reference 1, Packer Engineering Report B51956-R1-Rev. 0, "Crystal River 3 8R/9R Bobbin Voltage (S/N) Growth Rate Calculations," dated March 1995.

    D. Reference 7 of Reference 3: "OTSG Pulled Tube Catalog," B&W Report 1190991, December 1988; and/or Reference 7 of Reference 1, "OTSG Pulled Tube Catalog," Revision 1 BWNT Report 1190991, August 1994

    E. Reference 5 of Reference 1: "OTSG Trending Report" 7th Edition, BWNT Report 51-1229259-00, July 1994

    F. Reference 10 of Reference 5: BWNT Document 51-1229575-00.

    G. Reference 2 of Reference 7: "Determination of Minimum Required Tube Wall Thickness for 177-FA Once Through Steam Generators," Babcock & Wilcox, No. 10146. April 1980.

    H. Reference 3 of Reference 7: "Review and Update of OTSG Tube Loads, Task 1 Summary," Babcock & Wilcox No 51-1202303-00, February 28, 1991.

36. Section 2.3.1.2 of Reference 3 indicates that the tapered wear scars ranged up to 0.64 inches in length. Table 2-3 indicates that one tapered wear scar was 0.812-inch. Clarify this discrepancy. What was the depth of this indication?

37. The number of indications identified with the bobbin coil (3) and the RPC (2) in the 0.075-inch to 0.099-inch bin of Figure 2-8 in Reference 3

appears inconsistent. It seems that the number of indications should be the same for both (i.e., either there were 2 or 3 indications from the destructive examination). Please clarify the number of indications identified by destructive examination in the 0.075-inch to 0.099-inch bin in Figure 2-8.

38. Confirm the circumferential extent for tube section 109-71-7 listed in Table 3-2 of Reference 1.

39. In equation 5-1 of Reference 1, an allowance for NDE uncertainty is made. Was the adjustment made to the beginning of cycle voltage (i.e., the repair limit voltage) or the structural limit (LL) voltage?

40. The labeling of the vertical axis of Figure 1-4 in Reference 3 states that the data is given "per 100 tubes inspected." Provide graphs showing the voltage distribution of all S/Ns currently in service in steam generator "A" and steam generator "B" (i.e., exclude the tubes repaired in 1994). How many active tubes in each steam generator have S/N indications?

41. The results provided in Table 4-12 of Reference 1 do not correspond to the results given in your letter dated May 25, 1994 (pages 20 and 57 of the Attachment). Specifically, the sample size and number of failures for the second expansion do not match. Please clarify.

References

1. "Alternate Disposition Strategy for Low Volume OTSG Eddy Current Indications," forwarded as Attachment 1 to a Florida Power Corporation (FPC) letter dated May 31, 1995 (3F0595-05).

2. "OTSG Tube Inservice Inspection Refuel Outage 9 12 Month Report," forwarded as an attachment to a FPC letter dated May 31, 1995 (3F0595-07).

3. "Examination of Crystal River-3 Pulled Steam Generator Tubes - Final Report," forwarded as an attachment to a FPC letter dated May 31, 1995 (3F0595-07).

4. "Refuel 9 Inspection Plan for Once Through Steam Generators," submitted by a FPC letter dated April 19, 1994 (3F0494-09).

5. "Crystal River Unit 3 Steam Generator Regulatory Guide 1.121 Evaluation Revision 2," forwarded as Attachment 2 to Reference 4.

6. "Draft EPRI Tube Pull Report," TR-103756, forwarded as Appendix A to Attachment 2 to Reference 4.

7. "MPR Structural Analysis," forwarded as Appendix B to Attachment 2 to Reference 4.