October 9, 2001

Mr. J. A. Scalice
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SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 1 — REQUEST FOR ADDITIONAL INFORMATION RE: STEAM GENERATOR ALTERNATE REPAIR CRITERIA PRESSURIZATION RATE ISSUE (TAC NO. MA8635)

Dear Mr. Scalice:

The Nuclear Regulatory Commission staff is reviewing Tennessee Valley Authority's (TVAs) letter of August 22, 2001, which submitted additional justification for TVA's technical specification change request for Watts Bar to implement voltage-based tube repair criteria. We need additional information to complete our review of the information related to the inspection of dented locations and the pressurization rate used for burst testing. I discussed the enclosed Request for Additional Information with Ms. Becky Mays and other members of the TVA staff on October 9, 2000. At the conclusion of the call, Ms. Mays agreed to respond to this request by November 8, 2001. Please contact me if you have any questions.

Sincerely,

/RA/
Ronald W. Hernan, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosure: Request for Additional Information

cc w/ enclosure: See next page

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Request for Additional Information

Steam Generator Alternate Repair Criteria

Pressurization Rate Issue

Watts Bar Nuclear Plant, Unit 1

Docket No. 50-390

By letter dated August 22, 2001, Tennessee Valley Authority (TVA) submitted additional justification for their technical specification change request for Watts Bar to implement voltage-based tube repair criteria per Generic Letter (GL) 95-05. The information supplied was primarily related to the inspection of dented locations and the pressurization rate used for burst testing.

Based on the staff's review of Enclosures 2, 3, and 4, we have the following observations and questions.

1. With respect to the dent inspection, TVA indicated that if circumferential cracking is identified at Watts Bar in a dented tube support plate intersection that is equal to 2 volts, the inspection plan expands to hot leg dented intersections greater than or equal to 1.0 volt. Please clarify the intent of this statement. Literally read, circumferential cracking could occur at a dent of magnitude 2.01 volts and no expansion would be necessary. Is it the intent of the statement that if a circumferential indication is observed in a dent whose magnitude is between 2.0 and 5.0 volts, then the inspection would be expanded?

The following questions and comments are related to the pressurization rate issue and focus on the burst pressure database used in support of GL 95-05. Although the scope of some of the questions may appear to go beyond the scope of GL 95-05, the staff believes the information is necessary to ensure the licensee has properly identified when the effect will be observed, if at all.

The testing programs performed by TVA and by the industry resulted in several significant observations:

a. In certain circumstances, the Cochet equation (or partial through-wall equation) may overpredict the "burst pressure" for flaws whose crack tips do not end in full thickness material (i.e., are not rectangular shaped). This phenomena occurs when a crack pops through the tube wall and then stops in less than full thickness material (i.e., stops along the original crack profile) until the pressure is elevated to a point where unstable crack tearing occurs (pages 2-5 and 7-6 of Enclosure 4). The term "stops in less than full thickness material" is used to indicate a crack/notch that starts to tear in the axial direction but stops before the length of the crack on the outside diameter of the wall is the same as the length of crack on the inside diameter of the wall (i.e., the crack profile is not rectangularly shaped).

ENCLOSURE

b. A flaw that is pressurized and tears to a given length and through-wall thickness will have a lower burst pressure (if retested) than a flaw initially of the same dimensions (i.e., one not previously pressure tested). This was attributed to the plastic strain field at the crack tip (page 18 of Enclosure 3). It is not clear from the description whether the flaw must tear into full thickness material for this to be true.

c. The severity of the pressurization rate/foil effect appears to be more severe for longer flaws with a "deep section" (e.g., the Type 14 specimen). The foil effect is larger for larger flaws such as the 1.42-inch specimen and there is only a "possible very mild" strengthening effect for a 0.75-inch long slot.

d. There is a small amount of time dependent deformation apparent in tensile tests of alloy 600 between room temperature and typical steam generator operating temperatures.

2. Please clarify the statement on page 7 of Enclosure 3 indicating that "crack extension into full thickness material is not a necessary condition to signify that the burst pressure has been reached, although it is a sufficient condition for steam generator tubing." For the specimens used in the fast rate tests without foil, four of the six specimens reached their maximum pressure during the initial pressurization tests performed without a bladder. For these tests, did the "crack" tear into full thickness material? Was the same true for the other two specimens? If the initial pressurization rate tests were performed with a facility of unlimited capacity would the "burst pressure" have been higher than reported? If so, would this alter the conclusion that the effect is only a "foil effect"?

3. For Figure 2.6 in Enclosure 3: For each data point (fast and slow rate tests), provide the following information showing how the "measured tearing pressure" was arrived at (preferably in one table):

   a. sequence of testing

   b, conduct of test - with bladder, with bladder and foil, no bladder or foil

   c. post test appearance

   For example, was specimen WAT-14-001, first tested "fast" without bladder and foil and then tested with a bladder. If so, what was the pressurization rate and the "burst pressure" for each of these two tests (recognizing that only two of six had higher burst pressures in the second test)? At the completion of each of these two tests, describe whether a Figure 2.4 or Figure 2.5 post test appearance was observed. In addition, describe whether the axial tearing stopped in full thickness material, extended beyond the original notch length (typically 1.42" for Type 14 specimens), or whether it stopped in less than full thickness material.

   The staff is requesting this information to assess whether any of the information learned from the series of tests (discussed above) is affecting the data, thereby affecting the comparisons among the various tests (in particular, retesting of specimens that started to tear and/or didn't tear into full thickness material).

Address whether this includes all Type 14 specimen data reported in Enclosures 3 and 4. The staff notes that the data reported in Table 2-2 of Enclosure 4 does not match the text in Enclosure 4 regarding the average burst pressures and standard deviations.

4. The results provided in Section 2 of Enclosure 3 were performed for 3 conditions: fast with foil, fast without foil and slow without foil. Were any tests performed at slow pressurization rates with foil for the Type 14 specimens? Would the effect be of the same magnitude?

5. For the GL 95-05 database, provide the conditions under which the tests were performed including pressurization rate, temperature, bladder, foil, and whether one pressure test was followed by another. For the French data, address whether a foil effect was observed given the French data are consistently higher than the mean correlation and foil "reinforcement" was used for these slow pressurization rate tests. Do the results imply these geometries exhibited a foil effect at slow pressurization rates? How do the flaw profiles of the French tubes compare to the flaw profiles of the tubes in the 3/4" database? Does the method of attaching the foil affect the results?

6. For Figure 3.8 of Enclosure 3, which was derived from Table 3-1, please address the following:

    a. For the indications with maximum depths between approximately 65% and 85%, the predictive model underpredicted the burst pressures for specimens tested without foil. In Enclosures 3 and 4, it was indicated that the Cochet equation may overpredict the burst pressure of partial through-wall cracks that do not end in full thickness material. In addition, it was indicated that the Cochet equation provides a conservative prediction of the burst pressure. Please address whether the underprediction for the 65% to 85% through-wall specimens tested without the foil is attributed to the limitations of the Cochet equation (related to cracks that do not end in full thickness material) or some other mechanism. If the underprediction is due to this effect, wouldn't it be more appropriate to compare the mean of the data for a specific depth (or a small depth range) for those specimens tested without a foil to the mean of the data for the same depth for those specimens tested with a foil to assess the effect of a foil for this specific geometry? If this were done, would it alter the conclusion that a foil effect is being observed and/or its magnitude?

    b. Given the scatter in the burst pressure data for any given depth (approximately 5 to 10% in the burst pressure), discuss whether normalization of the data (to a mean curve) is appropriate and/or whether more testing needs to be performed to reach the conclusions drawn in the report.

    c. The staff notes that the tests depicted in Figure 3.8 were performed at slow pressurization rates and the tests indicating a foil effect were done at fast pressurization rates. These latter tests compared "fast-foil" tests to "slow-no foil" and "fast-no foil" tests. See question 4.

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