April 7, 2003

Mr. J. A. Scalice
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 1 - REQUEST FOR ADDITIONAL INFORMATION CONCERNING REPAIR OF STEAM GENERATOR TUBES (TAC NO. MB6976)

Dear Mr. Scalice:

By letter dated December 13, 2002, Tennessee Valley Authority submitted an application to revise the Technical Specifications for the Watts Bar Nuclear Plant, Unit 1. The proposed license amendment would allow the use of Westinghouse leak-limiting Alloy 800 sleeves to repair defective steam generator tubes as an alternative to plugging the tube. The Nuclear Regulatory Commission staff has reviewed your submittal and finds that a response to the enclosed request for additional information is needed before we can complete the review.

This request was discussed with Ms. Becky Mays of your staff on April 1, 2003, and it was agreed that a response would be provided within 45 days of receipt of this letter.

If you have any questions, please contact me at (301) 415-1496.

Sincerely,

/RA/

Kahtan N. Jabbour, 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/encl: See next page

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REQUEST FOR ADDITIONAL INFORMATION

REPAIR OF STEAM GENERATOR TUBES

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-390

1. In the license amendment request, TVA (the licensee) proposed the following: Technical Specification (TS) 5.7.2.12.g.1.h, Tube Inspection will be defined as ". . . an inspection of the SG [steam generator] tube from the point of entry (hot-leg side) completely around the U-bend to the top support of the cold leg excluding the portion of tube within the tubesheet below the F* distance for a tube with no tubesheet sleeve and excluding the portion of tube within the tubesheet below the sleeve for a tube with a tubesheet sleeve . . . ."

   A. In the December 13, 2002, submittal, the licensee did not provide a technical basis to exclude the inspection of the tube region inside the tubesheet below the F* distance. The December 13, 2002, submittal focused on the sleeve repair method. Please provide a technical basis to support the proposed change regarding the F* tube inspection.

   B. In the December 13, 2002, submittal, the licensee did not provide a technical basis to exclude the inspection of the tube region inside the tubesheet below the tubesheet sleeve. Please provide a technical basis to support the proposed change regarding excluding the inspection of the tube region in the tubesheet below the tubesheet sleeve.

2. The licensee stated that it will plug a sleeved tube upon detecting a defect in the pressure boundary portion of the sleeve-tube assembly as shown on page E1-6 of Enclosure 1 to the December 13, 2002, submittal.

   A. Clarify the wording in the proposed TS 5.7.2.12.g.1.f.2 to reflect the plug-on-detection approach that the licensee has committed to on page E1-6 of Enclosure 1 to the December 13, 2002, submittal.

   B. Delete the reference, WCAP-15918, from the proposed TS 5.7.2.12.g.1.f.2 because WCAP recommends (e.g., page 5-2 of the report) rather than requires plug-on-detection. If this reference is incorporated in TS 5.7.2.12.g.1.f.2, it implies that plug-on-detection would be a recommended approach instead of a regulatory required approach. The WCAP reference in TS 5.7.2.12.g.1.f.2 would present a regulatory ambiguity and a conflict with the licensee's intent.

3. The inspection sample size in the proposed Table 5.7.2.12-1 for repaired (sleeved) tubes is not adequate and is not consistent with the guidance in Electric Power Research Institute (EPRI) "Steam Generator Examination Guidelines," Revision 5. The repaired tube(s) needs to have larger inspection samples than the inspection sample in

the proposed TS Table 5.7.2.12-1. Please submit a separate SG tube sample inspection table for the sleeved tubes, which should be similar to the table in the EPRI SG examination guidelines.

4. On page E1-8 of Enclosure 1 in the December 13, 2002, submittal, the licensee stated that future inservice inspection of the sleeve-tube assembly will be consistent with plant TSs and EPRI "Steam Generator Examination Guideline" Revision 6. The staff has not completed its review of Revision 6. Clarify whether there is a relaxation in sleeve inspection in Revision 6 as compared to Revision 5 of the EPRI SG examination guidelines.

Questions on WCAP-15918-P

5. On page 2-2, it is stated that ". . . . Acceptable sleeve locations covered in this report are from the top of the tubesheet up to and including the fourth tube support . . . ."

   A. Confirm that the uppermost tube support plates in the Watts Bar SGs are the seventh support plates.

   B. Confirm that the above sleeve installation procedure is applicable to the cold-leg side of the tube bundle.

   C. Discuss whether a sleeve installed at the fourth tube support plate would increase stresses at the U-bend region.

6. On page 4-1, Section 4.2, Sleeve Material Selection, as documented in U.S. Nuclear Regulatory Commission NUREG-1570, "Risk Assessment of Severe Accident-Induced Steam Generator Tube Rupture," the staff is concerned with the potential consequences associated with SG tube failures under severe accident conditions in which the primary system temperature may reach 1200 to 1500 degrees F. The Alloy 800 sleeving method relies on residual stresses and differential thermal expansion to achieve leakage and structural integrity of the repaired tube. The residual stresses may relax at severe accident-induced temperatures (e.g., 1500 degrees F); therefore, the staff believes that this subject should be studied further for the sleeve repair method.

   A. The staff requests that the licensee provide an assessment demonstrating that an acceptable level of risk would be maintained for tubes repaired using the proposed sleeving method. Such an evaluation may include assessment to demonstrate that: (1) the frequency of initiating events that may challenge SG tube repairs is negligible, (2) the integrity of sleeve repairs under severe accident conditions is commensurate with inservice SG tubes, (3) the total increase in the large, early release frequency determined by considering the results of the assessments for (1) and (2) is low.

   B. Discuss the material properties (e.g., yield strength) of Alloy 800 material at the severe accident conditions in which the primary system temperature may reach 1200 to 1500 degrees F. Discuss whether, at the high temperature range, the Alloy 800 sleeve would maintain its intended function and the structural and leakage integrity of the sleeve-repaired tube.

7. On page 4-2, Sleeve-Tube Assembly, it is stated that a sleeve installed in an SG tube which does not meet the minimum requirements may be re-rolled for rolled joint, or re-expanded for the hydraulic expansion.

   A. Discuss the minimum requirements of the sleeve installation to prevent re-roll or re-expansion.

   B. On page 1-1, it is stated that tube plugs will be installed if a sleeve installation is unsuccessful or if there is degradation in the pressure boundary section of the sleeves or sleeved tubes. Discuss the installation conditions that are considered to be unsuccessful.

   C. Discuss the limits on the number of re-rolls and re-expansions that can be applied to a sleeve. Discuss whether the cold work loads generated by the re-rolls or re-expansions affect the structural integrity of the sleeve-tube assembly.

   D. Discuss whether there is a criterion to specify that prior to sleeve installation, the primary pressure boundary of the parent tube of the sleeve-tube assembly is free of degradation, other than the degradation that is being repaired.

8. On page 4-2, it is stated that in the unlikely event that a sleeved tube is found to have an unacceptable defect in the pressure boundary portion of the tube or sleeve, the tube can be taken out of service with tube plugs. Also, on page 5-2, Westinghouse stated that it is the plant owner’s decision to plug a tube upon the detection of a defect in the sleeve. Define an unacceptable defect that would cause a sleeved tube to be plugged in the Watts Bar SGs. Discuss in which document this defect definition will be stated.

9. On page 5-2, several inspection probes were discussed in WCAP-15918-P. However, the staff is not clear whether the licensee will follow the recommendations in WCAP-15918-P or use plant-specific eddy current procedures for sleeve inspection in Watts Bar.

   A. Discuss the eddy current techniques that will be used to inspect sleeves in the Watts Bar SGs in future inservice inspections.

   B. The staff noted that in a domestic nuclear plant, a routine sleeve (not Alloy 800 sleeve) inspection showed that a large indication having large voltage responses in the tube masked the voltage responses from a smaller indication in the sleeve when the sleeve indication and tube indication occur on the same tube elevation. The problem was resolved by combining a high-frequency coil with the existing low-frequency coil in the probe. Address this inspection issue pertaining to the Watts Bar SG tubes.

10. On page 6-2, it is stated that “. . . Some oxygen will initially be present within the sleeve/tube crevice, however, any tendency to trap oxygen will be reduced with this design because of joint leakage at lower temperatures. Based on this, oxygen-rich crevice conditions are not considered to last long enough after startup to be of concern . . .” This statement implies that there could be a path for oxygen or

corrosive impurities to enter and exit the crevices/annulus between the sleeve and tube joint during heatup and cooldown of the plant. Oxygen may not be trapped, but the impurities may be trapped in the annulus. Discuss the potential corrosion problem caused by the trapped corrosive materials in the crevice that could degrade the sleeve-tube assembly.

11. In Section 7.0, Westinghouse performed cyclic load tests on sleeve specimens to determine maximum sleeve slippage. After the cyclic tests, the specimens were used to perform the leak tests.

    A. Discuss whether tests were conducted to determine whether leakage would occur during the cyclic loading when the sleeve slips. This is to simulate a potential case in which reactor coolant leaks through the defect in the parent tube when the sleeve slips inside the tube.

    B. Discuss whether the number of cycles used in the thermal and load cycling tests satisfies the total number of the thermal cycles in the design bases of the Watts Bar plant.

12. On page 7-11, Westinghouse assumed “W” gallons per day (gpd) for the leakage limit from all Alloy 800 sleeves for normal operation and “V” gallons per minute (gpm) for the main steam line break/feedwater line break condition. (The leakage limit values in the topical report are proprietary information.) Discuss the basis for assuming both leakage limits. How is the leakage allowable allocated between the unsleeved tubes and sleeved tubes in the leakage assessment?

13. On page 7-11, in the leak tests, it seems that all specimens have either a severing cut (360 degrees in circumferential extent and 100 percent throughwall) or a drilled hole on the tube wall. Clarify whether a leak test was conducted on a specimen that had a 100 percent throughwall flaw fabricated on the sleeve as well as on the tube. Discuss the leak rate of this specimen under normal operation and accident conditions. If this specimen was not fabricated, discuss the potential leakage from such a flaw configuration in the field.

14. On page 7-11, it is stated that “. . . Without a through wall defect in the parent tube spanned by the repair sleeve, there will be no leakage . . . .” However, the staff is not clear whether a leak test was conducted for a sleeve-tube specimen without defects. Discuss the basis to support the above statement because the sleeve design does consider inherent leakage in the sleeve assembly.

15. On page 7-11, Westinghouse calculated a number of tubesheet sleeves and tube support sleeves that are allowed to be installed to satisfy the assumed leakage limits under normal operation and accident conditions.

    A. Clarify whether the allowable number of sleeves is allocated for one SG or for all four SGs.

    B. It seems that Westinghouse calculated the allowable number of sleeves based on leakage consideration, not on thermal hydraulics consideration. Discuss the thermal hydraulics of the primary and secondary system of an SG, in case the maximum number of sleeves allowed is installed in that SG.

16. On pages 8-18 to 8-22, in Tables 8-2C to 8-2G, it is shown that the sleeve and tube regions have three different temperatures. In the footnote of the tables, the primary temperature (sleeve inside diameter) and secondary temperature (tube outside diameter) were used to calculate the temperature for the normal tubes.

    A. Discuss whether the temperatures assigned to the sleeve, upper and lower tubes would result in a conservative temperature gradient within the sleeve-tube assembly wall such that the conservative thermal stresses are calculated to meet the American Society of Mechanical Engineers (ASME) Code allowable.

    B. It seems that the temperatures assigned and calculated in Tables 8-2C to 8-2G are based on the temperature profiles in the hot leg side of the tube bundle. Discuss whether the temperature profiles in Tables 8-2C to 8-2G are also applicable to the tubes in the cold leg side. Discuss whether the thermal stresses calculated according to the ASME Code bound the thermal stresses in the tubes in the hot leg side and cold leg side.

17. On page 8-27, it is stated that ". . . the prestressed state of a locked-in tube to be sleeved is not of significant concern, so long as it does not hamper the sleeve installation process . . . ." Clarify whether sleeve installation would add additional residual stresses to a locked-in tube, which may cause the tube to exceed the allowable stresses in the ASME Code.

18. On page 8-30, it seems that the seismic evaluation was based on a tubesheet sleeve and not a tube support sleeve. A tube support sleeve installed at a fourth tube support plate intersection may experience higher seismic vibration loads than a tubesheet sleeve located at a lower elevation and is more rigid by virtue of the tubesheet support. Clarify whether the seismic stresses from a tube support sleeve are bounded by the seismic evaluations of a tubesheet sleeve.

19. On page 8-32, it is stated that ". . . any nonconservatism introduced by not applying a stress intensification factor at expansion zones is covered by the other conservatism in the modeling and loading assumptions . . . ."

    A. List other conservatism in the modeling and loading assumptions.

    B. Discuss whether the exclusion of the stress intensification factor at the expansion zones is permitted by the ASME Code.

    C. The expansion zone is an area of the tube that is a stress riser and where flaws would likely occur. The expansion zone is similar to the discontinuity in a pipe, such as at a branch line connection or a welded joint. In the ASME Code piping stress analysis, a stress intensification factor is applied to the stress riser location to account for the stress concentration. It seems that a stress intensification factor should be applied to the expansion zone. If the stress intensification factor were to apply to the expansion zones, discuss whether the stresses at expansion zones in the Watts Bar SGs would still satisfy the ASME Code allowable stresses.

20. On page 8-32, it is stated that ". . . stresses introduced during the installation of the sleeves will "shake down" during the first few operational cycles and are neglected in the ASME evaluations . . . ."

    A. Discuss the shakedown process of the sleeve installation stresses.

    B. The staff is not clear regarding the above statement that ". . . [stresses] that are neglected in the ASME evaluation . . . ." Clarify whether the ASME code neglects to consider the installation stresses or whether Westinghouse neglected to consider the installation stresses in the stress analysis in accordance with the ASME Code. Discuss whether the exclusion of the installation stresses affects the structural and leakage integrity of the sleeve.

21. On page 8-34, verify that the number of transient cycles in the Watts Bar design bases is bounded by the number of transient cycles applied in Table 8-4B.

cc:
Mr. Karl W. Singer, Senior Vice President
Nuclear Operations
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. James E. Maddox, Acting Vice President
Engineering & Technical
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. William R. Lagergren
Site Vice President
Watts Bar Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Spring City, TN 37381

General Counsel
Tennessee Valley Authority
ET 11A
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. Robert J. Adney, General Manager
Nuclear Assurance
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Mark J. Burzynski, Manager
Nuclear Licensing
Tennessee Valley Authority
4X Blue Ridge
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Paul L. Pace, Manager
Licensing and Industry Affairs
Watts Bar Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Spring City, TN 37381

Mr. Larry S. Bryant, Manager
Watts Bar Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Spring City, TN 37381

Senior Resident Inspector
Watts Bar Nuclear Plant
U.S. Nuclear Regulatory Commission
1260 Nuclear Plant Road
Spring City, TN 37381

Rhea County Executive
375 Church Street
Suite 215
Dayton, TN 37321

County Executive
Meigs County Courthouse
Decatur, TN 37322

Mr. Lawrence E. Nanney, Director
Division of Radiological Health
Dept. of Environment & Conservation
Third Floor, L and C Annex
401 Church Street
Nashville, TN 37243-1532

Ms. Ann P. Harris
341 Swing Loop Road
Rockwood, Tennessee 37854