Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

MAY 1 9 2003

WBN-TS-02-16

10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

In the Matter of	)	Docket No.50-390
Tennessee Valley Authority	)	

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - PROPOSED LICENSE AMENDMENT REQUEST CHANGE NO. WBN-TS-02-16 - STEAM GENERATOR TUBE REPAIR SLEEVE - RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION (TAC NO. MB 6976)

The purpose of this letter is to provide TVA's response to NRC's request for additional information (RAI) dated April 7, 2003. Enclosure 1 of this letter provides TVA's response to NRC's questions. Enclosure 2 provides the proposed changes to the markups of the technical specification pages as requested by NRC. Enclosure 3 provides the re-typed pages. Only technical specification pages that are being revised or added are enclosed with this response. The remaining pages of proposed changes are included in TVA's December 13, 2002, request for the license amendment.

The responses and proposed changes to the technical specification are and no change is warranted to the no significant hazards determination included in TVA's December 13, 2003, letter.

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There are no new regulatory commitments associated with this submittal. If you have any questions about this matter, please contact me at (423) 365-1824.

I declare under penalty of perjury that the foregoing is true and correct. Executed on 19th day of May, 2003.

Sincerely,

P. L. Pace
Manager, Site Licensing
and Industry Affairs

Enclosures
1. Response to Request for Additional Information
2. Proposed Technical Specification Changes (mark-up)
3. Proposed Technical Specification Changes (re-typed)

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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
WBN-TS-02-16 STEAM GENERATOR SLEEVING

This enclosure provides TVA's responses to NRC's request for additional information (RAI) dated April 7, 2003. This RAI is the result of NRC's review of TVA's Proposed License Amendment Request dated December 13, 2002. TVA's response are provided below:

QUESTION 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 focuses 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.

RESPONSE 1A and 1B

A clarification concerning inspection was added to the original Technical Specification 5.7.2.12.g.1.h request due to the staff's previous questions to the industry. Per a conversation between the staff and TVA on March 27, 2003, TVA will not make a change to Technical Specification 5.7.2.12.g.1.h. Insert B has been deleted as shown in Enclosure 2 of this submittal.

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QUESTION 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 in 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.

RESPONSE 2A and 2B

Insert A.2 of Enclosure 2 in the December 13, 2002, letter has been revised to read: "Westinghouse Alloy 800 leak-limiting repair sleeve/tube assembly at detection of degradation." The revised pages are included in Enclosures 2 and 3 of this letter.

QUESTION 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) need 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.

RESPONSE 3

This table is provided in Enclosures 2 and 3 of this submittal for incorporation into the Technical Specifications as Table 5.7.2.12-2.

QUESTION 4:

On page E1-8 of Enclosure 1 to 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.

RESPONSE 4

The primary difference between Revision 5 and Revision 6 of the EPRI Examination Guidelines is the separation of the various types of material and how each is inspected. Revision 6 of the EPRI Examination Guidelines requires the following inspection for Alloy 800 tube sleeves:

> A preservice over the full length of all sleeves shall be performed prior to the steam generator being returned to service. The preservice shall also include a utility review, in addition to vendor reviews, of the installation process parameters for each installed sleeve to ensure that the sleeve installation process was performed as intended.
>
> The first inservice inspection establishes an operational baseline to determine if degradation has initiated; therefore, all sleeves shall be examined.
>
> Subsequent examinations would follow a prescribed sampling plan provided there is no active degradation identified in the previous examinations.
>
> If active degradation is detected, the sleeves would be inspected each outage. If the degradation is not associated with cracking, the testing would apply to a critical area. If the degradation is associated with cracking, 100 percent of the sleeves would be inspected.

ENCLOSURE 1

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QUESTIONS CONCERNING WCAP-15918-P

QUESTION 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 upper most 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.

RESPONSE 5

A. The upper most tube support plate in the WBN steam generator is the seventh support plate. In addition, there is a flow distribution baffle approximately eight inches above the tubesheet.

B. The Alloy 800 sleeve installation described in the WCAP is applicable to the cold leg side of the tube bundle. A total of eighteen of these sleeves were installed in the cold leg of the Calvert Cliffs Unit 1 steam generators.

C. The installation of a sleeve at the fourth tube support would have minimal, if any effect on the stresses in the tube U-bend region. If the tube is locked in a support above the sleeve installation, there would be no effect on the U-bend region. If the tube is not locked in a support above the sleeve installation, there would be a minimal change in the stress distribution in the U-bend region. During the sleeve installation process, minimal tensile stresses would be introduced above the sleeve in the parent tube due to the expansion process. During operation, the sleeve "grows" more than the tube due to differential thermal expansion properties, leading to minimal compressive stresses in the parent tube above the sleeve. A discussion of the installation stresses is presented in the WCAP Section 7.4.

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QUESTION 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 to 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.

RESPONSE 6.A.1

Under Revision 2 of the WBN Probabilistic Safety Assessment (PSA), Steam Generator Tube Rupture accounts for about 9 percent of the core damage risk with an initiator frequency of 2.84E-2 per year. Because the integrity of the sleeve repair is commensurate with the integrity of the inservice steam generator tubes (as discussed in the responses to the rest of this question), then sleeving should have no impact on the risk.

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RESPONSE 6.A.2

The concern here is what happens to the sleeve to tube joint at high pressure (2500 pounds per square inch [psi]) and high temperature (1200-1500 degrees Fahrenheit [F]). Pressure tends to loosen the joint because the Radius/thickness (R/t) for the tube is greater than for the sleeve. Temperature tends to tighten the joint because of the different thermal expansion coefficients.

At operating temperatures, the radial displacement due to thermal expansion is much greater than the radial expansion due to pressure, and the combination of steam line break pressure and 600 degrees F temperature (conservatively neglecting the thermal gradient) produces joint tightening. As the temperature increases, the difference in thermal expansion coefficients decreases slightly, but the combined effect of higher temperatures produces additional tightening.

As the temperature increases toward 1500 degrees F, both the sleeve and the tube will yield at steam line break pressures. Because the sleeve material is specified to have a low yield stress (30 kips per square inch [ksi] minimum, carefully controlled maximum), the sleeve will yield at a lower temperature (or pressure) than the tube, thereby tending to tighten the joint.

At 1500 degrees F, the ultimate stress of the sleeve material is higher than the tube material which indicates that ultimate failure of the tube is expected prior to ultimate failure of the sleeve. Therefore, the integrity of the sleeve repair is commensurate with the integrity of the inservice steam generator tubes.

Supporting calculations:

Consideration of high pressure, high temperature conditions on the sleeve joint

- Tube outside diameter (OD) = 0.75 inches, Tube thickness = 0.043 inches, inside radius = 0.332, outside radius = 0.375

Displacement of inside radius of tube due to pressure, P = 2500 psi

- Dtp = P x 0.332 x [(0.375E2 + 0.332E2)/(0.375E2 -0.332E2)+v]/E = 2.839 P/E = 0.0979P x 10E-6 inches = 244.75 x 10E-6 inches

- Assuming Poisson ratio = 0.3, E = 29 x 10E6

Sleeve OD = 0.625 inches, Sleeve thickness = 0.040 inches, inside radius = 0.2725, outside radius = 0.3125

Displacement of outside radius of sleeve due to pressure

- Dsp = P x 2 x 0.2725 x [0.3125E2 /(0.3125E2-0.2725E2)]/E = 2.275 P/E = 0.0784 P x 10E-6 inches = 196.0 x 10E-6 inches

Displacement of inside radius of tube due to temperature at 600 degrees F

- Dtt = 7.8 x 10E-6 x(600-70) x 0.332 = 1,372 x 10E-6 inches

Displacement of outside radius of sleeve due to temperature at 600 degrees F.

- Dst = 9.0 x 10E-6 x (600-70) x 0.3125 = 1,491 x 10E-6 inches.

Therefore at operating conditions even for steam line break conditions, the joint will be tighter than installation. Total radial displacement of tube = (244.75 + 1372) x 10E-6 = 1617 x 10E-6 inches.

Total radial displacement of sleeve = (196 + 1491) x 10E-6 = 1687 x 10E-6 inches. Difference = 70 x 10E-6 inches tighter than at installation.

At higher temperatures, the pressure displacement remains the same, but the temperature displacement difference becomes greater. Assuming elastic conditions:

Displacement of inside radius of tube due to temperature at 1500 degrees F.

- Dtt = 9.0 x 10E-6 x (1500-70) x 0.332 = 4,273 x 10E-6 inches.

Displacement of outside radius of sleeve due to temperature at 600 degrees F.

- Dst = 10.0 x 10E-6 x (1500-70) x 0.3125 = 4469 x 10E-6 inches.

Therefore at 1500 degrees F, even for steam line break conditions, the joint will be tighter than at operating conditions. Total radial displacement of tube = (244.75 + 4273) x 10E-6 = 4518 x 10E-6 inches.

Total radial displacement of sleeve = (196 + 4469) x 10E-6 = 4665 x 10E-6 inches. Difference = 147 x 10E-6 inches tighter than installation, 77 x 10E-6 inches tighter than steam line break at 600 degrees F.

The stress in the sleeve = Pr/t = 2500 x 0.2925/ 0.040 = 18,281 psi, and the stress in the tube = 2500 x 0.353/ 0.043 = 20,523 psi.

The yield stress at 1200 degrees F is estimated to be 20.7 ksi for the sleeve and 25.6 ksi for the tube. The ratio of stress to yield therefore is 0.88 for the sleeve, and 0.80 for the tube, indicating that the sleeve would yield prior to the tube maintaining the tight joint.

The yield stress at 1500 degrees F is estimated to be 10.7 ksi for the sleeve and 12.8 ksi for the tube. The ratio of stress to yield therefore is 1.71 for the sleeve, and 1.60 for the tube, indicating that the sleeve would yield prior to the tube maintaining the tight joint.

RESPONSE 6.B

The strength of the Alloy 800 (SB-163, UNS N08800) sleeve is slightly weaker than the Alloy 600 (SB-163, UNS N06600) steam generator tube. Typical data presented by the alloy developer indicates a greater percentage reduction in properties for Alloy 800 at 1200 degrees F and approximately the same reduction for both alloys at 1500 degrees F. Applying the appropriate percentages to each of the alloy's minimum room temperature properties, results in values given in the following table.

	Alloy 600		Alloy 800	
Temperature (°F)	Yield Strength (ksi)	Ultimate Strength (ksi)	Yield Strength (ksi)	Ultimate Strength (ksi)
R.T. Min	35	80	30	75
1200	25.6	54.4	20.7	45.2
1500	12.8	23.4	10.7	21.3

QUESTION 7

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

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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.

RESPONSE 7A

The sleeve expansion process is controlled by repair software loaded on the work station. After the sleeve is positioned at the proper location, the expansion process is activated. This program will determine when the sleeve contacts the tube and when tube yield begins. This value (psi) is then utilized to determine the amount of piston stroke required to properly expand the tube. The piston stroke is measured by a linear variable displacement transducer (LVDT) mounted in the expansion cabinet. There is no operator control of this process, other than to terminate the process. If a bladder or fitting fails during the expansion process, then the expansion is unacceptable. If this expansion is the first set of three, then the tool may be lowered and another set of expansions performed in the same tube. Should this set of expansions be properly performed, the tool can be re-positioned at the unacceptable expansions and re-expanded using pressure control. The pressure is determined from the successful set of expansions and must be performed in the same tube. The same concept applies if the lower set of expansions is unacceptable. The pressure reading from the upper set of expansions may be used to re-expand the lower set. In both cases, an acceptable set of expansions must be made in a sleeved tube using software control in order for a re-expansion to be performed.

The rolling operation is also controlled by the repair software. A minimum and maximum torque value is established for the rolling operation to be successful. If the torque value does not reach the minimum value, the system may be adjusted and the joint re-rolled. If the maximum torque value is exceeded, then the torque value is analyzed to determine if the joint is acceptable.

RESPONSE 7B

The following sleeve installation conditions would be cause to take a sleeved tube out of service by plugging:

- As discussed in the previous paragraphs, an unacceptable set of expansions would be a cause to plug a sleeved tube. This condition would occur if an acceptable set of expansions, with software control, could not be performed.

- If the torque value for the rolled joint did not fall within the proper torque range, a sleeved tube would be plugged.

- If the two sets of expanded joints were not positioned at the proper elevation, then the sleeved tube would be plugged. This could occur due to operator error in positioning the sleeve and performing the first set of expansions with the tool in the lower position, resulting in a sleeve positioned in the tube lower than required. Additionally, there is a requirement that the lowest of the upper expansions be separated from the highest of the lower expansions by a minimum of 0.4 inches. This condition would result from the operator positioning the tool incorrectly during sleeve installation and would be identified during the baseline eddy current testing (ECT) program.

- If the baseline ECT program identifies any type of unacceptable indication in the pressure boundary of the tube/sleeve assembly, then the tube would be plugged.

RESPONSE 7C

The total number of rolling operations that can be performed on a sleeve to tube joint inside tube sheet is six, two of which must meet the torque value requirements. This number was based on testing performed on plug rolled joints and sleeve roll joints. The reason for performing a re-roll in a steam generator is that the minimum torque value was not reached, and the proper wall thinning was not established. The re-roll operation is intended to increase the wall thinning value by increasing the torque

applied. There is a necessary increase in cold working due to this operation, but no more than had the proper torque value (and wall thinning) been reached on the initial rolling operation. Based upon testing, the sleeve/tube pullout loads and leak rate characteristics of the joint are not affected by the re-roll operation. The torque range for the lower rolled joint is 100 inch-pound (in-lb) to 160 in-lb. No unacceptable additional cold working is placed in the sleeve by additional rolling operations as long as the torque remains below the 160 in-lb value.

In the case of the expansion joint, the same logic applies, except that a pressure value is trying to be reached instead of a torque value. A total of six expansions may be attempted in order to reach the proper pressure value, and subsequent expansion size. Based upon testing, the sleeve/tube pullout loads and leak rate characteristics of the joint are not affected by the re-expansion operation.

RESPONSE 7D

A plant specific document that specifies the allowable locations of tube ECT indications in order to perform a successful sleeve installation will be established upon approval of these TS changes. This sleeving criterion is utilized to determine that a tube is an acceptable sleeving candidate. Tubes with indications outside of the acceptable locations would not be sleeved.

QUESTION 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 WBN SGs. Discuss in which document this defect definition will be stated

RESPONSE 8

TVA will plug a tube upon the detection of any indication in the pressure boundary portion of the sleeve or tube. TVA does not employ a technique in which defect sizing is attempted, thus all

detected indications will result in tube plugging. Therefore, there is no need for a definition of an unacceptable defect.

QUESTION 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 WBN 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.

RESPONSE 9

A. The eddy current inspection of the installed sleeves at WBN will utilize a rotating +point probe, per the inspection qualification program. Should new techniques be developed for inspections, TVA would qualify the new process for use on the sleeve/tube assembly prior to use.

B. The dual coil probe was implemented to address weld root cracking in welded Inconel 690 sleeves. The second, high frequency coil allowed the inspection of the weld surface to be performed in unison with the lower frequency coil. Westinghouse uses this method in the inspection of installed Tungsten Inert Gas Welded Inconel 690 sleeves. In this case, the high frequency coil is used to inspect the sleeve weld inside diameter surface and the lower frequency coil is used to inspect for indications in the weld itself. This approach was utilized in the early portion of the Alloy 800 sleeve program. It was determined that the use of the high frequency coil for this type of sleeve inspection did not yield additional useful information and made the inspection

more difficult. It was decided to perform the inspection with a single mid-range coil in a +point probe. This inspection was qualified to Appendix H of the EPRI Guidelines.

Though it is possible that a large indication may exist in the parent tube, there is no reason to expect degradation in the Alloy 800 sleeve in the free span pressure boundary region of the sleeve. There is no mechanism for the sleeve to degrade in the region of interest. Should the tube indication occur in the pressure boundary region of the tube/sleeve interface, then the tube would be plugged based on the "plug on detection" approach.

QUESTION 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.

RESPONSE 10

Experience with Alloy 800 tubes in European steam generators, as well as testing in faulted secondary environments referenced in Section 6 of the WCAP, indicates Alloy 800 exhibits excellent corrosion resistance under anticipated design and fault primary and secondary environments. Further, examination of in-service sleeved tubes with similar crevices, although of the welded Alloy 690 design, have not shown any corrosion attack associated with crevice deposits.

QUESTION 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.

RESPONSE 11A

Leak testing was not performed during load cycling. Slippage takes place only during the first load application as the sleeve and tube reposition themselves within the joint.

RESPONSE 11B

The cyclic testing was designed to bound the transients described in Table 8-4B to evaluate the deformation and wear of the sleeve joint and resultant leak rates. As discussed on page 7-7, the sleeve joint was tested at a 65 percent (%) higher load for 75% more cycles than calculated for the worse case transient (heatup/cooldown) given in Table 8-4B. It is considered that these additional cycles at this load range are conservative with respect to evaluating the effect of the larger number of cycles at considerably less load ranges.

QUESTION 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?

RESPONSE 12

The basis for these leakage limit values, as stated on page 7-11, is the ease of ratioing them to specific plant limits. These values do not represent any particular plant's leak limit, but were chosen based on Westinghouse's experience with certain plants and the previously made statement. The analysis performed in the WCAP does not attempt to make an allocation between sleeved tubes and unsleeved tubes. The analysis assumes tube through wall defects and associated leakage for each sleeve installed, and no leakage from any other sources.

The plant specific operational leakage limit for WBN is 150 gpd primary to secondary leakage through any one steam generator as stated in Technical Specification 3.4.13, *RCS Operational LEAKAGE*. The MSLB assumed leakage for WBN is currently 1 gpm as stated in the Updated Final Safety Analysis Report (UFSAR) Section 15.5.4, *Environmental Consequences of a Postulated Steam Line Break,* and UFSAR Table 15.5-17, *Doses from Main Steam Line Break*. In the future, TVA may consider a design change to an assumed leakage of 3 gpm however, such an increase would require a 10 CFR 50.90, *Application for amendment of license or construction permit*, request.

QUESTION 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.

RESPONSE 13

Leak testing was not conducted on a specimen that had a 100 percent throughwall flaw in the sleeve as well as the tube. The purpose of the leak tests was to determine the operating characteristics of the sleeve to tube joint. Inasmuch as the sleeve plugging criterion is to plug on detection, a 100 percent throughwall defect in the sleeve would be highly unlikely.

ENCLOSURE 1

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QUESTION 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.

RESPONSE 14

Leak testing was not conducted on a specimen without defects. This was only intended as a general statement of the fact that if the tube was not breached there would be no primary-to-secondary leakage.

QUESTION 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.

RESPONSE 15A

The analysis performed in Section 7 of the WCAP did not take into account individual steam generators versus multiple steam generators. The focus of this section was to determine the amount of sleeves allowed based on an assumed leakage limit. This was discussed in the response to Question 12. WBN plant staff determines the steam generator balance based on previously sleeved tubes, etc.

RESPONSE 15B

Section 7 of the WCAP does analyze the amount of sleeves based only on leakage assessment. Section 10 of the WCAP addresses the thermal hydraulic effects of the sleeve installation. The table in that section stipulates a sleeve to plug ratio for various types of sleeves and sleeve combinations. Based on the plugging limit of the plant, a calculation could be made to determine the maximum number of sleeves which could be installed within the confines of the plugging limit. An additional consideration would be given to the balance of these considerations between each steam generator.

QUESTION 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 3 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 temperatures 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.

RESPONSE 16A

The calculation of axial loads in the subject report does not take credit for a temperature gradient in the sleeve-tube assembly. It is conservatively assumed that the lower tube is at the secondary temperature and the sleeve remains at the primary temperature. Hence, axial loads are based on the difference in

bulk fluid temperature. More recent calculation have been performed (using one-dimensional heat transfer models) that credit the temperature gradient in the sleeve-tube assembly and show significantly lower axial loads. Thus, the assumptions in the licensing report for tube and sleeve temperatures are considered conservative.

RESPONSE 16B

The axial loading in the tube-sleeve assembly is directly related to the temperature difference between the sleeve and the tube. Since the primary (sleeve) temperature on the cold leg side will always be lower than the primary temperature on the hot leg side, the existing calculation is bounding for all locations in the tube bundle.

QUESTION 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.

RESPONSE 17

Installing a sleeve will provide additional support to an existing tube. In general, tubes that become locked into a tube support do so during normal operation (e.g., from tube denting). Thus, during normal operation the tube will be in a zero-stress condition. As the tube cools a small tensile stress could develop in the tube between the attachment points in the tubesheet and the lock-in point at the first tube support. It is then assumed that a sleeve is installed while the tube is in a tensile stress condition. As the tube-sleeve assembly is heated during plant startup both components expand and the preload on the tube decreases. Since the Alloy 800 sleeve will want to expand more than the tube, the tube will expand back to the zero-stress condition at normal operation and the sleeve will be in compression.

During a transient the sleeve will restrain the tube from contracting as much as it would if it were unsleeved, thereby limiting the amount of tensile stress on the tube. Thus, the amount of stress on a sleeved tube will be less than an unsleeved

tube that is locked in the first tube support. A more detailed discussion of installation stresses is contained in Section 7.4 of the WCAP.

QUESTION 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 which is 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.

RESPONSE 18

The seismic evaluation of the tube-sleeve assembly does not take credit for the additional support provided by the tubesheet. The maximum moment for both a "fixed-pinned" model and a "pinned-pinned" model is calculated using the same equation. The only difference in the seismic evaluation when the sleeve is moved up to the fourth support is the span length. For WBN, the span increases from 36.25 inches (currently in the report) to 44 inches. This increase affects the natural frequency of the tube but it remains below the value calculated for the Combustion Engineering (CE) plants. Hence, the tube-sleeve assembly will still be above the cut-off frequency of 33 Hz.

The increase in tube span increases the maximum moment for the Westinghouse plant from 28.669 to 34.584 in-lbs. The resulting stress in the sleeve increases from 2.7 ksi to approximately 3.3 ksi. This value is still well below the ASME Code allowable stress of 30.0 ksi.

QUESTION 19

On page 8-32, it is stated that "…any non-conservatism 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.

RESPONSE 19A

The major conservatisms in this analysis, relate to the treatment of the thermal conditions and the assumption that the sleeve to tube attachment points are rigid. The use of a thermal gradient across the tube-sleeve assembly wall will result in a significant reduction in the temperature differential between the sleeve and tube. This reduced temperature differential will result in a reduction in the actual tube loading. In addition, although the rolled joint at the tubesheet is relatively rigid, the mechanical connection at the upper joint is more flexible. No credit is taken for either of these assumptions in the stress analysis.

RESPONSE 19B

The ASME Code does not address mechanical joints. A rolled or mechanical joint does not concentrate stresses the way a welded joint does because the two bodies are not directly bonded together. It is only interfacial pressure and friction that is used to maintain the integrity of the joint. Several cyclic tests were performed to evaluate the effect of these types of loadings on the integrity of the joint as described in Section 7.2.3 of the WCAP. In general, the integrity of the joint was either unaffected or improved following the tests. Hence, cyclic loadings will not degrade joint integrity.

RESPONSE 19C

The maximum fatigue usage factor calculated for the sleeve is a very low value (less than 0.004) but did not include a stress intensification factor. However, the cyclic testing described in

Section 7.2.3 was performed with test specimens that are equivalent to the production sleeves. Hence, any stress intensification that would occur during sleeve installation would occur in the test specimen. As described in the report, there was no effect on the sleeve integrity over the course of over 140,000 transient cycles. These tests provide added confidence that the low usage factor in the analytical evaluation is valid.

QUESTION 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.

RESPONSE 20A

During the initial plant heatup following Alloy 800 sleeve installation, the sleeve will expand more than the parent tube. As the sleeve lengthens, it will be restrained by the upper and lower joints and the tube will be in compression. At some point during the initial heatup, the sleeve will move (with respect to the tube) and the compressive stresses will be reduced. During subsequent plant heatups there will be no relative movement between the sleeve and tube and compressive stresses on the tube will be lower than occurred during the initial heatup. A more detailed explanation of this process is contained in Section 7.2 of the report.

RESPONSE 20B

The stresses on the sleeves that occur during the installation process are not neglected in the ASME Code analysis. The

stresses are treated separately. A detailed description of the installation stresses is contained in Section 7.4 of the WCAP. As described therein, residual stresses were maintained below the yield stress of the material and were evaluated as part of the material evaluation in Section 6.0 of the WCAP.

As described previously, axial stresses on the tube (tension) and sleeve (compression) are reduced during the initial plant heatup when the sleeve is displaced. This displacement does not occur during subsequent heatups and cooldowns and the stress on the components is less than during the first cycle. Further, axial loads on the sleeve are calculated assuming no displacement of the sleeve relative to the tube. Hence, the axial loads calculated in the report are conservative relative to those that would occur in a steam generator. Other stresses calculated in the report for normal and faulted conditions are dependent on the primary to secondary pressure differential and are unaffected by installation stresses.

Question 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.

RESPONSE 21

A review of the latest revision of the design specification for the WBN steam generators (Design Specification G-679059, Revision 8, dated August 7, 1989) was performed. This review indicated that the transient cycles described in Section 8.5 of the WCAP bound those described in the design specification.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1

PROPOSED TECHNICAL SPECIFICATION CHANGES - WBN-TS-02-16
REVISED MARK-UP

I. **AFFECTED PAGE LIST:**

5.0-19
5.0-19B
Revised Insert
Table 5.7.2.12-2

5.7 Procedures, Programs, and Manuals

5.7.2.12 Steam Generator (SG) Tube Surveillance Program (continued)

NO CHANGE TO THIS PAGE EXCEPT FOR PAGE ROLL SHOWN IN ENCLOSURE 3. INSERT B HAS BEEN DELETED.

This definition does not apply to flow distribution baffles and tube support plate intersections for which the voltage-based repair criteria are being applied. Refer to Specification 5.7.2.12.g.1.1 for repair limit applicable to these intersections.

g) Preservice Inspection - An inspection of the full length of each tube in each SG performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed prior to initial MODE 1 operation using the equipment and techniques expected to be used during subsequent inservice inspections.

h) Tube Inspection - An inspection of the SG tube from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg.

i) Unserviceable - The condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operational Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break accident as specified in Specification 5.7.2.12.f.

j) F* Distance is the distance into the tubesheet from the bottom of the steam generator tube roll transition or the top of the tubesheet, whichever is lower in elevation (further into the tubesheet), that has been conservatively chosen to be 1.40 inches (which includes NDE uncertainty).

k) F* Tube is the tube with degradation equal to or greater than 40%, below the F* distance and not degraded (i.e., no indications of degradation) within the F* distance.

l) The Tube Support Plate Repair Limit - The Tube Support Plate Repair Limit is used for the disposition of Alloy 600 steam generator tubes for continued service that are experiencing predominantly axially oriented outside diameter stress corrosion cracking confined within the thickness of the tube support plates and flow distribution baffle (FDB). At tube support plate intersections (and FDB), the repair limit is based on maintaining steam generator tube serviceability as described below:

(Continued)

5.7 Procedures, Programs, and Manuals

5.7.2.12 Steam Generator (SG) Tube Surveillance Program (continued)

The mid-cycle repair limits are determined from the following equations:

$$V_{MURL} = \frac{V_{SL}}{1.0 + NDE + Gr\left[\frac{CL - \Delta t}{CL}\right]}$$

$$V_{MLRL} = V_{MURL} - (V_{URL} - V_{LRL})\left[\frac{CL - \Delta t}{CL}\right]$$

where:

V_{URL}	=	upper voltage repair limit
V_{LRL}	=	lower voltage repair limit
V_{MURL}	=	mid-cycle upper voltage repair limit based on time into cycle
V_{MLRL}	=	mid-cycle lower voltage repair limit based on V_{MURL} and time into cycle
Δt	=	length of time since last scheduled inspection during which V_{URL} and V_{LRL} were implemented
CL	=	cycle length (the time between two scheduled steam generator inspections)
V_{SL}	=	structural limit voltage
Gr	=	average growth rate per cycle length
NDE	=	95-percent cumulative probability allowance for nondestructive examination uncertainty (i.e. a value of 20-percent has been approved by the NRC)

Implementation of these mid-cycle repair limits should follow the same approach used in specifications 5.7.2.12.g.1.1.1, 5.7.2.12.g.1.1.2, and 5.7.2.12.g.1.1.3.

* The upper voltage repair limit is calculated according to the methodology in GL 95-05 as supplemented. V_{URL} will differ at the tube support plates and flow distribution baffle.

INSERT C →

2. The SG shall be determined OPERABLE after completing the corresponding actions (plug **or repair** all tubes exceeding the plugging limit and all tubes containing through-wall cracks) required by Table 5.7.2.12-1 **and 5.7.2.12-2.**

ADD →

h. Reports - The content and frequency of written reports shall be in accordance with Specification 5.9.9.

WATTS BAR NUCLEAR PLANT UNIT 1
TECHNICAL SPECIFICATION WBN-TS-02-16

REVISED INSERTS

INSERT A:

Plugging Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging, or repaired by sleeving in the affected area. The plugging limit imperfection depths are specified as follows:

1. Original tube wall at greater than or equal to 40% nominal wall.

2. Westinghouse Alloy 800 leak-limiting repair sleeve/tube assembly at detection of degradation. ~~as described in the proprietary Westinghouse WCAP-15918-P (Draft CEN-633-P, Revision 05-P), "Steam Generator Tube Repair For Combustion Engineering and Westinghouse Designed Plants with ¾ Inch Inconel 600 Tubes Using Leak Limiting Alloy 800 Sleeves."~~

This definition does not apply to the portion of the original tube in the tubesheet below the F* distance provided the tube is not degraded within the F* distance for F* tubes.

~~INSERT B:~~

~~Tube Inspection - An inspection of the SG 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.~~

INSERT C:

m) Tube Repair refers to a process that reestablishes tube serviceability. Tube repair of defective tubes will be performed where applicable by installation of the Westinghouse Alloy 800 leak-limiting repair sleeve as described in the proprietary Westinghouse Report WCAP-15918-P, Revision 00 (Draft CEN-633-P, Revision 05-P), "Steam Generator Tube Repair For Combustion Engineering and Westinghouse Designed Plants with ¾ Inch Inconel 600 Tubes Using Leak Limiting Alloy 800 Sleeves".

5.7 Procedures, Programs, and Manuals (continued)

ADD TABLE

TABLE 5.7.2.12-2

STEAM GENERATOR REPAIRED TUBE INSPECTION
SAMPLING REQUIREMENTS

1st Sample Inspection			2nd Sample Inspection	
Sample Size	Result	Action Required	Result	Action Required
A minimum of 20% of repaired tubes	C-1	None	N/A	N/A
	C-2	Plug defective repaired tubes and inspect 100% of the repaired tubes in this SG	C-1	None
			C-2	Plug defective repaired tubes
			C-3	Perform action for C-3 result of first sample.
	C-3	Inspect all repaired tubes in this SG, plug defective repaired tubes and inspect 20% of the repaired tubes in each other SG. Notification to NRC pursuant to 10CFR50.72	All other SGs C-1	None
			Some SGs C-2 but no other is C-3	Perform action for C-2 result of first sample.
			Additional SG is C-3	Inspect all repaired tubes in each SG and plug defective repaired tubes. Notification to NRC pursuant to 10CFR50.72.

ENCLOSURE 3

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1

PROPOSED TECHNICAL SPECIFICATION CHANGES - WBN-TS-02-16
REVISED PAGES

I. **AFFECTED PAGE LIST:**

5.0-18
5.0-19
5.0-19C
5.0-20a

5.7 Procedures, Programs, and Manuals

5.7.2.12 Steam Generator (SG) Tube Surveillance Program (continued)

c) A loss-of-coolant accident requiring actuation of the Engineered Safety Features, or

d) A main steam line or feedwater line break.

g. Acceptance Criteria

1. Terms as used in this specification will be defined as follows:

a) Degradation - A service-induced cracking, wastage, wear, or general corrosion occurring on either inside or outside of a tube;

b) Degraded Tube - A tube containing imperfections greater than or equal to 20% of the nominal wall thickness caused by degradation;

c) % Degradation - The percentage of the tube wall thickness affected or removed by degradation;

d) Defect - An imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective;

e) Imperfection - An exception to the dimensions, finish, or contour of a tube from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections;

f) Plugging Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging, or repaired by sleeving in the affected area. The plugging limit imperfection depths are specified as follows:
1. Original tube wall at greater than or equal to 40% of the nominal wall.
2. Westinghouse Alloy 800 leak-limiting repair sleeve/tube assembly at detection of degradation.
This definition does not apply to the portion of the original tube in the tubesheet below the F* distance provided the tube is not degraded within the F* distance for F* tubes.

For tubes to which the F* criteria is applied, a minimum of 1.5 inches of the tube into the tubesheet from the top of the tubesheet or from the bottom of the roll transition, whichever is lower in elevation, shall be inspected using rotating pancake coil eddy current technique or

(Continued)

5.7 Procedures, Programs, and Manuals

5.7.2.12 Steam Generator (SG) Tube Surveillance Program (continued)

an inspection method shown to give equivalent or better information on the orientation and length of cracking. A minimum of 1.40 inches (which includes NDSE uncertainty) of continuous, sound expanded tube must be established, extending from either the bottom of the roll transition or the top of the tubesheet, whichever is lower in elevation, to the uppermost extent of the indication.

This definition does not apply to flow distribution baffles and tube support plate intersections for which the voltage-based repair criteria are being applied. Refer to Specification 5.7.2.12.g.1.1 for repair limit applicable to these intersections.

g) Preservice Inspection - An inspection of the full length of each tube in each SG performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed prior to initial MODE 1 operation using the equipment and techniques expected to be used during subsequent inservice inspections.

h) Tube Inspection - An inspection of the SG tube from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg.

i) Unserviceable - The condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operational Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break accident as specified in Specification 5.7.2.12.f.

j) F* Distance is the distance into the tubesheet from the bottom of the steam generator tube roll transition or the top of the tubesheet, whichever is lower in elevation (further into the tubesheet), that has been conservatively chosen to be 1.40 inches (which includes NDE uncertainty).

l) F* Tube is the tube with degradation equal to or greater than 40%, below the F* distance and not degraded (i.e., no indications of degradation) within the F* distance.

l) The Tube Support Plate Repair Limit - The Tube Support Plate Repair Limit is used for the disposition of Alloy 600 steam generator tubes for continued service that are experiencing

(Continued)

5.7 Procedures, Programs, and Manuals

5.7.2.12 Steam Generator (SG) Tube Surveillance Program (continued)

m) Tube Repair refers to a process that reestablishes tube serviceability. Tube repair of defective tubes will be performed where applicable by installation of the Westinghouse Alloy 800 leak-limiting repair sleeve as described in the proprietary Westinghouse Report WCAP-15918-P, Revision 00 (Draft CEN-633-P, Revision 05-P), "Steam Generator Tube Repair For Combustion Engineering and Westinghouse Designed Plants with ¾ Inch Inconel 600 Tubes Using Leak Limiting Alloy 800 Sleeves."

2. The SG shall be determined OPERABLE after completing the corresponding actions (plug or repair all tubes exceeding the plugging limit and all tubes containing through-wall cracks) required by Tables 5.7.2.12-1 and 5.7.2.12-2.

h. Reports - The content and frequency of written reports shall be in accordance with Specification 5.9.9.

(continued)

5.7 Procedures, Programs, and Manuals (continued)

TABLE 5.7.2.12-2

STEAM GENERATOR REPAIRED TUBE INSPECTION
SAMPLING REQUIREMENTS

1st Sample Inspection			2nd Sample Inspection	
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	C-2	Plug defective repaired tubes and inspect 100% of the repaired tubes in this SG	C-1	None
			C-2	Plug defective repaired tubes
			C-3	Perform action for C-3 result of first sample.
	C-3	Inspect all repaired tubes in this SG, plug defective repaired tubes and inspect 20% of the repaired tubes in each other SG. Notification to NRC pursuant to 10CFR50.72	All other SGs C-1	None
			Some SGs C-2 but no other is C-3	Perform action for C-2 result of first sample.
			Additional SG is C-3	Inspect all repaired tubes in each SG and plug defective repaired tubes. Notification to NRC pursuant to 10CFR50.72.

(continued)