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Ref: 10CFR50.90

CPSES-200302528
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File # 00236

January 8, 2004

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

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
DOCKET NO. 50-445
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION RELATED TO LICENSE AMENDMENT REQUEST 03-03, REVISION TO TECHNICAL SPECIFICATION (TS) 5.5.9 STEAM GENERATOR TUBE REPAIR USING LEAK LIMITING ALLOY 800 SLEEVES (TAC NO. MC0197)

REF: 1) TXU Energy Letter, logged TXX-03102, from C. L. Terry to the U. S. Nuclear Regulatory Commission, dated July 21, 2003.

Gentlemen:

The purpose of this letter is to reply to your Request for Additional Information (RAI) concerning our submittal of License Amendment Request 03-03 originally transmitted by Reference 1. The NRC questions are restated in Attachment 1 with TXU Energy's responses immediately following each question.

Attachment 2 provides a copy of the existing Unit 1 Steam Generator repaired tube inspection sample selection table (Technical Specification Table 5.5-3) to support review of this submittal.

Attachment 3 provides a revised copy of the affected Technical Specification pages, marked-up to reflect the proposed changes.

Attachment 4 provides retyped Technical Specification pages which incorporate the requested changes.

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The contractor report WCAP-15918-P, Revision 0, "*Steam Generator Tube Repair for Combustion Engineering and Westinghouse Designed Plant with ¾ Inch Inconel 600 Tubes Using Leak Limiting Alloy 800 Sleeves,*" is being revised to support our responses. Final approval of WCAP-15918-P, Revision 1 is expected to be completed by January 30, 2004, and the revised report will then be forwarded to support NRC review of this submittal.

Should you require any other additional information please contact Mr. Bob Kidwell at (254) 897-5310.

This communication contains no new licensing basis commitments regarding CPSES Units 1 and 2.

I state under penalty of perjury that the foregoing is true and correct.

Executed on January 8, 2004.

Sincerely,

TXU Generation Company LP
By: TXU Generation Management Company LLC,
Its General Partner

Mike Blevins
Senior Vice President and Principal Nuclear Officer

By: Roger D. Walker
Roger D. Walker
Regulatory Affairs Manager

OAB/rk

Attachments
1. TXU Energy Response to RAI
2. Technical Specification Table 5.5-3; "STEAM GENERATOR REPAIRED TUBE INSPECTION FOR UNIT 1 ONLY"
3. Markup of revised Technical Specifications Pages
4. Retyped revised Technical Specification Pages

c - B. Mallett, Region IV
W. D. Johnson, Region IV
M. C. Thadani, NRR
Resident Inspectors, CPSES

Ms. Alice Rogers
Bureau of Radiation Control
Texas Department of Public Health
1100 West 49th Street
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Attachment 1 to TXX-03198

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
COMANCHE PEAK STEAM ELECTRIC STATION (CPSES) UNIT 1
LICENSE AMENDMENT REQUEST 03-03

TAC No. MC0197

1. In Technical Specification 5.5.9.f, page 5.0-16, a plugging limit of 20% of the nominal sleeve wall thickness for Westinghouse Leak Tight and Leak Limiting sleeves was proposed. However, on page 6 of Attachment 1 to your 7/21/03 License Amendment Request, it was indicated that a sleeved tube would be plugged upon the detection of degradation in the sleeve/tube assembly.

   Please modify your proposal for Technical Specification 5.5.9.f to indicate that a sleeved tube would be plugged upon detection of degradation in the sleeve/tube assembly. For example: All tubes repaired with Westinghouse Alloy 800 Leak Limiting sleeves shall be plugged upon detection of imperfections in the (a) sleeve and/or (b) pressure boundary portion of the original tube wall in the sleeve/tube assembly (i.e., the sleeve-to-tube joint). In the case of Westinghouse Alloy 800 Leak Limiting sleeves, an imperfection is considered to include eddy current indications that are less than 20% of the nominal sleeve wall thickness.

   <u>TXU Energy Response</u>:

   TXU Energy has modified the Technical Specification 5.5.9.f to reflect that an Alloy 800 Leak Limiting sleeved tube shall be plugged if an imperfection is detected in the installed sleeve, and/or in the pressure boundary of the original tube wall in the Alloy 800 leak limiting sleeve/tube assembly (i.e., the sleeve to tube joint). The applicable page of the modified Technical Specifications is attached to this letter.

2. In Technical Specification 5.5.9.f, page 5.0-16, it is stated that the proposed definition for plugging limit for Leak Tight and Leak Limiting sleeves does not apply to that portion of the Unit 1 tubing that meets the definition of an F* tube. This definition could be interpreted as follows: If an F* tube is sleeved inside the tubesheet, there would be no plugging limit applied to flaws detected in the parent tube in or below the sleeve/tube joint, which is below the F* distance. This would imply that a flaw is allowed to exist in the pressure boundary, as defined in WCAP-15918-P, Rev. 0.

   Discuss the appropriate plugging limit for flaws with sleeves installed in F* tubes in the tubesheet. If flaws are permitted in this region, discuss the technical basis. If flaws are not permitted, discuss your plans to modify the Technical Specification.

TXU Energy Response:

TXU Energy will evaluate and plug a tube upon the detection of any imperfection in the pressure boundary portion of the sleeve and/or in the pressure boundary of the original tube wall in the Alloy 800 leak limiting sleeve/tube assembly (i.e., the sleeve to tube joint), as indicated in response to question No. 1 above. If the tube flaw detected is above the lower sleeve joint, then it is contained by the sleeve and the tube is allowed to stay in service. If the tube flaw is below the sleeve, then it is allowed to stay in service due to the F* analysis. If the tube flaw is at the intended location of the lower sleeve to tube joint, then the tube will not be sleeved based on the sleeving criteria documents.

3. The proposed Technical Specification does not modify the inspection sampling requirements for tubes repaired by sleeving.

Please clarify the inspection scope and expansion criteria to be applied to the sleeved portion of the tube. Provide a proposal for modifying the Technical Specification to incorporate these inspection requirements. An example of a previously approved Technical Specification proposal can be found under ADAMS Accession # ML032300143. Include in your discussion the requirements for the preservice inspection, first inservice inspection, and subsequent inservice inspections.

TXU Energy Response:

TXU Energy is proposing an initial minimum inspection of 20-percent of the installed sleeves at each refueling outage. In addition to the 20-percent initial sample, additional sleeves may be inspected depending on the extent of sleeve degradation. The current CPSES Technical Specification Table 5.5-3; *"STEAM GENERATOR REPAIRED TUBE INSPECTION FOR UNIT 1 ONLY"* reflects this sampling and expansion criteria. A copy of this table is provided in Attachment 2 for information.

The proposed inspection sampling is consistent with the current industry guidance for steam generator sleeve examinations as specified in the latest revision of Appendix H of the Electric Power Research Institute (EPRI) report, "Pressurized Water Reactor Steam Generator Examination Guidelines."

4. On page 6 of Attachment 1 to your 7/21/03 License Amendment Request, the operational experience with Alloy 800 is discussed.

   Discuss whether any leakage has been attributed to Alloy 800 sleeves and the magnitude of the leakage. Describe the conditions under which leakage was observed, and compare the magnitude of the observed leakage to the leakage values provided in WCAP-15918-P, Rev. 0.

   TXU Energy Response:

   Leakage assessment is discussed in Section 7.3 of WCAP-15918-P, Rev. 1. Assumed leakrates of the leak tight sleeves have been developed for both Transition Zone (TZ) and Tube Support (TS) sleeves. The operational experience to date has confirmed these calculated values to be conservative.

   However, to account for the uncertainties in sleeve life expectancy based upon the accelerated corrosion tests, TXU Energy considers the sampling and expansion criteria (see answer to Question No. 3) as providing adequate conservatism to ensure that any degradation in the sleeve assembly is detected and addressed early.

5. Please discuss your plans for including references to your responses to the RAI(s) in the parts of the Technical Specification where you reference WCAP-15918-P, Rev. 0, since both the WCAP report and the RAI(s) reflect the technical basis for this License Amendment Request.

   TXU Energy Response:

   The modifications to the proposed Technical Specifications as a result of the RAI(s) are contained in Attachments 2 and 3 of this letter. Additionally, as a result of these RAI(s), the WCAP-15918-P, Rev. 0 has been revised to discuss each of these issues. This new revision will be transmitted to the NRC after its approval. WCAP-15918-P, Rev. 1 will now be referenced in the Technical Specifications instead of WCAP-15918-P, Rev. 0.

Questions on Westinghouse report WCAP-15918-P, Rev. 0

6. Alloy 800 was selected as the sleeve material, per page 4-1, Section 4.2, Sleeve Material Selection. The proposed Alloy 800 sleeve relies on residual stresses and differential thermal expansion to achieve leakage and structural integrity of the sleeve/tube assembly. As documented in U.S. Nuclear Regulatory Commission report NUREG-1570, "Risk Assessment of Severe Accident-Induced Steam Generator Tube Rupture," the primary system temperature may reach 1200°F to 1500°F. Since severe accident conditions may cause relaxation of the residual stresses inherent in the sleeve/tube assembly, the following is requested:

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

   <u>TXU Energy Response</u>:

   6.A.1 In the Comanche Peak Steam Electric Station Unit 1 Probabilistic Safety Assessment (PSA), Steam Generator Tube Rupture accounts for about 1 percent of the core damage risk with an initiator frequency of 7.0E-03 per year. Because the integrity of the sleeve repair is commensurate with the integrity of the inservice steam generator tubes (as discussed in response 6.A.2 to this question), then sleeving should have no impact on the frequency of initiating events.

   6.A.2 The concern here is what happens to the sleeve to tube joint at high pressure (2500 psi) and high temperature (1200°F-1500°F). Pressure tends to loosen the joint because the 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 600F 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°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 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 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 OD = 0.75 inches
Tube thickness = 0.043 inches
Inside radius = 0.332 inches
Outside radius = 0.375 inches

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

$D_{tp} = P \times 0.332 \times [(0.375^2 + 0.332^2) / (0.375^2 - 0.332^2) + v] / E$
$= 2.839\ P/E = 0.0979P \times 10^{-6}$ inches = **244.75×10^{-6} inches**
(Assuming Poisson Ratio = 0.3, then $E = 29 \times 10^6$)

Sleeve OD = 0.625inches
Sleeve thickness = 0.040 inches
Inside radius = 0.2725
Outside radius = 0.3125

Displacement of outside radius of sleeve due to pressure

$D_{sp} = P \times 2 \times 0.2725 \times [0.3125^2 / (0.3125^2 - 0.2725^2)] / E =$
$2.275\ P/E = 0.0784\ P \times 10^{-6}$ inches = **196.0×10^{-6} inches.**

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

$D_{tt} = 7.8 \times 10^{-6} \times (600-70) \times 0.332 =$ **$1,372 \times 10^{-6}$ inches.**

Displacement of outside radius of sleeve due to temperature at 600°F

$D_{st} = 9.0 \times 10^{-6} \times (600-70) \times 0.3125 =$ **$1,491 \times 10^{-6}$ inches.**

Therefore, at operating conditions even for steam line break conditions, the joint will be tighter than at installation.

Total radial displacement of tube = $(244.75 + 1372) \times 10^{-6} =$ **1617×10^{-6} inches.**

Total radial displacement of sleeve = $(196 + 1491) \times 10^{-6} =$ **1687×10^{-6} inches.**

Difference = 70×10^{-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°F

$D_{tt} = 9.0 \times 10^{-6} \times (1500-70) \times 0.332 =$ **$4,273 \times 10^{-6}$ inches.**

Displacement of outside radius of sleeve due to temperature at 600°F

$D_{st} = 10.0 \times 10^{-6} \times (1500-70) \times 0.3125 =$ **4469×10^{-6} inches.**

Therefore at 1500F, even for steam line break conditions, the joint will be tighter than at operating conditions.

Total radial displacement of tube = $(244.75 + 4273) \times 10^{-6} =$ **4518×10^{-6} inches.**

Total radial displacement of sleeve = $(196 + 4469) \times 10^{-6} =$ **4665×10^{-6} inches.**

Difference = 147×10^{-6} inches tighter than installation, 77×10^{-6} inches tighter than steam line break at 600F.

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°F is estimated to be 20.7ksi for the sleeve and 25.5ksi 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°F is estimated to be 10.7 for the sleeve and 13.0 for the tube. The ratio of stress to yield therefore is 1.71 for the sleeve, and 1.58 for the tube, indicating that the sleeve would continue to yield prior to the tube maintaining the tight joint.

6.A.3 Because the integrity of the sleeve repair is commensurate with the integrity of the inservice steam generator tubes (as discussed in response 6.A.2 to this question), the use of Alloy 800 sleeves should have no impact on either the frequency of initiating events, nor the Large Early Release Frequency (LERF).

B. Discuss the material properties (e.g., yield strength) of Alloy 800 material under severe accident conditions. Using calculations, show that the sleeve-tube assembly would maintain its structural and leakage integrity under any realistic combination of pressure and temperature during severe accident conditions.

TXU Energy Response:

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°F and approximately the same reduction for both alloys at 1500°F. Applying the appropriate percentages to each alloys' minimum room temperature properties results in values given in the following table.

	Alloy600		Alloy800	
Temperature (°F)	Yield Strength (ksi)	Ultimate Strength (ksi)	Yield Strength (ksi)	Ultimate Strength (ksi)
R.T. Min	35	80	30	75
1200	25.6	51.4	20.7	45.2
1500	12.8	20.4	10.7	21.3

7. On page 4-2, Section 4.3, Sleeve/Tube Assembly, it is stated that an installed Westinghouse Alloy 800 Leak Limiting sleeve may be re-rolled (for a rolled joint) or re-expanded (for a hydraulically expanded joint), if the sleeve does not meet the minimum requirements.

   A. Discuss in detail the sleeve installation steps necessary to minimize the need to perform re-rolls or re-expansions.

   TXU Energy Response:

   The sleeve expansion process is controlled by 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 (in 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 control cabinet. There is no operator control of this process, other than to terminate. 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. 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 will be analyzed to determine if the joint is acceptable.

B. On page 1-1, Section 1.1, Purpose, 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 sleeve or sleeved tube. List and discuss the installation conditions that would lead to a conclusion that the installation was unsuccessful.

TXU Energy Response:

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 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". This condition would result from the operator positioning the tool incorrectly during sleeve installation and would be identified during the baseline 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.

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-roll or re-expansion affect the structural integrity of the sleeve/tube assembly.

TXU Energy Response:

The total number of rolling operations that can be performed on a sleeve to tube joint 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 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.

In the case of the expansion joint, the same logic applies, except that a pressure value is 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.

D. Discuss whether there is a criterion that specifies that, prior to sleeve installation, the parent tube must be free of degradation at the locations where the sleeve joints are to be established.

TXU Energy Response:

A plant specific document will specify the allowable locations of tube ECT indications in order to perform a successful sleeve installation. The sleeving criteria are utilized to determine that a tube is an acceptable sleeving candidate. Indications outside of the acceptable locations would not be sleeved.

8. On page 5-2, Section 5.1, Background, several inspection probes were mentioned, but it was unclear as to which type of inspection probe would be used.

Discuss the eddy current techniques that will be used to inspect the sleeves. Please clarify that it is your intent to perform eddy current inspections with equipment and techniques capable of detecting all flaw types which may potentially be present in the pressure boundary of the sleeve/tube assembly, as discussed in WCAP-15918-P, Rev. 0. In addition, discuss whether this is consistent with your interpretation of the Technical Specification. If it is not, propose modifications to the Technical Specification to indicate the necessary inspection equipment and techniques.

TXU Energy Response:

The eddy current inspection of the installed sleeves at Comanche Peak Steam electric Station Unit 1 will utilize a rotating +point probe. This is one of the probes used in the baseline tube examination and use of this probe is consistent with our Technical Specifications.

9. On Pages 5-2 and 5-3, Section 5.1, Background, it is stated that, "... inspection detection capability has been demonstrated separately for the sleeve and tube, using the appropriate flaw sizes for the specific pressure boundary thickness." Clarify whether the eddy current techniques intended for inspection of the sleeve/tube assembly are qualified to detect cracks that may be present, given the sleeve/tube configuration. For example, were flaws simulated in the parent tube at the location of the sleeve/tube joint? If not, discuss the basis (including test data) which shows that flaws can be reliably detected, given the sleeve/tube configuration. Discuss the number of sleeve/tube samples having SCC flaws and the inspection results for these samples.

TXU Energy Response:

The statement that "... the inspection detection capability has been demonstrated separately ... " explains that the size of the flaws used in each component were determined based on the specific wall thickness - minimum allowable degradation for that component alone, without structural reinforcement provided by the other. As stated in Section 5.2, the qualification program was performed on actual sleeve/tube assemblies that included EDM notches in both components at each of the transitions and expansion zones (i.e., joints) to the depths described. The qualification program did included sixteen (16) sleeve/tube assemblies containing laboratory grown stress corrosion cracks. Because of Electric Power Research Institute (EPRI) report, "Pressurized Water Reactor Steam Generator Examination Guidelines," Appendix H requirements, not all of these flaws could be used in the qualification data set.

10. On page 5-2, Section 5.1, Background, it is stated that flaw detection capability was demonstrated for flaws greater than or equal to 50% through-wall for the tube and 45% for the sleeve. The structural limit for the sleeve was calculated to be 48% through-wall, based on cracking.

Given that one of the possible sleeve degradation mechanisms is wall thinning, discuss what the structural limit is for sleeve wall thinning and whether the techniques to be used during the inspections are qualified to detect degradation at or below the wall thinning structural limit.

TXU Energy Response:

The structural limit for the sleeve, as stated on page 5-2, is for cracking as this is the worst case and most likely degradation mechanism. General wall thinning due to wear / wastage would allow an even greater reduction in wall thickness. Calculation of the allowable degradation for both modes is described in Section 8.2 of WCAP-15918-P, Rev 1. Sufficient sensitivity to volumetric type flaws such as general wall thinning is demonstrated by detection of the calibration standard ASME machined flaws in both the sleeve and parent tube.

Further details of the number and location of flaws are contained in the EPRI report, "Pressurized Water Reactor Steam Generator Examination Guidelines," Appendix H qualification report (Reference 5.3.1 CENO Report No. 97-TR-FSW-019P).

11. On page 6-2, Section 6.2.1, Primary Side Performance, 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 crevice/annulus between the sleeve and tube joint during heat-up and cooldown of the plant. Oxygen may not be trapped, but the impurities may be trapped in the annulus.

Discuss whether there is a potential corrosion problem as a result of trapping corrosive materials in the crevice. Discuss whether these deposits could degrade the performance of the sleeve/tube assembly.

TXU Energy Response:

Experience with Alloy 800 tubes in European steam generators, as well as testing in fault secondary environments, referenced in Section 6 of WCAP-15918-P, Rev 1, indicates Alloy 800 exhibits excellent corrosion resistance under both primary and secondary nominal and fault 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.

12. On page 7-11, Section 7.3.2, Leak Test Evaluation, the assessment of leakage under post accident conditions is discussed.

A. Identify the leak rate that will be used to assess the leakage from sleeve joints, and identify the number of sleeves that will be assumed to be leaking. If all sleeves are not assumed to be leaking, discuss the technical basis.

<u>TXU Energy Response</u>:

Yes, all sleeves are assumed to leak at the design basis leak rates provided in WCAP-15918-P, Rev 1, Section 7.3.1 (page 7-10), for the accident conditions specified. The rates are provided for use by CPSES plant staff to determine the total number of sleeves that may be installed, given the other sources of leakage from the steam generators, such as calculated leakage from alternate repair criteria.

Conditions	Leakage rate per sleeve (gal/hour)	
	TZ[1]	TS[2]
Normal Operation	*[3]	*[3]
MSLB/FLB	*[3]	*[3]

Notes:
1. TZ = Transition Zone sleeve.
2. TS = Tube Support sleeve
3. Leakage values may be found in the proprietary version of WCAP-15918-P, Rev 1, Section 7.3.1 (page 7-10).

These values represent the upper 95% confidence limit on the mean value of leakage for appropriate temperature and pressure conditions (WCAP-15918-P, Rev 1, Tables 7-2 and 7-3).

B. Confirm whether the leakage attributed to the sleeves will be combined with other sources of leakage for comparisons to the leakage limits.

<u>TXU Energy Response</u>:

Yes, leakage attributed to the sleeves will be combined with other sources of leakage for comparisons to the leakage limits.

C. Provide your plant-specific limit for accident-induced primary-to-secondary leakage.

<u>TXU Energy Response</u>:

The plant specific operational leakage limit for CPSES Unit 1 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 CPSES is 27.79 gpm as stated in the Final Safety Analysis Report (FSAR) Table 15.1-3, *PARAMETERS FOR POSTULATED MAIN STEAM LINE BREAK ACCIDENT ANALYSIS.*

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

A. Discuss whether the temperature assigned to the sleeve, upper tube, and lower tube would result in a conservative temperature gradient within the sleeve/tube assembly wall. Discuss the implications of using the calculated temperature gradient in terms of meeting the ASME Code allowable stress.

<u>TXU Energy Response</u>:

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 calculations 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.

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

<u>TXU Energy Response</u>:

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.

14. On page 8-27, Section 8.3.5, Effect of Tube Prestress Prior to Sleeving, 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, causing the tube to exceed the allowable stresses in the ASME Code.

<u>TXU Energy Response</u>:

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 will expand and the preload on the tube will decrease. 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 WCAP-15918-P, Rev 1.

15. On page 8-30, Section 8.4.3, Seismic Evaluation, the seismic evaluation was apparently based on a tubesheet sleeve and not a tube support sleeve.

Please clarify whether the seismic evaluation for a tube support sleeve are bounded by the seismic evaluations of a tubesheet sleeve.

TXU Energy Response:

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 above the fourth support is the span length. For the case of Comanche Peak Steam Electric Station Unit 1, the span increases from 36.25 inches (currently in the report) to 43 inches. This increase affects the natural frequency of the tube but it remains below the value calculated for the 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 33.798 in-lbs. The resulting stress in the sleeve increases from 2.7 ksi to approximately 3.22 ksi. This value is still well below the ASME Code allowable stress of 30.0 ksi.

16. On page 8-32, Section 8.5, Evaluation of Sleeve to Tube Expansion Section, it is stated that, "Any non-conservatism introduced by not applying a stress intensification factor at expansion zones is covered by the other conservatisms in the modeling and loading assumptions."

A. List the other conservatisms in the modeling and loading analysis.

TXU Energy Response:

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.

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

TXU Energy Response:

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 are used to maintain the integrity of the joint. Several cyclic tests were performed to evaluate the effect of this type of loading on the integrity of the joint as described in Section 7.2.3 of WCAP-15918-P, Rev 1. In general, the integrity of the joint was either unaffected or improved following the tests. Hence, cyclic loadings will not degrade joint integrity.

17. The expansion zone area of the sleeve/tube assembly is a stress riser where flaws are likely to occur. The expansion zone is similar to the discontinuity in a pipe, such as that found at a branch line connection or 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 appears that a stress intensification factor should be applied to the expansion zone.

If the stress intensification factor were to be applied to the expansion zones of the sleeve/tube assembly, discuss whether the stresses at the expansion zones still satisfy the ASME Code allowable stress.

TXU Energy Response:

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 more than 140,000 transient cycles. These tests provide added confidence that the low usage factor in the analytical evaluation is valid.

18. On page 8-32, Section 8.5, Evaluation of Sleeve to Tube Expansion Section, 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 how the stresses will "shake down" during the first few operational cycles.

<u>TXU Energy Response</u>:

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.

B. Discuss how the ASME Code addresses installation stresses. Discuss how the Westinghouse approach addresses installation stresses in accordance with the ASME Code. Discuss whether the exclusion of installation stresses affects the structural and leakage integrity of the sleeve-tube assembly.

<u>TXU Energy Response</u>:

The stresses on the sleeves that occur during the installation process are not neglected in the ASME Code analysis, they are treated separately. A detailed description of the installation stresses is contained in Section 7.4 of the report. 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 report.

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.

19. On page 8-34, verify that the number of transient cycles in the licensee's design basis is bounded by the number of transient cycles applied in Table 8-4B.

TXU Energy Response:

Westinghouse performed an initial review of the latest revision of the design specification for the Comanche Peak steam generators (Design Specification G-952124, Revision 5, dated June 1984). This review indicates that the transient cycles described in Section 8.5 of the report bound those described in the design specification.

ATTACHMENT 2 to TXX-03198

CPSES TECHNICAL SPECIFICATION
COPY of TABLE 5.5-3;
“STEAM GENERATOR REPAIRED TUBE INSPECTION FOR UNIT 1 ONLY”

5.5 Programs and Manuals

83

TABLE 5.5-3

STEAM GENERATOR REPAIRED TUBE INSPECTION FOR UNIT 1 ONLY

1ST SAMPLE INSPECTION			2ND SAMPLE INSPECTION	
Sample Size	Result	Action Required	Result	Action Required
A minimum of 20% of repaired tubes (1)	C-1	None	N.A.	N.A.
	C-2	Plug defective repaired tubes and inspect 100% of the repaired tubes in this S.G.	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 S.G., plug defective tubes and inspect 20% of the repaired tubes in each other S.G.	All other S.G.s are C-1	None
		Notification to NRC pursuant to §50.72(b)(2) of 10 CFR Part 50	Same S.G.s C-2 but no additional S.G. are C-3	Perform action for C-2 result of first sample
			Additional S.G is C-3	Inspect all repaired tubes in each S.G. and plug defective tubes. Notification to NRC pursuant to §50.72(b)(2) of 10 CFR Part 50

(continued)

(1) Each repair method is considered a separate population for determination of initial inservice inspection and scope expansion.

ATTACHMENT 3 to TXX-03198

PROPOSED TECHNICAL SPECIFICATION CHANGES (MARK-UP)

Pages 5.0-16 and 5.0-17

5.5 Programs and Manuals

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

f) Plugging or Repair Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging or (for Unit 1 only) repaired by sleeving and is equal to 40% of the wall thickness. The plugging limit for laser welded sleeves is equal to 43% of the nominal wall thickness. All tubes repaired with Westinghouse Alloy 800 Leak Limiting sleeves shall be plugged upon detection of imperfections in the (1) sleeve and/or (2) pressure boundary portion of the original tube wall in the sleeve/tube assembly (i.e., the sleeve-to-tube joint). The plugging limit for Leak Tight sleeves is equal to 20% of the nominal wall thickness.

This definition does not apply to that portion of the Unit 1 tubing that meets the definition of an F* tube. This definition does not apply to tube support plate intersections for which the voltage-based plugging criteria are being applied. Refer to 5.5.9e.1m) for the repair limit applicable to these intersections;

g) Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in Specification 5.5.9d.3, above;

h) Tube Inspection means an inspection of the steam generator tube from the tube end (hot leg side) completely around the U-bend to the top support of the cold leg. For a tube repaired by sleeving (for Unit 1 only) the tube inspection shall include the sleeved portion of the tube;

i) Preservice Inspection means an inspection of the full length of each tube in each steam generator performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed prior to initial POWER OPERATION using the equipment and techniques expected to be used during subsequent inservice inspections;

j) F* Distance (Unit 1 only) is the distance of the hardroll expanded portion of a tube which provides a sufficient length of non-degraded tube expansion to resist pullout of the tube from the tubesheet. The F* distance is equal to 1.13 inches, plus an allowance for eddy current measurement uncertainty, and is measured down from the top of the tubesheet, or the bottom of the roll transition, whichever is lower in elevation;

k) F* Tube (Unit 1 only) is that portion of the tubing in the area of the tubesheet region below the F* distance with a) degradation below the F* distance equal to or greater than 40%, b) which has no indication of degradation within the F* distance, and c) that remains inservice;

(continued)

5.5 Programs and Manuals

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

4. Certain intersections as identified in WPT-15949 will be excluded from application of the voltage-based repair criteria as it is determined that these intersections may collapse or deform following a postulated LOCA + SSE event.

5. If an unscheduled mid-cycle inspection is performed, the following mid-cycle repair limits apply instead of the limits identified in 5.5.9e.1.m)1., 5.5.9e.1.m)2., and 5.5.9e.1.m)3. The midcycle 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 limit based on time into cycle
V_{MLRL}	=	mid-cycle lower voltage repair limit based on V_{MLRL} 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 per cycle
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 as in TS 5.5.9e.1.m)1., 5.5.9e.1m)2., and 5.5.9e.1.m)3.

n. Tube Repair (for Unit 1 only) refers to the process that establishes tube serviceability. Acceptable tube repairs will be performed in accordance with the process described in Westinghouse WCAP-13698, Rev. 3 and Westinghouse Letter WPT-16094 dated March 20, 2000, WCAP-15090, Rev. 1, and CEN-630-P, Rev. 2 dated June 1997, and WCAP-15918, Rev. 1.

(continued)

ATTACHMENT 4 to TXX-03198

RETYPED TECHNICAL SPECIFICATION PAGES

Pages 5.0-16 and 5.0-17

5.5 Programs and Manuals

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

f) Plugging or Repair Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging or (for Unit 1 only) repaired by sleeving and is equal to 40% of the wall thickness. The plugging limit for laser welded sleeves is equal to 43% of the nominal wall thickness. All tubes repaired with Westinghouse Alloy 800 Leak Limiting sleeves shall be plugged upon detection of imperfections in the (1) sleeve and/or (2) pressure boundary portion of the original tube wall in the sleeve/tube assembly (i.e., the sleeve-to-tube joint). The plugging limit for Leak Tight sleeves is equal to 20% of the nominal wall thickness.

This definition does not apply to that portion of the Unit 1 tubing that meets the definition of an F* tube. This definition does not apply to tube support plate intersections for which the voltage-based plugging criteria are being applied. Refer to 5.5.9e.1m) for the repair limit applicable to these intersections;

g) Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in Specification 5.5.9d.3, above;

h) Tube Inspection means an inspection of the steam generator tube from the tube end (hot leg side) completely around the U-bend to the top support of the cold leg. For a tube repaired by sleeving (for Unit 1 only) the tube inspection shall include the sleeved portion of the tube;

i) Preservice Inspection means an inspection of the full length of each tube in each steam generator performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed prior to initial POWER OPERATION using the equipment and techniques expected to be used during subsequent inservice inspections;

j) F* Distance (Unit 1 only) is the distance of the hardroll expanded portion of a tube which provides a sufficient length of non-degraded tube expansion to resist pullout of the tube from the tubesheet. The F* distance is equal to 1.13 inches, plus an allowance for eddy current measurement uncertainty, and is measured down from the top of the tubesheet, or the bottom of the roll transition, whichever is lower in elevation;

k) F* Tube (Unit 1 only) is that portion of the tubing in the area of the tubesheet region below the F* distance with a) degradation below the F* distance equal to or greater than 40%, b) which has no indication of degradation within the F* distance, and c) that remains inservice;

(continued)

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

4. Certain intersections as identified in WPT-15949 will be excluded from application of the voltage-based repair criteria as it is determined that these intersections may collapse or deform following a postulated LOCA + SSE event.

5. If an unscheduled mid-cycle inspection is performed, the following mid-cycle repair limits apply instead of the limits identified in 5.5.9e.1.m)1., 5.5.9e.1.m)2., and 5.5.9e.1.m)3. The midcycle 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 limit based on time into cycle
V_{MLRL}	=	mid-cycle lower voltage repair limit based on V_{MLRL} 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 per cycle
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 as in TS 5.5.9e.1.m)1., 5.5.9e.1m)2., and 5.5.9e.1.m)3.

n. Tube Repair (for Unit 1 only) refers to the process that establishes tube serviceability. Acceptable tube repairs will be performed in accordance with the process described in Westinghouse WCAP-13698, Rev. 3 and Westinghouse Letter WPT-16094 dated March 20, 2000, WCAP-15090, Rev. 1, and CEN-630-P, Rev. 2 dated June 1997, and WCAP-15918, Rev. 1.

(continued)