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

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
DOCKET NOS. 50-445
REQUEST FOR ADDITIONAL INFORMATION REGARDING STEAM GENERATOR TUBE REPAIR USING LASER WELDED SLEEVES

REF: 1) NRC letter from David H. Jaffe to Stuart A. Richards of the NRC dated March 20, 2001

Gentlemen:

Reference 1 describes the meeting held between NRC staff and TXU Electric on February 28, 2001. The purpose of the meeting was to discuss the NRC staff's review of the Westinghouse reports that had been submitted in support of the laser welded sleeving of the Comanche Peak Steam Electric Station (CPSES), Unit 1, Steam Generators.

In Reference 1, the NRC staff indicated that additional information would be needed to complete its evaluation of the Westinghouse laser welded sleeving report. NRC staff's request as we understand it and TXU Electric's responses are as follows:

1. A summary of the laser welded sleeve test report, which might be provided in proprietary and non-proprietary forms.

A001

TXU Electric response

Refer to the attachment to this letter.

2. An opportunity for the NRC staff to review calculation TH-97-08, “Sleeve Code Multiplier for Excess Conservatism”.

TXU Electric response

Due the propriety nature of the calculation, TXU Electric will notify the CPSES NRR Project Manager as to when and where the subject calculation will be available for review. Westinghouse will consider making this calculation available for the staff review in its Rockville, Maryland office.

3. Documentation concerning the SLEEVE Code.

TXU Electric response

Refer to the attachment to this letter.

4. Laser welded sleeve/flow data from other plants.

TXU Electric response

TXU Electric does not posses this data. TXU Electric believes that this information is provided to the NRC staff by other plants via the special or the 12-month reports and is available to the staff.

5. Insights on the affects of laser welded sleeving on accidents and transients. If determined to be needed, this information will be requested via specific questions from the NRC staff.

TXU Electric response

No response required at this time.

This communication contains no new licensing basis commitments regarding CPSES Units 1 and 2. Should you have additional questions please contact Obaid Bhatty at (254) 897-5839 to coordinate this effort.

Sincerely,

C. L. Terry

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

OAB/ob

Attachment

Cc: E. W. Merschoff, Region IV
D. N. Graves, Region IV
D. H. Jaffe, NRR
Resident Inspectors, CPSES

SLEEVE Code Summary Report

Background

Westinghouse has installed SG tube sleeves of various lengths in SGs with varying tube OD and wall thickness dimensions since 1981. As the sleeve has a smaller diameter than the tube in which it is being installed, the sleeve acts as a restriction, and thus reduces the amount of flow through each tube that a sleeve is installed. The Technical Specifications have requirements for minimum RCS loop flow during operation, thus it is necessary to estimate the amount of flow restriction introduced by the application of sleeving. Additionally, it is desirable to know the hydraulic equivalencies for estimation of the RCS loop flow during transient and accident conditions. Westinghouse has developed a calculation code called SLEEVE, which estimates this restriction and equates the resulting restriction to flow.

This document provides additional information regarding the methodology of the SLEEVE code as well as providing additional test information recently performed for full-scale sleeve flow tests.

SLEEVE Code Methodology

The SLEEVE code computes hydraulic loss coefficients for sleeved and unsleeved tubes, which are used to estimate a hydraulic equivalency for the sleeve. The hydraulic coefficients are calculated using standard correlations for losses due to contractions, expansions and wall friction. The following are the loss coefficients used for the different regions of the tube/sleeve.

1. <u>Contraction</u>

a) Tube inlet K = 0.5 - Tube end extends below cladding surface with fillet weld between tube OD and tubesheet cladding.
Tube inlet K = 0.23 - Tube end flush with cladding surface with rounded weld.

b) Contract within tube/sleeve (sudden contraction)

$$K = 0.5 \times \left[1 - \left(\frac{D_{small}}{D_{large}}\right)^2\right]$$

2. Expansion

a) Expansion within tube/sleeve (sudden expansion)

$$K = \left[1 - \left(\frac{D_{small}}{D_{large}}\right)^2\right]^2$$

b) Tube exit   K=0.6

3. Friction Losses

$$K = 4f\left(\frac{L}{D}\right)$$

where, f is the friction factor, L is length and D is diameter

$$f = 0.0014 + \frac{0.125}{\mathrm{Re}^{0.32}}$$

where Re is the Reynolds number.

All loss coefficients are adjusted such that they are referenced to the flow area defined by tube ID.

4. Hydraulic Equivalency

The hydraulic equivalency number can be shown by the following equation:

$$N_{hyd} = \frac{1}{1 - (K_{unslv} - K_{slv})^{1/2}}$$

The input to the code consists of tube and sleeve dimensions and operating conditions. The sleeve dimensions are entered as an array of inside diameters starting at the hot leg end of the sleeve and a corresponding array of lengths. The code can model any combination of tubesheet and tube support sleeves in the hot leg and/or cold leg.

Full Scale Testing Summary

It has long been assumed that the calculational methodology of the SLEEVE code contained excess conservatism. As this conservatism could only be proven by test, full scale sleeve/tube configurations were tested to determine loss coefficients and Reynolds Numbers for the sleeve configuration.

The sleeve configuration used was for the 30" and 36" Hybrid Expansion Joint (HEJ) tubesheet sleeve. In the HEJ tubesheet sleeve, the lower end of the sleeve is flared to an outside diameter slightly larger that the tube ID so that during insertion, the flare is abutted firmly against the tube end. At the lower end, and near the upper end, the sleeve is hydraulically expanded to contact with the parent tube. The expansion process continues to produce a tube OD expansion in the upper (freespan) joint of approximately 0.013" to 0.028" diametrically. Once the hydraulic expansion is performed, a mechanical roll is performed at the tube/sleeve entry and in the center of the upper hydraulic expansion. The tested sleeve configuration differs from the laser welded sleeve (LWS) design in the upper joint region. In the LWS design, the hydraulic expansion process in controlled to produce only a 0.000" to 0.003" tube OD diametrical expansion. The mechanical roll is produced at the tube entry, and a laser weld is produced in the center of the upper expansion region. The LWS design in the upper joint has one less expansion and one less contraction as compared to the HEJ design since the LWS does not include a mechanical roll in the upper joint. Additionally, the hydraulically expanded sleeve inside diameter in the upper joint region is less for the LWS design, thus providing for a less severe diameter change in this region.

The test procedure involved testing first the unsleeved tube configuration. Pressure taps were provided at the inlet to the tube, and at a location downstream of the eventually installed sleeve. Pressure measurements were performed for varying flow rates (33 to 67 gpm) and fluid temperatures (78 to 155°F). HEJ sleeves were then installed. The flow rates and temperatures used in the unsleeved case were then repeated for the sleeved case. Pressure/flow measurements were repeated for each case. The pressure data were then used to compute the loss coefficients and Reynolds Number for each case. The resultant loss coefficients and Reynolds Numbers were then input into the SLEEVE code to determine the hydraulic equivalencies for the unsleeved and sleeved cases. As sleeves can be installed in both the hot leg and cold leg in the same tube, the test configuration was such that a sleeve was installed in both ends of the tube. A prototypic Reynolds Number for operating SGs is approximately 9×10^5. The range of test parameters produced Reynolds Numbers ranging from 1×10^5 to 7×10^5. These values were selected to examine the effects of Reynolds Number upon hydraulic equivalency as the RCS temperature and flow rates change during the power escalation cycle. Figure 1 presents a summary of the calculated loss coefficients for each case, unsleeved and sleeved, for varying Reynolds Numbers. As seen from this figure, the unsleeved case yields loss coefficients approximately equal for the 30" and 36" test setups. For these two cases, the tube ID's varied by a few mils. As would be expected, the 30" sleeved case has a lower loss coefficient than the 36" sleeved case.

Once the loss coefficients for the sleeved tube test case were determined, the hydraulic equivalency was determined for the test conditions. The hydraulic equivalency was then determined using the standard input assumptions applied to the SLEEVE code. The result shows that the standard input assumptions and calculational methodology of the SLEEVE code is quite conservative compared to the test data for prototypically installed sleeves.

For the 30" hot leg sleeve, the hydraulic equivalency determined from the test data was found to be on average 3.38 times greater than the hydraulic equivalency calculated using the SLEEVE code. For the 36" hot leg sleeve, the hydraulic equivalency was found to be on average 2.35 times greater than the hydraulic equivalency calculated using the SLEEVE code. The test data suggests that as the Reynolds Number increased, the ratio of hydraulic equivalency for test to calculated conditions indicates a slightly increasing ratio. Thus for the prototypic Reynolds Number conditions, the actual hydraulic equivalency should be larger for the actual installed condition. The variance between test and calculated hydraulic equivalencies may be due to actual installed conditions of the 30" and 36" sleeves and individual tube conditions.

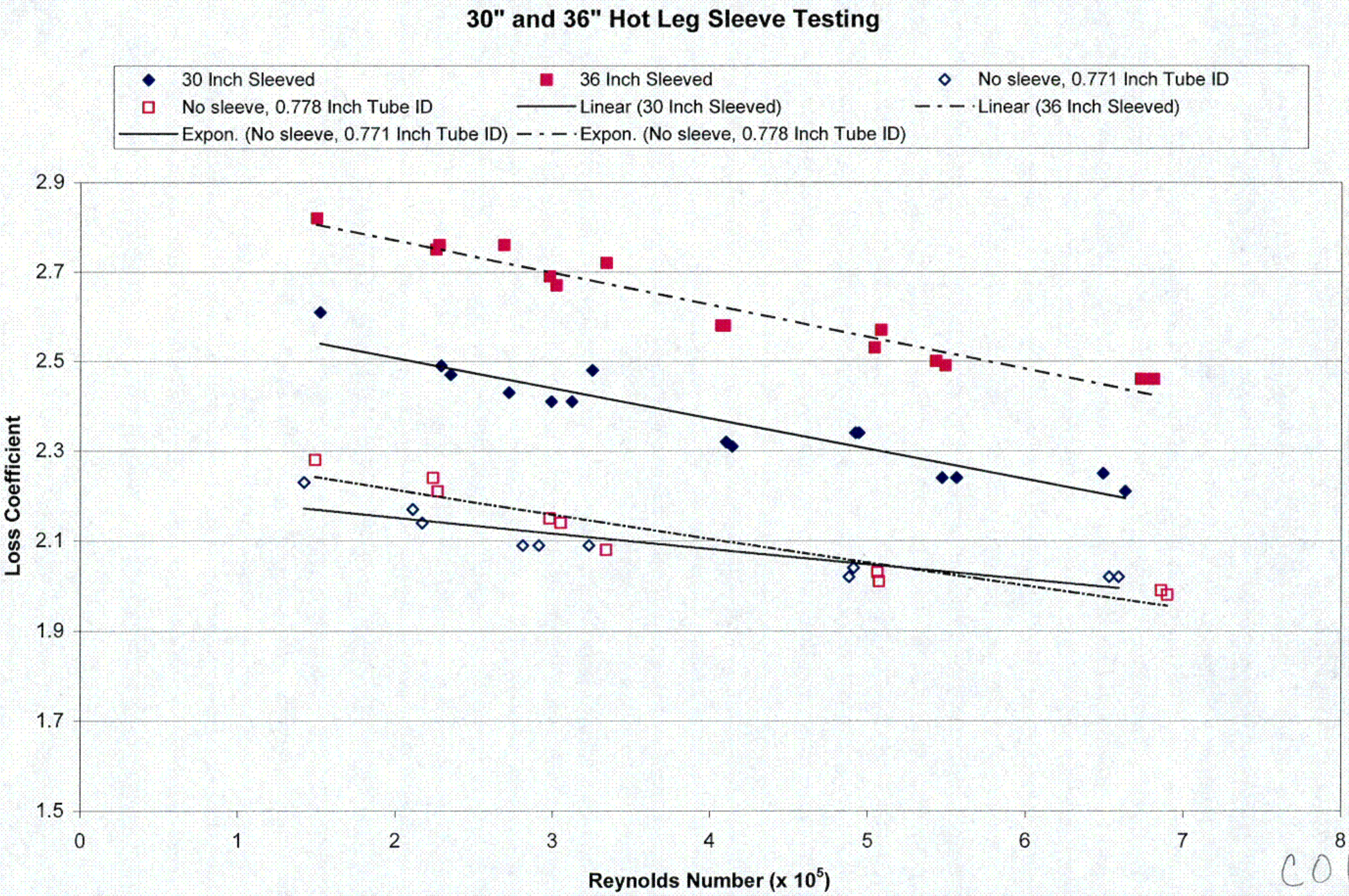
Conclusions

The sleeve flow tests indicate that significant conservatism is provided in the SLEEVE code calculation compared to test results. The test data shows that the SLEEVE code calculation remains conservative for all test conditions and sleeve lengths. The SLEEVE code results are expected to remain conservative for any evaluated sleeve length or joint design condition.

Comanche Peak 1 Sleeve Configuration

As the sleeve configuration for Comanche Peak Unit 1 will be elevated LWS tubesheet sleeves, the hydraulic equivalencies are expected to be significantly improved compared to 30" or 36" LWS tubesheet sleeves. In the elevated LWS tubesheet sleeve configuration, the sleeve length is 12", with the approximate mid-point of the sleeve located at the top of tubesheet region. The elevated LWS tubesheet design does not include a flared end. For the elevated LWS tubesheet sleeve, a taper region is provided at the lower sleeve end. This taper region facilitates eddy current inspection as well as acting to reduce entrance losses. All sleeve designs (HEJ or LWS) include an identical taper at the upper end of the sleeve. Both ends of the sleeve are hydraulically expanded, then a mechanical roll is produced at the lower joint and a laser weld produced at the upper joint. The only significant difference is the sleeve length. The shorter sleeve length will effectively provide a lesser loss coefficient for the sleeve length between the joints regions due to a much shorter effective length in this region. The unexpanded sleeve diameters are consistent, and for equal Reynolds Number, the ratio of loss coefficients becomes the ratio of unexpanded tube lengths. For the12" elevated LWS and 30" LWS tubesheet cases, the joint configurations are consistent, and the ratio of unexpanded tube length between joints is approximately 24"/6", or 4. Therefore, the loss coefficient for this area of the sleeve is 4 times less for the 12" elevated LWS compared to the 30" tubesheet LWS.

Figure 1


30" and 36" Hot Leg Sleeve Testing
30 Inch Sleeved
36 Inch Sleeved
No sleeve, 0.771 Inch Tube ID
No sleeve, 0.778 Inch Tube ID
Linear (30 Inch Sleeved)
Linear (36 Inch Sleeved)
Expon. (No sleeve, 0.771 Inch Tube ID)
Expon. (No sleeve, 0.778 Inch Tube ID)
Loss Coefficient
2.9
2.7
2.5
2.3
2.1
1.9
1.7
1.5
0
1
2
3
4
5
6
7
8
Reynolds Number (x 10^5)

C01