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William J. Cahill, Jr.
Group Vice President

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

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)- UNIT 2
DOCKET NOS. 50-446
LEAK-BEFORE-BREAK QUALIFICATION FOR THE ACCUMULATOR
INJECTION LINES

REF: NRC letter dated May 5, 1992 to William J. Cahill, Jr.,
"Request for Additional Information - Comanche Peak
Unit 2, Accumulator Line Analysis (TAC No. M1986)"

Gentlemen:

In response to your request for additional information referenced above, we are providing responses to your request in Attachment 1. To assure clarity, each request is repeated and then responded to in the attachment.

If there are any questions, please call Mr. Chris E. Jensen at (214) 812-8826.

Sincerely,

William J. Cahill, Jr.

By: D.R. Woodlan
D. R. Woodlan
Docket Licensing Manager

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REQUEST FOR ADDITIONAL INFORMATION
COMANCHE PEAK UNIT 2, ACCUMULATOR
LINE ANALYSIS (TAC NO. M81986)

SAFE SHUTDOWN EARTHQUAKE (SSE) LOAD MODELING

1. Describe in sufficient detail the SSE methodology used for generating Table 4-1.

RESPONSE

Earthquake Load Generation for the RCL and Class 1 Piping.

A. Earthquake Inertia Effects

Seismic input to the piping system is in the form of amplified response spectra (ARS) at the building floors as provided in specification CPES-S-1032G. The ARS are applied in each appropriate global coordinate direction and are felt by the system through its supporting media. When piping models span two structures or different elevations within the same structure, an enveloped ARS curve is developed and applied uniformly to the entire model. This results in a final set of ARS, one in each global coordinate direction, to be used for analysis.

Analysis is performed using damping values in accordance with Code Case N-411. Code Case N-411 damping was used for all W piping analysis performed for CPSES.

When using the response spectrum method, the effects of three-directional (two horizontal and one vertical) components of earthquake motion are considered. The coupling effect of closely spaced modes is calculated by SRSS of the modal responses. Closely spaced modes (within a 10% band of frequency) are accounted for by the modified grouping method. A particular mode can only be included in one closely spaced grouping. Groups are formed starting from the lowest frequencies. (FSAR section 3.7N.2.7).

$$R_T^2 = \sum_{i=1}^{N} R_i^2 + 2 \sum_{j=1}^{S} \sum_{k=M_j}^{N_j-1} \sum_{l=k+1}^{N_j} R_k R_l \epsilon_{kl}$$

$$\epsilon_{kl} = \left\{1 + \left(\frac{\acute{w}_k - \acute{w}_l}{\beta_k w_k + \beta_l w_l}\right)^2\right\}^{-1}$$

$$\acute{w}_k = w_k \, (1-(\beta_k)^2)^{1/2}$$

R_T = Total unidirectional response

$$\beta_k = \beta_k + \frac{2}{w_k t_d}$$

R_i = Absolute value of response mode 1

N = Total number of modes

β_k = Damping Ratio

W_k = Frequency

t_d = 30 seconds

S = Number of groups of closely spaced modes

M_j = Lowest modal number associated with group j of closely spaced modes

N_j = Highest modal number associated with group j of closely spaced modes

ϵ_{kl} = Coupling factor

These formulas differ from Regulatory Guide 1.92 as discussed in Section 1A(N) of the FSAR.

High frequency modes (above 33 Hz) are accounted for by the Residual Load Method: The higher frequency contribution is calculated statically using the residual acceleration vector[1] and then combined with the lower frequencies response by SRSS.

The combination of the three uni-directional responses is performed by SRSS to arrive at the three directional system response.

For all Class 1 piping attached to the Reactor Coolant Loop (RCL) or flexible equipment, the RCL or equipment dynamic model is included in the analysis, and the RCL or equipment support elevation is included in developing the ARS.

The seismic RCL model used for combination with the Class 1 auxiliary lines represents a simplified linearized model of the RCL piping, equipment and equipment supports which simulates the frequency content of the detailed RCL analysis. Included in the simplified RCL model is the effects of the mainstream and feedwater lines which are represented as stiffness matrices in the model.

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1 "Computation for Rigid Body Effects and Harmonic Excitation with KWUROHR," Leinbach, K. R., Lauren, H. and Sterkel, H. P., Proceedings of Sixth International SMIRT Conference, K9/6, Paris 1981.

B. Earthquake Displacement Effects

There are two categories of displacements, or seismic anchor motions (SAMs), for each direction of earthquake. One category represents the rigid body displacements of the structure that are common to all points on the structure. The second category represents the deformation of the structure. Relative displacements within the containment building occur between the containment shell and the interior concrete. This relative displacement is considered out of phase and is accounted for by static differential displacement analysis.

For stress evaluation, the three components of seismic anchor movement are analyzed separately and combined absolutely with the inertial load case. The Design Specification requires that OBE SAM be included in pipe stress evaluation. For the purpose of conservatism, SSE SAM pipe stress is included in the analysis. This conservatism can be deleted if margin is required to qualify the system.

Loads resulting from OBE and SSE anchor movement effects are provided for all containment penetrations and pipe support reactions.

LEAK RATE CALCULATION

1. Supply L/D_H and f values used in the frictional pressure drop calculation for node point 2041, which leads to the resulting crack length for 10 gpm leakage reported in the first row of Table 5-1; also provide the corresponding values for pressure losses ΔP_f and ΔP_{2d} pertinent to this node point.

RESPONSE

In reviewing the computer output for the leak rate calculation, it is observed that certain intermediate calculational results are not printed. However, from the results that are printed, it is possible to bound the requested parameters and thus provide a reasonable numerical estimate. For node point 2041, the ratio of channel length, L, to the hydraulic diameter, D_H, (L/D_H) is reported for crack lengths of l = 4 in. and l = 5 in.. The following values are reported in the computer output.

For l = 4 in., L/D_H = 100, and leak rate = 7.7 GPM
For l = 5 in., L/D_H = 69, and leak rate = 18.7 GPM

The crack length corresponding to a leak rate of 10.0 GPM is obtained by graphic interpolation, and is determined to be l = 4.3 inches. For this crack length, L/D_H is not reported directly; however, L/D_H will be between 69 and 100 for a leak rate of 10.0 GPM. The friction factor, f, used in the frictional pressure drop calculation for node 2041 was f = 0.065, and was obtained from the Moody Chart in the rough region, independent of the Reynolds number.

The friction loss, ΔP_f, and the pressure loss caused by choking, $\Delta P_{2\theta}$, are also not directly available from the computer output. However, the pressures at the choking plane for crack lengths 1 = 4 in. and 1 = 5 in. are reported, and are given below:

For 1 = 4 in., P_c = 841.1 psi
For 1 = 5 in., P_c = 892.0 psi

Thus, at node 2041, for a leak rate of 10.0 GPM (which corresponds to a crack length of 4.3 in.), the pressure at the choking plane is between 841.1 psi and 892.0 psi.

2. Justify L/D = 40 as used in the submittal. Studies sponsored by NRC (documented in NUREG/CR-3475 and CR-5128) indicate that flasning occurs at L/D = 12.

RESPONSE

The ratio of L/D_H above which both choking and frictional effects must be considered is reported as approximately 40 in paragraph 5.2.1 of WCAP-13167. This value is consistent with previously submitted and approved leak before break reports, including Comanche Peak Steam Electric Station Unit 1.

Although other studies indicate that flashing could occur at L/D_H ratios as low as 12, it should be noted that the calculated L/D_H ratio at node 2041 is between 69 and 100 (see previous response). Thus, since the minimum L/D_H ratio of 69 is well above either value (12 or 40), both choking and frictional effects are properly considered in the leak rate calculations.

3. Justify the number of 45° and 90° turns assumed for the flow path through the crack.

RESPONSE

The Westinghouse analysis for PWRs assumed that there were no turns at all for the flow path through the crack. The 45° and 90° turns alluded to above are appropriate for the winding type intergranular stress corrosion cracks found in Boiling Water Reactors (BWR's), therefore not applicable for CPSES.