TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

October 9, 1984

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391
		50-438
		50-439

By letter dated June 27, 1984, TVA transmitted a proposal to utilize new techniques in the seismic analysis of rigorously analyzed piping at Bellefonte. Based on follow-up telecons with NRC representatives on July 27 and August 24, 1984, enclosed is additional information applicable to both Watts Bar and Bellefonte Nuclear Plants. Enclosure 1 proposes the use of higher variable damping values and an alternate peak broadening technique in seismic piping analysis, and enclosure 2 provides a method for the use of multiple response spectra. In order to facilitate resolution of this matter, we request an expeditious review of the enclosed information.

If you have any questions concerning this matter, please get in touch with K. Mali at FTS 858-2680.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 9th day of Oct. 1984

Paulette H. White
Notary Public
My Commission Expires 8-24-88

Enclosures (2)
cc: U.S. Nuclear Regulatory Commission (Enclosures)
Region II
Attn: Mr. James P. O'Reilly Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

ENCLOSURE 1

BELLEFONTE AND WATTS BAR NUCLEAR PLANTS
USE OF HIGHER VARIABLE DAMPING VALUES
AND AN ALTERNATE PEAK BROADENING TECHNIQUE
IN SEISMIC PIPING ANALYSIS

The following information is provided in response to the telephone conference discussions held with NRC on July 27 and August 24, 1984.

1. TVA will use the variable damping and response spectrum shifting techniques as discussed in our June 27, 1984, letter to the NRC for the seismic analyses of piping systems at both Bellefonte (BLN) and Watts Bar (WBN). These techniques will be implemented immediately unless directed otherwise by the NRC.

2. TVA will use ASME code cases N-397 and N-411 for both the WBN and the BLN analyses.

3. The proposed piping analysis changes will not be used for time history analyses until such time as its use is endorsed by the Pressure Vessel Research Committee (PVRC).

4. The proposed piping analysis changes are not limited to computer-modeled (rigorous) analyses but will also be applied for piping supported by criteria (alternate analyses).

5. The BLN proposal has been revised to permit a more general use of the proposed piping analysis changes. The revised request is included as attachment 1.

6. The Watts Bar request is included as attachment 2.

7. The design used for Watts Bar includes a two-dimensional earthquake (the largest combination of vertical plus either horizontal component) rather than the three-dimensional (combination of the two horizontal plus vertical components per Regulatory Guide 1.92) as was used for BLN.

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TVA proposes to utilize the following two developments reported by the Pressure Vessel Research Committee (PVRC) in any future seismic analysis of the piping at Bellefonte Nuclear Plant (BLN). Use of these techniques will still produce conservative results for BLN seismic analyses. These developments by PVRC (with TVA participating) have been submitted by PVRC to NRC for approval.

Variable Damping Values for Piping Analysis

The Task Group on Damping Values of the PVRC Technical Committee on Piping Systems has recently completed a review of a significant data base of damping tests. The results of the review clearly indicate the justification for increasing the present damping values for seismic design of nuclear power plant piping above those specified in Regulatory Guide 1.61. Based upon their evaluations, the current recommendation of the Task Group members is that damping of 5 percent is acceptable to 10 Hertz (Hz) linearly decreasing to 2 percent at 20 Hz and held constant at 2 percent to 33 Hz. Recommendations are for both operating basis earthquake and safe shutdown earthquake and are independent of pipe diameter.

The main steam lines at TVA's BLN were reanalyzed before the PVRC findings due to the revised seismic spectra for various buildings. The damping values used in the spectral analysis method were in accordance with NRC Regulatory Guide 1.61. The reanalysis resulted in overloading of several rigid and seismic pipe supports.

Based on the PVRC recommendations, TVA performed a second iteration on the analysis of main steam lines using the new damping values. The pipe support loads obtained by using these variable damping values (5 percent to 2 percent) were compared with those obtained by using standard damping values from Regulatory Guide 1.61. As a result of this comparison, it was discovered that fewer pipe supports exhibited significant load increase. Four rigid supports and ten dynamic snubbers, which were overloaded in the earlier analysis, did not overload in the later analysis using higher damping values. Elimination of redesign and installation work on these four supports and ten snubbers alone will result in savings in the range of $500,000.

Spectra Shifting

Regulatory Guide 1.122 recommends that the calculated dominant peaks of the floor response spectra be broadened to account for uncertainties in the structural frequencies owing to uncertainties in the material properties of the structure and soil and to approximations in the modeling techniques. This method of peak broadening is very conservative. An alternative method of broadening of the structural peaks can be based on a probabilistic approach. In the particular case where there is more than one piping frequency located within the frequency range of a widened spectrum peak, the floor spectrum curve may be more realistically applied in accordance with the following criterion.

Based on the fact that the actual natural frequency of the structure can assume only one single value within the frequency range defined by $f_j \pm \delta f_j$, but not a range of values, only one of these piping modes can respond with the magnitude of the peak spectral value. Therefore, seismic analysis of piping systems using the broadened floor design response spectra may be accomplished by the following alternative:

1. Determine the natural frequencies (f_e) of the piping system to be qualified.

2. Consider all piping natural frequencies in the interval

$$f_j - .15\, f_j \leq (f_e)_n \leq f_j + .15\, f_j$$

   where f_j is the frequency of maximum acceleration in the unbroadened spectra; and n = 1 to K (K is the number of natural frequencies within the interval).

3. The piping system shall then be evaluated by sequentially performing K + 3 analyses using the unbroadened floor design response spectrum and also the unbroadened spectrum modified by shifting the frequencies associated with the spectral values by a factor of +.15, -.15, and $[(f_e)_n - f_j]/f_j$, where n = 1 to K.

4. The results of these separate analyses shall then be enveloped to obtain the final resultant desired (pipe stress, support loads, accelerations, etc.).

If no piping system natural frequencies exist in the interval associated with the maximum acceleration peak, then the interval associated with the next highest peak shall be used in the above procedure.

It is obvious that the analysis utilizing peak broadening becomes cumbersome and less efficient for multiple support motion (multiple zones) and also if there is more than one peak within a defined frequency range of interest. It is TVA's intent to use the spectra shifting technique only if relief is required on a particular pipe support where substantial rework is determined to be required by the standard method.

Recommendations

The proposed recommendations have been accepted by the PVRC Task Group on Damping, the Technical Committee on Piping Systems, and the Steering Committee on Piping Systems. The proposals have been forwarded to NRC (reference 1) and considered by ASME (reference 2) for review and approval on a generic basis. NRC was represented on the PVRC committees. Dr. S. N. Hou and Dr. W. F. Anderson were on the Technical Committee on Piping Systems, Task Group on Damping, and R. J. Bosnak participated on the Steering Committee on Piping Systems. The response spectra peak shifting method has been accepted by NRC for inclusion in Standard Review Plan 3.9.2. The Damping proposal has been accepted by NRC for use by Southern California Edison on San Onofre unit 1 (reference 3).

We believe that the changes proposed by PVRC for higher damping values and for an alternative to peak broadening are more realistic but still result in a conservative design. Such findings were substantiated by the Lawrence Livermore National Laboratory on three piping systems at Zion Nuclear Plant (reference 4). TVA plans to employ these two techniques in future analysis efforts for BLN.

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ATTACHMENT 2

USE OF HIGHER VARIABLE DAMPING AND RESPONSE SPECTRA SHIFTING TECHNIQUES FOR THE DYNAMIC ANALYSIS OF PIPING SYSTEMS AT TVA'S WATTS BAR NUCLEAR PLANT

The current piping analysis techniques used by TVA in the analysis of the piping at Watts Bar Nuclear Plant (WBN) are conservative in the area of dynamic analysis. TVA proposes to utilize the following two developments reported by the Pressure Vessel Research Committee (PVRC) in any future dynamic analysis of the piping at WBN. These developments by PVRC (with TVA participating) have been submitted by PVRC to NRC for their approval.

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The Task Group on Damping Values of the PVRC Technical Committee on Piping Systems has recently completed a review of a significant data base of damping tests. The results of the review clearly indicate the justification for increasing the present damping values for dynamic design of nuclear power plant piping above those in use at WBN. Based upon their evaluations, the current recommendation of the Task Group members is that damping of 5 percent is acceptable to 10 Hz linearly decreasing to 2 percent at 20 Hz and held constant at 2 percent to 33 Hz. Recommendations are independent of pipe diameter.

These higher recommended damping values can translate into substantial savings in time, effort, and cost towards the requalification of the existing piping systems or in the design of new piping systems.

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We believe that the changes proposed by PVRC for higher damping values and for an alternative to peak broadening are more realistic and constitute a conservative design. Such findings were substantiated by the Lawrence Livermore National Laboratory on three piping systems at Zion Nuclear Plant (reference 4). TVA will use these two techniques in future analysis efforts at WBN for the requalification of existing design and in the analysis of new systems. Use of these methods will result in more flexible piping systems which, according to current industry thinking, would result in more reliable systems.

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USE OF MULTIPLE RESPONSE SPECTRA
IN THE SEISMIC ANALYSIS OF MULTIPLY SUPPORTED PIPING SYSTEMS

Several methods have been used or proposed for the combination of seismic response from piping supported from more than one support zone, where each zone may have a different seismic response. These methods include:

1. The enveloping of sets of all seismic spectra within the scope of a single piping analysis problem.

2. The combination of sets of zonal responses by the method of square root of the sum of the square (SRSS), particularly for cases where the responses from these support zones (from different buildings or equipment) are statistically independent.

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The Brookhaven National Laboratory report (identified here as reference 1) now supports the concept of combination of zonal responses by SRSS for all cases. On page 99 of the report, the statement is made "that it is felt that the level of conservation inherent in this method (SRSS combination between groups) is acceptable and consistent with current design practice." As such, we believe that the combination method proposed in reference 1 will result in a safe piping system design.

The referenced report indicates the use of SRSS combination of sets of zonal response (combination of support groups) even where the zones cannot be established as statistically independent. TVA plans to use this procedure for Watts Bar and Bellefonte piping analysis.

Reference:

1. NUREG/CR.3811, "Alternate Procedures for The Seismic Analysis of Multiple Supported Piping Systems," May 1984, published for the NRC by Brookhaven National Laboratory.

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1130 SS
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3. The combination of sets of zonal responses by absolute summation, particularly where the support zones are not statistically independent.

The Brookhaven National Laboratory report (identified here as reference 1) now supports the concept of combination of zonal responses by SRSS for all cases. On page 99 of the report, the statement is made "that it is felt that the level of conservation inherent in this method (SRSS combination between groups) is acceptable and consistent with current design practice." As such, we believe that the combination method proposed in reference 1 will result in a safe piping system design.

The referenced report indicates the use of SRSS combination of sets of zonal response (combination of support groups) even where the zones cannot be established as statistically independent. TVA plans to use this procedure for Watts Bar and Bellefonte piping analysis.

Reference:

1. NUREG/CR.3811, "Alternate Procedures for The Seismic Analysis of Multiple Supported Piping Systems," May 1984, published for the NRC by Brookhaven National Laboratory.