

SEQUOYAH NUCLEAR POWER PLANT, UNITS 1 & 2  
TECHNICAL EVALUATION REPORT FOR EMPLOYEE CONCERNS  
ELEMENT REPORT 221.2(B), REVISION 1  
"PIPE SUPPORT DESIGN

Evaluation of Difference in Analyzed Design Loads for Pipe Supports"

SUBJECT: This report summarizes the NRC audit of TVA  
investigation regarding SQN piping analysis zero  
period acceleration (ZPA) concerns.

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I. Subject

Category: Engineering (20000)  
Subcategory: Pipe Support Design (22100)  
Element: Evaluation of Difference in Analyzed Design Loads  
for Pipe Supports (22102)  
Concern: SQN-86-002-05

The basis for Element Report 22102 is Employee Concern SQN-86-002-05 which questions the consideration of zero period acceleration (ZPA) effects at Sequoyah Nuclear Power Plant (SQN).

II. Summary of Issue

The Employee Concern Task Group (ECTG) report translated the concern into the following two issues:

1. In certain piping configurations, ZPA loads may be greater than the low frequency seismic excitation loads.
2. Management does not want to discuss the ZPA issue as it may delay the startup.

Investigation of this concern apparently has been limited to the effects of seismic ZPA loads.

III. Evaluation

ZPA effects referred to are "rigid body" or high frequency (i.e., usually > 33 hertz) dynamic response effects. Many piping

analysis computer programs used for piping dynamic analysis in the nuclear industry employ modal superposition solution techniques. These programs usually permit truncation of higher frequency response as a cost consideration. Truncation of higher seismic response modes was frequently employed in the past because the principal analysis concern was piping dynamic response rather than high frequency, or rigid range response and because high frequency seismic spectral loading is typically much less than that of the low frequency (i.e., 0 thru 33 hertz) range. However, for some piping configurations, the rigid range response can be significant and this is the source of the ZPA issue.

The ECTG report discusses the SQN FSAR and current regulatory requirements for considering ZPA. The report notes that neither the FSAR nor regulations include specific requirements regarding ZPA effects in piping analysis. The report does note, however, that the NRC Standard Review Plan (SRP) has rules which can be used to address the issue. Although the report refers to SRP rules, its conclusions are based on studies which conclude that design limits are not exceeded when ZPA effects are included. This method of resolution is considered acceptable since there are no specific FSAR commitments regarding ZPA.

Three studies regarding ZPA potential effects on SQN piping design are referenced in the subject element report. Report conclusions for each study note that the effect of ZPA was not found to result in piping design modification. The results of these studies were reviewed as part of the NRC audit of this employee concern.

An Impell Corporation report, "Preliminary ZPA Review" dated December 16, 1985 noted that based on a limited study, no hardware modifications were expected to result from the inclusion of seismic ZPA effects in SQN piping design. The report did, however, recommend additional review to quantify the effect of ZPA on design. Subsequently, TVA performed a more detailed study of seismic ZPA effects on SQN piping design (TVA Memorandum dated November 3, 1986, "Sequoyah Nuclear Plant Unit 1 & 2 - Status Summary of Preliminary Review of ZPA by John Stiles, TVA, dated March - April 1986"). This study considered fifteen analysis problems for potential ZPA effects. As indicated in the element report, although support loads were found to increase in comparison to modal analysis resultant loads, they did not exceed design limits. A third study was performed by the ECTG. This effort included screening all rigorously analyzed piping isometrics for piping judged sensitive to ZPA loading. Five cases were selected and ZPA evaluated by comparing seismic ZPA loads to (existing) modal seismic analysis loads and allowables. These cases were selected based on judgement to represent piping configurations most sensitive to ZPA. Primarily, support and equipment loads were compared. Loads were found to increase due to inclusion of ZPA but all were found to be "well within design limits."

Final documentation of the ZPA issue is included in TVA Report

CEB-87-01, "Final Review of ZPA Effects on Sequoyah Nuclear Plant Piping," Revision 1 dated April 21, 1987. In the conclusion section of that report TVA notes that future analyses will be performed "using the (TPIPE computer program) missing mass option to account for the ZPA effects." During the NRC audit of this employee concern element TVA stated that a total of approximately twenty-five SQN reanalyses had been performed to date using the TPIPE program version which includes this option. TVA also noted that no hardware modifications resulted from these reanalyses.

Seismic ZPA was the subject of an earlier NRC review. The results of that review are included in NRC Inspection Report Number 50-327/87-31 and 50-328/87-31. An NRC observation was closed in that report based in part on a calculation which qualified a hanger bank for ZPA forces. Staff discussion of the observation also referred to TVA planned use of the TPIPE computer program version which incorporates ZPA loads for all future piping analysis.

As part of the NRC review of the ZPA concerns element a Gilbert/Commonwealth (G/C) report titled "Sequoyah Unit 2 Rigorous Analysis Review" and dated May 13, 1987 was reviewed. The G/C report was issued subsequent to the ECTG element report completion and was not reviewed as part of the ECTG effort. The report provides additional information regarding ZPA at SQN. Appendices B and C of that report present comparative pipe stress and pipe support load results for analyses performed with and without missing mass effects included. Appendix C, Problem N2-67-21R, Sheet 3 is of particular interest relative to this subject. On that page missing mass effects are shown to increase design loads by as much as 300% in the faulted condition. With missing mass effects included faulted loads are much greater than upset loads. Since the ratio of faulted to upset loads is much greater than the ratio of faulted to upset seismic should be, most of this faulted load appears to be due to the DBA missing mass (ZPA) load. TVA Report CEB-87-01 contains an earlier TVA report (CEB-80-58) titled "Sequoyah and Watts Bar Containment DBA Analysis - Consideration of Rigid Body Motion to Response Spectrum ZPA." In that report TVA noted that high DBA accelerations warrant including DBA ZPA loads in piping design calculations and that "ZPA forces resulting from DBA have been included in the piping system evaluation at both plants." It appears that Problem N2-67-21R did not include DBA ZPA effects as it should have per the Report CEB-80-58 statement. Based on the G/C report appendices, it also appears that ZPA effects are significant for the DBA load case.

Employee Concern SQN-86-002-05 was issued in January 1986. During the NRC audit of the subject element the date that the concern was first made known to TVA was not determined. The ECTG report states that TVA conducted an industry survey of ZPA evaluation in 1972 and introduced a ZPA evaluation option into the TPIPE computer code in 1975. However, the first of several studies which attempted to quantify ZPA effects was instigated by a memorandum from Mr. R.O. Barnett in November 1985. Therefore, although the ECTG report concluded there was no evidence that

management did not want to discuss the ZPA issue, the employee concern may have resulted in some additional effort by TVA regarding this subject.

#### IV. Conclusions

As discussed in the element report, the several evaluations of ZPA for SQN conclude higher than original seismic load results are possible when ZPA effects are included in piping analyses. However, the results of those evaluations also indicate that the net effect of seismic ZPA on piping is such that existing design is adequate to accommodate the higher loads without design modifications. Also, future SQN piping analysis (reanalysis) will incorporate ZPA loads. Since several evaluations have demonstrated current design to be unaffected by inclusion of seismic ZPA and since future analyses will incorporate ZPA loads, Issue "1" of this concern is considered to have been adequately addressed by TVA relative to seismic ZPA.

Based in the ECTG report, TVA had discussed ZPA in past studies. The employee concern could have resulted the later additional review by TVA. However, as a result of all the SQN ZPA studies referred to in this report, the concern with management discussion of ZPA is not a safety concern.

The TVA investigation of concerns regarding seismic ZPA is considered adequate and their resolution of the concern as described in Element Report 221.2(B), Revision 1 is acceptable. However, it is recommended that further review of DBA load case ZPA effects be performed considering the results of the G/C report.