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SEQUOYAH NUCLEAR POWER PLANT

DESIGN CALCULATION REVIEW PROGRAM

INSPECTION REPORT 50-327/88-12 AND 50-328/88-12

FEBRUARY 15-19, 1988

1. INTRODUCTION AND BACKGROUND

The design calculation review program was developed by the Division of Nuclear Engineering (DNE) because past audit findings and other reviews have shown that the design basis for TVA's nuclear power plants have not been adequately documented by supporting calculations or that such calculations, if performed, may no longer be retrievable. This program augmented the Sequoyah Nuclear Plant (SQN) design baseline and verification program (DBVP) by including a technical adequacy review of supporting calculations, a feature not included in the DBVP.

The design calculation review plan was initially described in an enclosure to TVA letter from R. L. Gridley dated January 20, 1987 and Revision 2 to Section III.4 of Sequoyah's Nuclear Performance Plan dated March 27, 1987. The design calculation review plan was subsequently updated in enclosure to TVA letters from R. L. Gridley dated July 31, 1987 and August 21, 1987. The design calculation review plan addressed the essential calculations required to support the SQN design basis in the four technical branches of DNE.

The NRC conducted three previous inspections of the design calculation review program and documented the results of these inspections in reports 50-327, 328/87-06, 50-327, 328/87-27 and 50-327, 328-87-64 (References 10, 18, 23). TVA has responded to the observations identified in these reports (References 4, 20, 21, 24, 25). In addition to the inspections on the design calculation review program, the NRC has conducted an Integrated Design Inspection (IDI) of the Essential Raw Cooling Water (ERCW) system. The results of these inspections are documented in reports 50-327, 328/87-48, 50-327, 328/87-74 and 50-327, 328/88-13 (References 26, 28, 30). TVA has responded to the observations identified in these reports (References 27, 29).

2. PURPOSE

The purpose of this inspection was to review TVA's corrective actions associated with the civil engineering portion of the calculation review program. The inspection scope included a review of rigorous piping analyses, regenerated piping support calculations and the followup of TVA corrective actions associated with NRC observations in the civil engineering area documented in previous NRC design control inspection reports including the IDI.

3. RESULTS OF NRC INSPECTION

The following paragraphs characterize the inspection findings and conclusions in each area of the civil engineering calculations review effort. The results of the followup review of findings from previous design calculation, DBVP and IDI items are provided in Appendices A, B and C, respectively. Appendix D contains a listing of open post-restart items resulting from this inspection.

3.1 Rigorous Piping Analysis Review

3.1.1 Scope

The Civil Engineering Branch (CEB) calculation review program in the rigorous piping analysis area was originally based on the recommendations for corrective action contained in CEB summary report, "Evaluation of Programs Establishing Technical Adequacy of the Civil Calculations," dated January 30, 1987 (RIMS No. B41 870130 013).

To assess the adequacy of Sequoyah Unit 2 (SQN 2) rigorous piping analyses TVA contracted Gilbert/Commonwealth (G/C) to perform a technical review of five sample rigorous analyses. The review was completed in May 1987 and documented in Gilbert/Commonwealth, Inc. Report No. 2689 (RIMS B41 870519 250).

The five rigorous analysis piping problems reviewed by G/C were selected from those SQN 2 problems for which engineering change notices had been executed subsequent to operating license issuance. They were selected to assure the following eight attributes identified by TVA would be overviewed:

Equipment nozzle qualification.
Valve with operator acceleration qualifi...
High energy lines.
Multiple seismic zones.
Primary loop displacements.
DBA load cases.
SCV penetrations.
ECNs.

The problems selected also represent a variety of piping systems, classifications and physical locations (i.e., structures). TVA explained during the inspection that excepting provisions for SCV connected piping reanalysis, pre- and post-operating license piping analysis criteria are essentially the same. Therefore, review and conclusion based on post operating license analysis review are applicable to all analyses irrespective of the current revision date (i.e., pre or post operating license). The review scope as described is considered representative of SQN 2 rigorous piping analyses.

3.1.2 TVA Disposition of Review Findings

TVA responded to the descrepancies identified by G/C review in a report, "TVA Review Program in Response to Gilbert/Commonwealth Report No. 2689" (RIMS B41 870617 250). Each disposition includes TVA determination of validity, significance, and required corrective action. TVA disposition of fifteen of the ninety-four G/C identified discrepancies associated with two of the five sample problems were reviewed during the inspection. An additional review of the G/C Report No. 2689 was performed by Robert L. Cloud Associates (RLCA), (RIMS B41 870521 250). The RLCA report provided an additional review of the adequacy of Sequoyah's rigorous piping analyses. The following paragraphs summarize observations resulting from the review of these rigorous piping analysis reports.

The corrective action in the TVA report for each of four review discrepancies (Items 15, 18, 33 and 34) was to include an entry to the SQN Analysis Open Items Log. This would assure identification of each discrepancy for correction during the next reanalysis for the affected problem. In three cases the TVA report indicated that the entry to the log had already been made. However, these open items had not been included in the log as of February 18, 1988. The log was updated on February 19, 1988 to include all open items from the TVA report.

The TVA report incorrectly dispositioned an analysis review discrepancy (Item 46) as invalid. The discrepancy identified two valves of Problem N2-74-5A for which the analysis specified weight was double the correct weight. In addition, the RLCA assessment of the G/C review also found the valve weights had been doubled in the analysis. However, TVA in their report concluded the weights had been correctly specified and the discrepancy was not valid. The review of this discrepancy during the inspection confirmed that it was valid as originally identified in the G/C report. TVA assessed the technical significance of the discrepant condition and concluded it does not significantly affect design. The assessment was based on the analyses of the problem that had been performed by both G/C and RLCA which used correct valve weights. The results of these analyses did not identify a design problem.

This inspection identified five deficiencies with TVA's resolution of the G/C findings. Four of these deficiencies involved TVA's failure to enter corrective actions in the analysis open items log as required by the TVA dispositions. The fifth deficiency, the incorrect conclusion that a review discrepancy was not valid, was not regarded as technically serious. In summary, although some deficiencies with TVA's resolution of the G/C findings were identified during the inspection, the identified deficiencies were not significant and the deficiencies did not require additional analyses or plant modifications for restart resolution.

As part of the inspection the SQN rigorous analysis handbook, "Sequoyah Nuclear Plant Rigorous Analysis Handbook Class 2 and 3 Analysis," December 9, 1987, was reviewed. The rigorous analysis handbook addresses design requirements and analysis procedures including detailed modeling procedures, qualification and

verification procedures which invoke extensive design and analysis procedure checklists, and documentation requirements. No concerns regarding the handbook were identified during the inspection.

3.1.3 TVA Generic Concern Identification and Disposition (RCL Displacements)

TVA produced a final closure report for the rigorous piping analysis review effort, "Closure Report for Technical Review of Rigorous Piping Stress Analysis," January 1988 (RIMS B41 880129 007). The TVA review closure report was reviewed during the inspection. In that report TVA reviewed the generic implication of the G/C review results. The TVA review of the G/C identified discrepancies concluded that three concerns potentially affected other SQN 2 rigorous analyses by generic implication. These concerns were valve/flange weights, reactor coolant loop (RCL)/steel containment vessel (SCV) movements, and equipment nozzle movements/allowable loads. TVA's report identified that a review of all post-OL reanalyzed stress analysis calculations revealed one discrepancy. This discrepancy was that equipment nozzle movements/allowable loads for the revised Westinghouse RCL analysis (TVA Stress Report No. SD 105, dated May 7, 1974) had not been incorporated into analyses for loop attached piping. To resolve this discrepancy TVA contracted G/C to perform an evaluation of the revised loop analysis resultant displacement effects. The seismic anchor motion (SAM) at twenty-four of the fifty piping attachments to the RCL were found to change by less than one-sixteenth of an inch. The revised displacements at the other twenty-six attachments were evaluated by a combination of computer and hand calculations. These evaluations concluded design criteria were met with the exception that five nozzle loads exceeded currently specified Westinghouse allowables. Based on further review G/C concluded nozzle equivalent stresses were acceptable (Summary of Activities for CAQR 761161 dated February 18, 1988). Based on the TVA evaluation, the final disposition of this concern by incorporation of the revised SAM displacements into problem reanalyses post restart is acceptable.

3.1.4 EA Review

SQN 2 rigorous analysis adequacy was also addressed by TVA Engineering Assurance (EA) Audit 87-09, Concern Observation C-1. The concern remained open in three EA corrective action status reports to EA 87-09 (December 2, 1987; February 2, 1988 and February 12, 1988). The TVA Closure Report for Technical Review of Rigorous Piping Stress Analysis concludes that the EA concern is closed except as it relates to an equipment "Q" list. In the EA memorandum dated February 12, 1988, EA agrees with the closure report except that it notes that the need remains to receive and review information from Bechtel regarding design basis accident (DBA) zero period acceleration (ZPA) effects. The issue of DBA ZPA effects is discussed in Section 3.7 of this Inspection Report.

3.2 TVA's Calculation Regeneration Program for Rigorously Analyzed Pipe Supports in SQN Unit 2 and Common

3.2.1 Procedures and Criteria

TVA's program plan and implementing instructions to regenerate the calculations which EDS and Basic Engineers originally prepared for the rigorously analyzed pipe supports in SQN Unit 2 and common are detailed in the following CEB procedures:

1. CEB-C1 21.80, "Program Plan for Calculation Regeneration of Pipe Supports on Rigorously Analyzed Category 1 Piping - Sequoyah 2," Revision 1, dated August 28, 1987.

2. CEB-D1 21.81, "Generation and Control of Rigorous Analysis Problem Connectivity Diagrams for Category 1 Piping: Sequoyah 2," Revision 1, dated August 28, 1987.

3. CEB-D1 21.83, "Functional Verification of Supports for Rigorously Analyzed Category 1 Piping: Sequoyah 2," Revision 3, dated December 14, 1987.

4. CEB-C1 21.84, "Control of Correspondence and Transmission of Design Documents between TVA and Engineering Services Contractors," Revision 1, dated August 28, 1987.

5. CEB-D1 21.85, "Generation of Pipe Support Design Data: Sequoyah 2," Revision 2, dated November 19, 1987.

6. CEB-C1 21.88, "Control of Input and Output from the Sqn Hanger Tracking Subprogram of CCRIS," Revision 1, dated October 19, 1987.

7. CEB-C1 21.89, "Modification Priorities for Pipe Supports on Rigorously Analyzed Category 1 Piping - Sequoyah Unit 2," Revision 2, dated December 18, 1987.

8. CEB-C1 21.90, "Gang Hanger and Terminal Procedure," Revision 0, dated August 31, 1987.

9. CEB-C1 21.91, "Handling of Pipe Support Calculation Review/Regeneration Results - Sequoyah 2," Revision 0, dated December 18, 1987.

10. CEB-C1 21.92, "Red Lining of Pipe Support Drawings," Revision 0, dated December 14, 1987.

On July 17, 1987, TVA issued design criteria SQN-DC-V-24.2, "Supports for Rigorously Analyzed Category 1 Piping," to specify the design criteria which Bechtel and Stone & Webster (SWEC) used to regenerate the pipe support calculations.

TVA reviewed pipe supports which did not meet the long-term design criteria of SQN-DC-V-24.2 to the interim design criteria of CEB-CI 21.89. Pipe supports which meet the interim design criteria will be modified post-restart.

3.2.2 Review Results

On February 15, 1988, TVA indicated that 4,984 of the 5,612 pipe support calculations in the calculation regeneration program met the long-term design criteria of SQN-DC-V-24.2. The remaining 628 pipe supports were evaluated to the interim design criteria of CEB-CI 21.89. 447 pipe supports met the interim criteria and are scheduled for modification post-restart. TVA has already modified the remaining 181 pipe supports.

According to TVA, the relative high proportion of pipe supports requiring modification is due in part to the requirements that friction forces be considered in the design of pipe supports, and that the maximum allowable stresses in built-up pipe supports be limited to nine-tenths of the material yield stress.

In order to assess the adequacy of TVA's pipe support calculation regeneration program, a sample of 23 pipe support calculations which meet the long-term design criteria of SQN-DC-V-24.2 was reviewed. These pipe supports are installed in the essential raw cooling water (ERCW), component cooling water (CCH) and main steam (MS) piping systems:

1. ERCW system:

   1-ERCWH-56 (Bechtel calculation)
   1-ERCWH-61 (Bechtel calculation)
   1-ERCWH-62 (Bechtel calculation)
   1-ERCWH-44 & -100 (Bechtel calculation; common hanger)
   1-ERCWH-132 (Bechtel calculation)
   47A450-21-216 (SWEC calculation)

2. CCH system:

   2-CCH-62 (Bechtel calculation)
   2-CCH-80 & -81 (Bechtel calculations; common hanger)
   1-CCH-677 (SWEC calculation)
   1-CCH-685 & -688 (SWEC calculation; common hanger)
   1-CCH-699 (SWEC calculation)
   1-CCH-736 & -737 (SWEC calculation; common hanger)

3. MS system:

   2-MSH-302 (Bechtel calculation)
   2-MSH-304 (Bechtel calculation)
   2-MSH-310 (Bechtel calculation)

2-MSH-346 & -347 (Bechtel calculation; common hanger)
2-MSH-384 (Bechtel calculation)
2-MSH-432 (Bechtel calculation)

Three deficiencies were identified during the course of this review.

The first deficiency was that Bechtel did not perform a check for beam web crippling due to pipe bearing in the sample of pipe support calculations reviewed during the inspection. To address this concern, TVA sampled an additional 50 pipe support calculations and confirmed that 49 of the 50 beams satisfied the web crippling check specified in the edition of the AISC code which design criteria SQN-DC-V-24.2 references. TVA confirmed that the remaining beam would meet the comparable criterion specified in the 1986 edition of the AISC code. TVA stated they would revise the design criteria SQN-DC-V-24.2 to specify that a beam web crippling check for pipe bearing be performed in accordance with the 1986 edition of the AISC code. This deficiency is closed based upon the results of TVA's generic review and evaluations which demonstrated that AISC structural criteria was met.

The second deficiency was that SWEC had incorrectly coded a 2,263 lb. thermal load into the SANDUL computer run used to analyze pipe support 1-CCH-677. The thermal load actually used to analyze the pipe support was 263 lbs. The load was not coded into the correct input field of the program, and the program input echo did not flag the truncation of the first digit. To address this deficiency, TVA retrieved an additional 25 pipe support calculations with SANDUL computer runs, and confirmed that the input loads for these runs were correctly coded. TVA will also revise the calculation for pipe support 1-CCH-677. This deficiency is closed based upon the results of TVA's generic review and TVA's decision to revise pipe support calculation 1-CCH-677.

The third deficiency was that Bechtel's calculations 2-MSH-346 & -347 for a combined spring hanger/snubber pipe support failed to qualify the pipe support. Calculation 2-MSH-346 for the spring hanger portion of the pipe support concluded that the spring hanger would bottom out when subjected to piping thermal displacement. The spring hanger would therefore be subject to the snubber design seismic loads in addition to the spring hanger design dead load. However, the calculation did not identify the need to modify the spring hanger support to eliminate this unacceptable condition.

To address this deficiency, TVA inspected the spring hanger and confirmed that adequate spring hanger travel exists to accommodate piping thermal displacement. TVA will revise the calculation for pipe support 2-MSH-346 to incorporate revised field measurements which confirm the adequate travel capacity of the spring hanger under piping thermal movement. This deficiency is considered to be isolated, and is closed based upon TVA's inspection of the spring hanger and TVA's decision to revise the calculation.

A sample of 10 pipe support calculations for pipe supports which TVA has scheduled for post-restart modification was also reviewed:

1. ERCW system:

   1-ERCWH-9 (Bechtel calculation)
   1-ERCWH-21 (SWEC calculation)
   1-ERCWH-51 (Bechtel calculation)
   1-ERCWH-174 (Bechtel calculation)
   1-ERCWH-226 (Bechtel calculation)
   47A450-21-228 (SWEC calculation)

2. CCH system:

   1-CCH-198 (SWEC calculation)
   1-CCH-205 (SWEC calculation)

3. MS system:

   2-H1-301 (Bechtel calculation)
   2-MSH-313 (Bechtel calculation)

The staff concurred with TVA's decision to modify these pipe supports post-restart.

Based upon staff review of TVA's program plans and design criteria, and review of a sample of the pipe support calculations which Bechtel and SWEC prepared, the staff concludes that TVA's pipe support calculations were generally prepared in accordance with program technical and quality assurance criteria.

3.2.3 EA Review

TVA's engineering assurance (EA) group has audited Bechtel and SWEC to confirm that the technical and quality assurance provisions of their contracts with TVA were being adequately implemented. TVA has documented these audits in the following TVA reports:

1. Sequoyah Nuclear Plant - Tasks Performed Under Personal Services Contract TV-72104A - Procured Services Audit 87P-51, dated October 14, 1987 (an audit of Bechtel in San Francisco during the periods August 17-21 and August 31-September 3, 1987).

2. Sequoyah Nuclear Plant (SQN) - Watts Bar Special Projects - Personal Services Contract TV-72102A - Engineering Assurance - Procured Services Staff Audit 87P-53 (an audit of SWEC in Boston during the periods August 25-28 and October 5-9, 1987, and in Knoxville during the period August 4-7, 1987).

3. Division of Nuclear Engineering (DNE) Engineering Assurance (EA) Audit 87-09 (Technical) - DNE Calculations Review Effort, dated December 2, 1987 (a followup to EA audit 87-09(T); includes EA review of 26 pipe support calculations).

4. Division of Nuclear Engineering (DNE) - Engineering Assurance (EA) Audit 87-09 (Technical) - DNE Calculations Review Effort - Civil Discipline, dated February 1, 1988 (an additional followup audit).

TVA EA additionally reviewed 54 Bechtel and SWEC pipe support calculations, and identified 20 deficiencies. Bechtel and SWEC have provided TVA EA with acceptable resolutions to these deficiencies.

Under the direction of TVA's lead pipe support engineer, TVA engineers also performed a three-tier review of the regenerated pipe support calculations in accordance with CEB-D1 21.87, which specifies that each pipe support calculation be checked against procedure NEP 3.1, Calculations, that ten percent of the pipe support calculations be reviewed programmatically, and that 100 pipe support calculations be reviewed line-by-line. TVA has indicated that, in addition to screening each pipe support calculation to the NEP 3.1 requirements, TVA programmatically reviewed approximately one-third of the pipe support calculations, and reviewed 80 pipe support calculations line-by-line. TVA was planning to issue a report on or about May 1, 1988 to summarize this review.

3.3 Thermal Monitoring of Supports

As part of the pipe support calculation regeneration effort, TVA developed a set of restart criteria, CEB-CI 21.89 (Reference 50). The staff accepted this criteria subject to restrictions (Reference 51). TVA revised this restart criteria based on additional discussions with the NRC staff (Reference 52). One of the revisions to the restart criteria allowed TVA to monitor snubber swing angles during plant heatup to verify that thermal binding would not occur. These measurements were to be used instead of using the calculated piping thermal movement for computing the angular swing for comparison with allowable tolerances. TVA identified 13 supports to be monitored during the heatup (TVA memorandum Hosmer to Abercrombie dated December 18, 1987 RIMS No. B25 871218 020). The staff review identified that four supports 2-H63-2, 2-H63-3, 2-H63-4 and 2-H63-5 were being monitored by strain gage to obtain thermal loads. These strain gage measurements were not part of the agreed upon criteria (Reference 52). TVA responded (Reference 41) that the four supports met the allowable stress criteria in CEB-C1-21.89. TVA also proposed using the measured loads to qualify the supports to the long term design criteria SQN-DC-V-24.2 The staff does not accept this long term solution unless the entire piping analysis problem is reanalyzed to determine a new load distribution of all supports. (Unresolved Item URI 88-12-01.)

3.4 U-bolt Allowable Loads

TVA's design criteria for piping supports, SQN-DC-VC-24.2, Figure I-7 has a table of load ratings for U-bolts. Based on review of the pipe support criteria in September 1987, the staff questioned the basis for the allowable loads used for U-bolts. TVA provided the basis for the U-bolt allowable loads as a Browns Ferry test report, CEB-85-06. According to CEB-85-06 the load

ratings were developed based on the winter addenda to the 1983 ASME Code. The staff review of CEB-85-06 questioned whether the allowable loads have been appropriately derived using the ASME Code criteria. TVA has not responded to this question. TVA presented an additional basis for the allowable U-bolt loads. The additional basis included a comparison of the allowables with a load rating procedure using the factor of safety quoted in industry standard MSS SP-58. This standard is referenced in ANSI B31.1 - 1967. The load rating calculations also included a check of deflection criteria in SQN-DC-V-24.2. The staff did not agree with the appropriateness of the deflection criteria used for the lateral load test. TVA had used an average value from tests of cinched and uncinched U-bolts. Based on further staff questions, TVA responded that they did not have cinched U-bolts in field installations. TVA typical drawing 17 W586-3, Revision 23 showed a gapped U-bolt configuration. A TVA check at the field during the inspection also identified that a gapped U-bolt configuration was typical. TVA then demonstrated that the U-bolts could meet a reduced allowable based on test data using the uncinched U-bolt tests. This was considered acceptable by the staff for restart. The staff will have further followup reviews of TVA's development of standard component support allowable loads after restart. (Unresolved Item URI 88-12-02.)

3.5 Seismic Load Combination for Piping

During the staff's IDI review during the week of February 1, 1988, it was identified that TVA's criteria for evaluating spatial earthquake responses for piping analysis used a two directional square root of the sum of the squares (SRSS) procedure. The method of combining these responses originally stated in FSAR Section 3.7 was a vectorial combination. TVA in Amendment 1 to the UFSAR (1984) clarified that the spatial combination was SRSS. However, the staff SER (1979) stated that the combination was absolute sum. Since the change to the FSAR was evaluated by TVA under a 10 CFR 50.59, there was no evidence that the NRC staff had reviewed and approved this spatial combination method. TVA's method of spatial combination is less conservative than the method required by current licensing criteria in Regulatory Guide 1.92. In order to assess the significance of this issue, the staff requested that TVA evaluate a sample of five piping systems using absolute sum and SRSS for the two directional response. The results were documented in a letter from TVA (Reference 42). This study showed a difference of approximately 10% between the two combination methods. In addition, a recent review of another nuclear facility revealed that a two directional SRSS of spatial responses had been reviewed and approved by the NRC staff. Since this method had been previously reviewed and accepted by the NRC staff and TVA had provided a clarification of the method in an FSAR update the staff accepted the results of TVA's sample study as sufficient to resolve this issue. Therefore, this issue is considered resolved for Sequoyah. However, since the two directional SRSS does not meet current licensing criteria, TVA should upgrade this analysis method for any future criteria changes that deviate from the original FSAR design criteria.

3.6 Employee Concerns Element Report 220.11

The staff evaluation of Element Report 220.11(B) summarizes the status of TVA's corrective actions to address the issue of thermal expansion of restrained pipe support structural members at SQN. The evaluation of the element report specified an open issue that the calculations of restrained thermal growth pipe supports 2-HIM-101, -102, -103 and 2-H36-111 should be reviewed when these calculations were complete.

On November 30, 1987, TVA revised subsection 6.3.13, Environmental Thermal Effects, of design criteria SQN-DC-V-24.2 to permit critical buckling stresses which exceed 0.9 of the material yield stress to be handled on a case-by-case basis. This revision to subsection 6.3.13 represents a relaxation of the criterion which the staff originally reviewed and accepted as part of TVA's calculation regeneration program. The staff raised a concern with TVA's modification of the design criteria to eliminate the buckling allowable limits. TVA responded that buckling limits had not been exceeded and that the actual criteria that had been used was an inelastic evaluation of the end connections (Reference 39). This type of evaluation is consistent with criteria used for structural evaluation of environmental thermal effects and is acceptable. TVA also committed to revise design criteria SQN-DC-V-24.2 to allow inelastic analysis on a case-by-case basis and eliminate the statement on exceeding buckling allowables.

3.7 Employee Concerns Element Report 221.2

The staff review of Element Report 221.2(B) identified that TVA had not followed the recommendations in civil engineering report CEB 80-58 for evaluating the zero period acceleration (ZPA) effects for the containment design basis accident (DBA) loads. In response to this concern, TVA evaluated a sample of five piping systems attached to the steel containment vessel. During the inspection, TVA presented the results of an evaluation of the containment penetrations for this load case. This evaluation demonstrated that the penetrations were adequate for the increased loads due to the DBA ZPA effects. The staff requested the results of the rest of the piping analyses including the supports. TVA stated that due to the low level of deflection caused by the ZPA loads the supports would not be loaded due to the support construction gaps. The staff disagreed with TVA's reasoning on this issue. TVA was attempting to use two contradictory sets of assumptions for the analysis. In determining that the piping had a rigid response, TVA assumed the supports were active. Then TVA assumed the supports were not active for the loads generated assuming the piping response was rigid. In response to the staff concern, TVA completed an evaluation of the supports where loads increased by more than 10% on the five sample piping analyses (Reference 40). The results of this evaluation demonstrated that the supports met either the interim or long term criteria. This sample evaluation was acceptable for restart. TVA should complete the evaluation of DBA ZPA effects for the remaining piping systems as a post restart effort. (Unresolved Item URI 88-12-03.)

3.8 Design Basis Accident Response Spectrum Generation for Steel Containment Vessel

In its safety evaluation on the use of ASME Code Case N-411 damping (Reference 34), the staff concluded that the use of ASME Code Case N-411 damping for evaluation of the piping systems attached to the steel containment vessel (SCV) under the load caused by the containment vibratory motions associated with a design basis accident (DBA) is acceptable provided the DBA response spectra at various locations on the SCV have been generated by conservative analysis techniques. TVA's generation of the DBA response spectra for the SCV was documented in Report No. CEB-86-20-C, R0, entitled, "Sequoyah Nuclear Plant Design Basis Accident Non- Axisymmetric Pressure Loading Dynamic & Static Analysis of the Steel Containment Vessel and Response Spectra for Attached Equipment."

The staff reviewed the TVA report during the inspection. The staff assessment of the adequacy of the DBA response spectrum generation is discussed below:

1. Analysis Model and Input - The containment was represented by a fixed base axisymmetric model containing shell elements. The structural damping was 1% of critical for the DBA dynamic analysis. The analysis model and damping value are acceptable.

   The DBA pressure transients were generated by Westinghouse assuming any one of the six hot or cold legs could break in a guillotine manner, and hence the spatial distribution of the pressure transients was non-axisymmetric. All pressure transients reached the steady-state pressure of about 12 psi at no later than about 0.9 seconds after the initiation of the accident. Based on its review, the staff found the input pressure transients acceptable for the dynamic analysis and generation of DBA response spectrum.

2. Structural Analysis and Generation of Response Spectrum - For the analysis of the axisymmetric containment model under pressure transient, TVA used the SUPERSHELL computer code that was originally developed by Ghosh and Wilson at the University of California, Berkeley. It was specifically developed for the analysis of an axisymmetric model subjected to non-axisymmetric loadings. The staff reviewed the verification of computer code and found that the code is acceptable for the DBA dynamic analysis.

   SUPERSHELL outputs displacement response time histories at any specified structural node. However, it only outputs acceleration response time histories at those nodes located at the 0-degree aximuth. To generate the response spectrum at the nodal points of interest, TVA first double-differentiated the displacement time history at the specified node to convert it into an acceleration time history, and then computed the response spectrum from the obtained acceleration time history. Both the

numerical double differentiation and spectrum computation were done by a TVA in-house computer code NUPRPOS. In 1986, TVA verified the double differentiation algorithm in SUPRPOS by applying it to one full cycle of harmonic motion that was digitized into twenty equal time steps. The output was in good agreement with the analytical solution. The staff considered this verification inadequate with respect to the DBA analysis because of the uncertainties involved when the double differentiation was applied. For the purpose of restart, TVA was requested to repeat their 1986 verification except with the harmonic motion re-digitized in ten and eight time steps, respectively. The output from both runs compared closely with the analytical solution, and the staff considered TVA's revised verification sufficient for restart. Because the structural response in the case of the DBA analysis is transient in nature and contains more than one cycle of oscillation, the staff requested a verification of SUPRPOS after the restart of Unit 2 by comparing the spectrum generated directly from the SUPERSHELL acceleration time history output at the 0-degree azimuth nodes to the corresponding spectrum generated indirectly from the displacement time history output.

The staff also reviewed the response spectra generated at the various locations on the containment, and expressed a concern with the adequacy of the 0.9-second duration which TVA adopted in the analysis. The concern was that at some locations the response might not have reached its real maximum yet when the analysis was cut off at the end of 0.9 seconds because the containment was very lightly damped (1% damping). The staff accepted the existing DBA response spectra for restart, but requested TVA to verify on a long term basis that the existing DBA response spectra did not miss their real maximum due to the 0.9-second cutoff during the spectrum generation.

In conclusion, the staff concluded that the existing DBA response spectra are acceptable for restart. TVA was requested to take two post-restart actions: (1) verify the adequacy of the double differentiation technique adopted by SUPRPOS by comparing the response spectrum directly generated from the SUPERSHELL acceleration time history at the 0-degree azimuth nodes with the corresponding response spectrum generated from the SUPERSHELL displacement time history, and (b) verify that the existing DBA response spectra did not miss the real maximum response due to the analysis being cut off at the end of 0.9 seconds. TVA committed to perform these post-restart actions in a letter dated March 2, 1988 (Reference 41). (Unresolved Item URI 88-12-04.)

3.9 Deficiency Evaluation of Voids in ERCW Pumphouse Support Cells

The ERCW pumping station is supported on two overlapping concrete filled sheet pipe cells founded on rock. The concrete in the cells was placed using tremie

concrete methods. The sheet piling was originally only considered as a formwork for placing concrete and was not considered as part of a Category I structure. After completion for the concrete placement, the concrete was cored and geophysical logs of the concrete were developed. The cores indicated cavities and areas of soft concrete. One of the cores indicates that approximately 7 feet of void exits between the two northern most intake liners. The liners are about 10 feet apart at this location.

In order to justify the strength of the concrete in the ERCW access cells, TVA submitted the data to the staff. The data was submitted in a report titled, "Rock and Concrete Investigation Report" dated January 1978. The report indicates that a total of eight holes were drilled. Two holes were core drilled and six were percussion drilled. Between elevation 620 feet and elevation 630 feet (the bottom of the cells), six of the cores indicated cavities. Sonic cross hole measurements were taken on the two northern and the two southern holes. These measurements indicated that the cavities were not continuous at these two locations. This is not surprising since one boring at each location did not indicate a cavity. Also these holes are not in the area of concern.

An analysis was performed assuming areas of sound concrete, soft concrete and voids or gravel pockets.

The analysis assumed the following:

1. Concrete does not take tension.

2. Areas assumed to be voids or gravel pockets do not take any load.

3. Areas assumed to be soft concrete would have a reduced modulus and a reduced allowable stress.

The results of the analysis indicate that the stress levels are acceptable when subjected to SSE loads. This analysis gives reasonable assurance that the ERCW pumping station will not fail or be subject to excessive deflections when subjected to the postulated SSE event. However, the staff requested that TVA confirm the extent and size of the cavities or gravel pockets as a post-restart action.

TVA has agreed to perform additional post-restart evaluations of the ERCW pumping station concrete to address the staff concern (Reference 36). The following post-restart actions were agreed to by TVA:

1. An evaluation program will be submitted to the staff for review and approval. Special emphasis will be placed on determining the extent and size of the cavities or gravel pockets.

2. Once the as-built condition is determined TVA will:

   a. Review the seismic qualification of ERCW equipment,

   b. Re-evaluate effect of ERCW pumping station deflections on ERCW piping,

   c. Confirm that the design requirements of the OBE concurrent with a water level at elevation 704 feet are satisfied.

This item is no longer considered a re-start issue for Sequoyah Unit 2 but remains open until the above commitments are completed. (Unresolved Item URI 88-12-05.)

4. OBSERVATIONS FROM CALCULATION REVIEW EFFORT

The inspection effort focused on the resolution of open restart items from previous design calculation, DBVP and IDI inspections in the civil engineering area. Although the restart open items were resolved during the inspection, several post restart open items were identified. These open items are listed in Appendix D of this report.

5. REVIEW OF PREVIOUS INSPECTION FINDINGS

The inspection reviewed TVA's responses and corrective actions documented the following previous NRC inspections associated with the design calculation, DBVP and IDI reviews.

- 50-327/86-27 and 50-328/86-27
- 50-327/86-38 and 50-328/86-38
- 50-327/86-45 and 50-328/86-45
- 50-327/86-55 and 50-328/86-55
- 50-327/87-06 and 50-328/87-06
- 50-327/87-14 and 50-328/87-14
- 50-327/87-27 and 50-328/87-27
- 50-327/87-31 and 50-328/87-31
- 50-327/87-48 and 50-328/87-48
- 50-327/87-64 and 50-328/87-64
- 50-327/87-74 and 50-328/87-74
- 50-327/88-13 and 50-328/88-13

The review of the open items from these inspection reports are documented in Appendices A, B and C. Although only open items in the civil engineering area were reviewed during the inspection, this report documents the restart closure of all open issues from the previous inspection reports. Some of the items

addressed in these appendices were closed in previous inspection reports based on ongoing licensing reviews at the time of the inspection report. A discussion of these items are included in the appendices to document the basis for restart closure. Tables A.1 and B.1 contain a complete listing of all items identified for followup review during the design baseline verification program and calculation program inspections conducted by the NRC and identifies the inspection reports the items were discussed, closed or transferred for licensing review. Inspection Report 86-27 listed five items as observations that did not require a response from TVA. These items were not included in Table B.1.

6. MEETING SUMMARIES AND REFERENCES

A summary of attendees at the entrance and exit meetings and a list of references are provided in Appendix E.

APPENDIX A

LICENSEE ACTION FOR PREVIOUS CALCULATION

REVIEW PROGRAM INSPECTION FINDINGS

Inspection Report No. 87-06

(Closed) Observation GEN-2, CAQ Operability Determinations

Inspection Report 87-06 identified the concern that the new corporate QA procedure for corrective actions NQAM, Part I, Section 2.16 required that component operability be determined by its technical specification safety-related function rather than its design related function. The inspection report also identified that Nuclear Engineering Procedure (NEP) 9.1 was in the process of being revised to agree with the new corporate procedure. TVA's response (Reference 4) stated that NQAM, Part 1, Section 2.16, "Corrective Action," Attachment 5, was revised to address this concern. Inspection Report 87-27 noted that TVA withdrew the recent revision to NEP 9.1. The resolution of this item was further discussed with the OSP staff (Reference 32) and based on those discussions TVA agreed to revise NQAM 2.16 and Attachment 5, "Guidelines for Potential Operability Determinations" to Sequoyah Instruction AI-12. These revisions were initiated by a memorandum from Capozzi to Kazanas dated January 12, 1988 (RIMS B05 880112 002). TVA subsequently revised NEP 9.1 on 3/31/88 to address the staff's concern. The revision assures that component operability assessments are performed for cases where design criteria are not met. This observation is closed.

(Closed Restart) Observation MEB-3, Waterhammer

Inspection Report 87-06 identified that TVA had performed an analysis of a feedwater waterhammer due to a postulated pipe break upstream of the feedwater check valve but had not formally issued the analysis. TVA's response (Reference 4) stated that the check valves and piping had been designed to withstand the pressure associated with the waterhammer and that further analysis of this event was not justified. Inspection Report 87-27 provided the detailed chronology of TVA's internal correspondence on the feedwater waterhammer issue and requested TVA's justification for not issuing an analysis of the piping system when it had been identified by TVA documentation as a licensing commitment. Inspection Report 87-64 stated the issue was still under review by CEB and TVA would provide a revised response to the observation. TVA's revised response (Reference 33) still contends that the original evaluation of the check valve and piping for the waterhammer pressure met TVA's licensing commitments and was adequate. However, TVA performed an analysis of the feedwater piping using forcing functions developed for the waterhammer transient. The piping was analyzed using a three-dimensional inelastic finite element analysis and these results were compared to criteria contained in

Appendix F of the ASME Code. The results of this analysis indicated that piping supports may fail or deform during the postulated transient, however, the results of the analysis also demonstrated piping system integrity would be maintained (ASME Code Appendix F limits were met). The results of this analysis are considered acceptable by the staff for Sequoyah restart. This observation is closed for restart. The staff will be performing additional review of the details of this analysis as a post-restart effort. (Unresolved Item URI 88-12-06.)

(Closed) Observation MEB-6, Component Cooling Water System Design Pressure

Inspection Report 87-06 identified a concern with TVA's calculation of system design pressure for the component cooling water system. TVA's response (Reference 4) stated a calculation of a revised system operating pressure had been completed and the operating pressure remained below the design pressure. Inspection Report 87-27 identified a number of open issues with TVA's revised calculation. Additional review of this item documented in Inspection Report 87-64. Inspection Report 87-64 requested the following items to be addressed in a revised calculation as a confirmatory item.

1. A design pressure calculation based on:

   (a) a static head produced by the surge tank water level at the high end of the normal level control range,

   (b) the lowest pump flow (highest total dynamic head) that can occur for any normal operating mode of the CCS, and

   (c) the lowest expected operating coolant temperature.

2. TVA should show by calculation that CCS pressure variations meet the requirements of Paragraph 102.2.4 of the Power Piping Code B31.1.0 - 1967. The team considered that events such as closure of the normal surge tank vent and increase in surge tank pressure to its relief valve setpoint plus accumulation can be considered pressure variations provided the event meets the spirit of the phrase "occasional periods of operation for short periods" contained in B31.1.0 - 1967 and is not permitted to be a normal mode of operation.

3. TVA should conduct a review to determine if all components meet the calculated design pressure.

Inspection Report 87-64 stated that TVA should revise the FSAR and notify the NRC if the calculation of design pressure calculation for the component cooling water system used assumptions other than pump shutoff head.

TVA's response (Reference 24) states the revised calculation shows that no portion of the system exceeds design pressure under normal operating conditions

and a separate calculation shows that CCS pressure variations do not exceed the allowances of ANSI B31.1.0 - 1967. In addition, TVA committed to revise FSAR Section 9.2.1.2 in the April 1989 update. The staff considers these actions sufficient to close this observation.

(Closed) Observation EEB-2, Breaker Coordination

Inspection Report 87-06 identified an error with the corrective action taken by TVA to resolve breaker coordination problems for the 480V diesel generator and essential raw cooling water system boards. TVA's response (Reference 4) stated that the correct corrective action for this observation would have been obtained by following the ECN procedure. Inspection Report 87-64 found TVA's corrective action described in ECN6883 acceptable. The inspection report also agreed with the post-restart classification for the completion of the corrective action. The inspection report held the observation open pending TVA's CCTS commitment to complete the corrective action. TVA's response (Reference 24) stated that the corrective action (ECN 6883) was complete. This observation is closed.

(Closed) Observation CEB-1, Rigorous Piping Analysis N2-67-8A

Inspection Report 87-06 identified three issues associated with this piping analysis. TVA's response (Reference 4) agreed with the observation findings and provided the proposed corrective actions. Report 87-27 closed the first two items based on TVA's corrective actions. The inspection report transferred the third item to licensing for review.

The third item of Observation CEB-1 stated that procurement documents for a 1 by 2 inch valve exempted the valve from seismic qualification requirements which are included in the SQN FSAR and TVA design criteria. In response to the observation TVA issued CEB Report 87-10C and Condition Adverse to Quality Report (CAQR) SQF870070. Report 87-10C documents the rationale for generic qualification of small bore hand operated globe and gate valves. The CAQR documents the deficiency and identifies the following corrective actions:

1. Verify and document seismic qualification of the specific valve identified.

2. Review other valve specifications that could have resulted in similar deficiencies.

3. Verify and document seismic qualification of valves identified by action item 2.

Corrective action item 1 has been completed. A copy of the qualification calculation was reviewed during the inspection. At the time of the inspection correction action item 2 was nearly complete and few, if any, additional valves were expected to be identified. Completion of the documentation for this

action has been designated as a post-restart effort. Corrective action item 3 has proceeded based on the unofficial list generated by action item 2. The majority of valves and all "seismically sensitive" valves (i.e., valves with extended operators such as air or motor operated valves) identified by item 2 have been evaluated. Completion of the documentation for this action has also been designated as a post-restart effort. TVA's completed corrective actions are considered adequate to address the safety concern with the seismic qualification of valves. The staff considers completion of the documentation as a post-restart effort acceptable. This item is closed.

(Closed) Observation CEB-2, Structural Steel Sizing Calculations

(Closed) Observation CEB-3, Structural Steel Details

(Closed) Observation CEB-4, Platform Steel Calculations and Drawings

(Closed) Observation CEB-5, Revisions to Steel Platform Calculations

(Closed) Observation CEB-6, Seismic Loads for Steel Platforms

Inspection Report 87-06 raised several concerns with the structural design adequacy of steel platforms located in different safety-related buildings. These were contained in observations CEB-2 through CEB-6. TVA's response (Reference 4), stated that Significant Condition Report (SCR) SQN 8711 was revised to address the concerns and provided a discussion of TVA's corrective actions. Inspection Report 87-27 noted that TVA's corrective actions had not been completed.

Inspection Report 87-64 discussed TVA's corrective actions to demonstrate the structural design adequacy of the platforms. TVA selected six platforms for reanalysis. Three of these platforms are located in the auxiliary building and the other three were selected from the reactor building. All platforms were walked down by TVA engineers to obtain as-built information, which was later used in the reanalysis. The inspection report stated that TVA Calculation B25 870926 805 which contained the reanalysis of the auxiliary building platform at elevation 724'-3" was reviewed. The inspection report also concluded that TVA's approach for demonstrating structural design adequacy of the steel platforms was acceptable, however, the inspection report identified three concerns that were left as open confirmatory items.

During this inspection, TVA's resolution for these three concerns was reviewed. The results of the review of the three concerns is discussed below:

1. TVA used 0.0 psf live load in the reanalysis of the steel platforms when combined with seismic loads. However, TVA has issued an administrative control program (B25 871127 009) to restrict the amount of live load that can be imposed on safety related platforms during plant operation. The restriction states: "When maintenance or repair activity is required on safety-related platforms which impose loads of more than 1000 pounds for 72 hours duration or more within any ten feet square area (100 square feet) or less, prior evaluation must be made by Division of Nuclear Engineering (DNE) to determine the effect of that loading for all applicable design criteria loading combination. If this evaluation concludes that the requirements of the loading combination can not be met, temporary supports or modifications will be used during the maintenance or repair activity to support the temporary loads. In addition, platforms shall not be utilized for long-term storage of materials or equipment."

2. TVA qualified certain connections by torsional tests performed at Singleton Materials Engineering Laboratory as shown in TVA document B46 870904 001. Because these tests are not standard tests and are not covered in the AISC code, an independent review of the tests was performed by Dr. Edwin G. Burdette (TVA Consultant) of the University of Tennessee. He has confirmed the adequacy of the testing procedure and the applicability of the test results.

3. TVA concluded that the bending stresses in the weak axis of one beam exceeded the FSAR stress limits for OBE load case. However, the maximum weak axis bending stress for the SSE load condition is below the yield stress. TVA will modify this beam for long term operation of the plant.

The results of this evaluation of the six steel platforms also showed that some self-drilling anchors did not meet the long term safety factors, however, the safety factors obtained were within the NRC approved safety factors for interim operation. These results are included in a TVA letter to the NRC (Reference 24). As stated by TVA, modifications will be installed after restart for all cases which do not meet the long term criteria.

The staff found the actions taken by TVA to resolve these observations to be adequate for restart. Therefore, this observation closed.

(Closed) Observation CEB-12, Use of Variable Damping for Conduits

Inspection Report 87-06 identified that TVA was using a variable damping value for qualifying conduit supports instead of the value shown in Table 3.7.2.4 of the Sequoyah FSAR. TVA's response (Reference 4) stated test data existed to justify the damping values used in the evaluations and that the FSAR would be revised to add new damping values for metal conduit. Inspection Report 87-27 closed the observation and transferred the issue to OSP for review. This issue was addressed in a staff safety evaluation report on variable damping

(Reference 55). Based on the staff safety evaluation report, this observation is closed.

Inspection Report No. 87-27

(Closed) Observation MEB-10, Loss of Station AC Power Calculation

Inspection Report 87-27 raised a concern with the lack of a calculation or other basis which substantiated the adequacy of HVAC to maintain adequate ambient temperature for essential equipment during a loss of station ac power. TVA's response (Reference 20) stated that this concern was beyond the design basis of the plant. However, TVA provided additional information to address the concern. Inspection Report 87-64 stated that TVA's original response was inadequate. The inspection report also found TVA's subsequent acknowledgement of a commitment to maintain hot shutdown following a loss of station ac power for a two hour period adequate to resolve the issue pending TVA's submittal of a revised response. TVA provided a follow-up response to this observation (Reference 24) documenting the basis for meeting the two hour commitment. TVA's response is considered adequate to resolve this issue. Therefore, this observation is closed.

(Closed) Observation EEB-7, HVAC Temperature and Flow Process Safety Limits

Inspection Report 87-27 identified that the MEB 480 volt board air handling unit temperature switch setpoint calculation did not establish process safety limits for a large number of safety-related HVAC temperature and flow measurements. TVA's response (Reference 20) stated the issue had been addressed by a new calculation. Inspection Report 87-64 identified an additional issue with TVA's corrective action. This issue involved a conflict between the lower process safety limit temperature used for the fifth vital battery room heater control and another calculation for battery operability. The inspection report recommended that the lower process safety limit calculation be revised to show the correct minimum value. TVA's response (Reference 24) committed to reevaluate the fifth vital battery room temperature as a post-restart effort by June 30, 1989. This resolution is considered acceptable since the calculation revision will not affect the plant hardware. Therefore, this observation is closed.

(Closed) Observation EEB-9, Containment Electrical Overcurrent Protection

Inspection Report 87-27 identified a concern with the overcurrent trip settings used to protect the circuits of penetration assemblies Nos. 52 and 53. TVA's response (Reference 20) stated that no corrective action was required based on manufacturers test data for the penetrations. Inspection Report 87-64 provided a review of calculations TVA had performed using vendor's test data to demonstrate the adequacy of the penetrations. The inspection report identified

an error in the ambient air temperature used in TVA's calculations and recommended that TVA revise the calculation. This was not considered a restart issue based on calculations performed by the inspection team but was held open pending TVA's commitment to revise the calculation. TVA's response (Reference 24) to the inspection report committed to complete the revised calculation by August 1, 1988. Based on this commitment this observation is closed.

(Closed) Observation EEB-10, Pump Start Time Delay Relay Setpoint Calculations

Inspection Report 87-27 identified that no time delay setpoint calculations had been prepared by TVA for both the 15 to 25 second and 0.5 second time delay relays used in pump start circuits for the ERCW, CCS, and AFW systems. TVA's response (Reference 20) stated the issue was being addressed. Inspection Report 87-64 identified that TVA subsequently revised procedure PM 86-02, "Method for Electrical Calculations," to specifically list a time delay relay category in the set of required calculations. TVA identified 38 specific time delay relay applications requiring setpoint calculations, and designated 12 of these as post-restart. Inspection Report 87-64 concurred with TVA's designation of the 12 post-restart items and held the observation open pending TVA's correspondence confirming entry of the calculations in the CCTS. TVA's response (Reference 24) to the inspection report committed to complete the post-restart calculations by June 30, 1989. TVA's letter to the NRC (Reference 43) contained this item on the CCTS. Based on this commitment this observation is closed.

(Closed) Observation EEB-11, Component Cooling System Setpoint Calculations

Inspection Report 87-27 identified that CCS flow alarm accuracy values had been discussed between EEB and MEB, but justifications for selecting particular values were not documented in an MEB calculation (RIMS No. B44 870602 001). TVA's response (Reference 20) stated that the flow alarm setpoints were not needed for the hot shutdown of the plant but they were considered desirable. TVA's response stated that demonstrated accuracy calculations for these alarm setpoints were planned as a post-restart item. Inspection Report 87-64 concurred with TVA's post-restart designation and held the observation open pending TVA confirmation of entry of the item in the CCTS. TVA's response (Reference 24) commits to complete these calculations by June 30, 1989. TVA's letter to the NRC (Reference 43) contained this item on the CCTS. Based on this commitment this observation is closed.

(Closed) Observation CEB-13, Regenerated CEB Pipe Support Calculations

Inspection Report 87-27 identified that CEB's calculation for pipe support H10-635 demonstrated that the pipe support failed when friction forces were considered, and that CEB did not document this deficiency on the calculation

cover sheet or in the CAQR which CEB subsequently prepared. In addition, the CEB calculation for pipe support H10-1219 did not include a thermal check of the pipe support and CEB did not note this as an unverified assumption on the calculation cover sheet or on CEB's pipe support calculation log. TVA's response (Reference 20) stated the supports were being reviewed as part pipe support calculation effort. Inspection Report 87-64 identified that these calculations were being regenerated as part of the pipe support calculation effort and held the observation open pending TVA's confirmation the actions were complete. TVA's response (Reference 24) stated the calculations had been completed and that pipe support H10-635 required a modification that was completed to meet the design criteria. Based on TVA's corrective actions this observation is closed.

(Closed) Observation CEB-15, Technical Adequacy of Miscellaneous Structural Steel

Inspection Report 86-27 stated that TVA reviewed 54 randomly selected features to determine the design adequacy of miscellaneous structural steel at Sequoyah Nuclear Plant Unit 2. The inspection report raised a concern that this initial sample size was not large enough to represent the total population of miscellaneous structural steel. TVA's response (Reference 20) stated the sample evaluation had identified five CAQR's that were being evaluated for operability requirements and that miscellaneous steel calculations would be reviewed and revised as necessary after restart. Inspection Report 87-64 identified that TVA had increased their sample size to review 38 additional calculations and also planned to select 60 equipment support calculations for review to determine whether the appropriate vendor loads were used in the design. TVA stated this effort was scheduled for completion by November 30, 1987. The inspection report found the sample size which TVA selected to determine the design adequacy of miscellaneous structural steel acceptable. The inspection report identified that interim criteria were being prepared by TVA specifically for the miscellaneous steel members which deviated from the FSAR requirements. The inspection report left the observation open pending TVA's confirmation that the evaluation was complete.

The staff reviewed TVA's criteria for the evaluation of miscellaneous structural steel. TVA used design criteria SQN-DC-V-1.3.3.1, which is compatible with the FSAR loading combinations and allowable stresses. TVA's review of the design records showed that there were differences between the design loads and vendor loads used for the design of equipment supports. TVA issued CAQRs SQP870188, SQP870209 and SQP8702109 to resolve these discrepancies. The resolution for CAQR SQP870188 required a modification to the containment spray heat exchanger support as documented in TVA calculation B25 880131 357. This calculation was reviewed by the staff and found to be acceptable.

As for generic evaluation related to inconsistencies in the use of vendor loads, TVA selected 60 equipment support designs and evaluated them to determine whether the appropriate vendor loads have been utilized in the design of equipment supports. This evaluation was performed in conjunction with the TVA response to NRC IDI Deficiency D4.6-1. The staff's review of the 60 equipment support evaluations are covered under this IDI deficiency.

The staff found the actions taken by TVA to resolve the concerns with the adequacy of miscellaneous structural steel adequate and therefore considers this observation closed.

(Closed) Observation CEB-16, Conduit and HVAC Duct Support Calculations

Inspection Report 87-27 identified that CEB's review of recently regenerated conduit and HVAC duct support calculations identified numerous discrepancies between the calculations and the design criteria. TVA's response (Reference 20) provided the details of TVA's corrective actions. Inspection Report 87-64 noted that TVA had not completed the corrective actions and held the observation open for further review. TVA's response (Reference 24) provided the results of the completed corrective actions. These results are discussed in detail below.

HVAC Ducts and Duct Supports

In order to resolve CAQR SQT870843, TVA has selected five worst case duct systems which were qualified by computer analyses. Gilbert/Commonwealth (TVA Consultant) was contracted to perform analyses on the five duct samples. The results of this evaluation is contained in Gilbert/Commonwealth (G/C) report for Task R0006.

The staff review of this report found that TVA used the 7% damped amplified response spectra (ARS) to determine the seismic loads for both OBE and SSE in four of the five duct samples, namely 1, 3, 4 and 5. This is in violation of the FSAR in which the use of 2% and 5% damped ARS was required for steel structures with bolted connections under OBE and SSE loading cases. During the inspection, TVA performed additional calculations using the loads calculated from the 5% damped ARS to show that the HVAC ducts and duct supports meet the restart criteria. 5% damping for SSE loading condition is acceptable to the staff for the HVAC duct evaluation. The staff reviewed these preliminary calculations and concluded that the sampled HVAC systems met the restart criteria requirements. However, the staff noted that these preliminary calculations should be finalized prior to restart. TVA submitted the final calculations (B25 880224) for staff's review (Reference 35). The staff reviewed these calculations and found them acceptable for restart. TVA should qualify these four duct samples plus additional samples from other duct systems to long term criteria post-restart.

The staff reviewed the support calculations (RIMs Nos. B25 871120 450, B25 871120 453 through B25 871120 455) related to sample 2 and also reviewed the preliminary G/C calculations for sample 2 in which overstresses in connection welds and drilled-in anchors were identifed. The staff review of the G/C calculations found that the overstressed welded connections are adequate to transfer the axial loads and would act as pinned connections rather than fixed connections, as modelled in the computer analyses. The staff requested that these preliminary calculations for qualifying the overstressed welds be revised to reflect the pinned end connections prior to restart. TVA submitted the finalized G/C calculations (RIMs Nos. B25 880224 308 through B25 880224 313) which considered the welded connections as pinned connections (Reference 35). The staff reviewed these calculations and found the results acceptable. Also, the staff accepted that the drilled-in anchors for sample 2 met a short term safety factor of 2.0. However, for post-restart, TVA needs to qualify all these anchors to the long term criteria and the G/C calculations should be revised to coincide with the evaluation results as shown in Tables 1 through 6 of their report for Task R0006. The documentation received from TVA (Reference 35) showed that TVA has committed to qualify the drilled-in anchors used in HVAC supports for compliance with the long term criteria and to revise the G/C calculations for sample 2 to reflect Table 2 of Report R0006, after restart.

In conclusion, the staff found that the five worst case duct samples meet the restart criteria. TVA should compute the evaluation of these five duct samples to the long-term criteria and select additional samples from other duct systems to evaluate to the long-term criteria. (Unresolved Item URI 88-12-07.)

Conduit and Conduit Supports

Sequoyah CAQR SQT870626, Revision 1, identified several issues regarding the adequacy of the seismic design of the conduits and conduit supports. The major issue was the compliance of the existing seismic design with design requirements specified in design criteria SQN-DC-V-13.10. In addition, the following six specific issues were identified:

1. Adequacy of conduit runs containing one-hole finger clamps;

2. Adequacy of conduit runs containing cast iron parts;

3. Adequacy of conduit systems with rigid and flexible supports intermixed;

4. Adequacy of conduit supports for axial loads;

5. Adequacy of conduits supported on structures and/or other equipment;

6. Effect of differential seismic movements between structures.

To resolve the major issue, i.e., compliance with the design criteria requirements, TVA performed walkdowns of the plant and evaluated a

representative worst case sample of 60 supports and the related conduits based on the restart criteria. For the restart evaluation of these 60 sample support cases under the SSE condition, TVA used (a) 2% damped amplified response spectra (ARS) for the conduit system, (b) an absolute-sum combination of the loads from all three earthquake components, and (c) the allowables for the OBE condition. The criteria used by TVA for this sample is more conservative than the currently accepted long-term criteria for the SSE loading condition which requires (a) 5% conduit system damping; (b) the absolute-sum combination of the loads from the vertical and one horizontal earthquake components; and (c) the SSE condition allowables. According to TVA's evaluation, all sampled cases (conduits and supports) were found to meet the restart criteria with three exceptions. The three exceptions are (a) both the aluminum conduit and Unistrut clamp at support AB25 were overstressed, (b) the aluminum conduit at support AB45 was overstressed, and (c) the Unistrut clamps at support 2AE3 were overstressed. TVA re-evaluated these three support cases using the long term criteria for the earthquake component combination and allowables and the existing seismic loads calculated from the 2% damped ARS. The re-evaluation results showed that all three supports met the long term criteria, however, the aluminum conduit stresses at supports AB25 and AB45 still exceeded the long term allowables by approximately 30% and 9%, respectively. The staff reviewed TVA's evaluation results of supports AB25 (RIMs Nos. B41-880205-020 and B25-880209-800), AB45 (RIMs Nos. B41-871106 and SCG2S-88-008) and 2AE3 (RIMs Nos. B25-880209-802 and B41-871106-086) and concurred with the TVA judgment that the conduit stresses would be within long term allowables if the currently accepted 5% damped ARS were used for the input motion. Therefore, the staff concludes that TVA's evaluation for the 60 representative sample supports and related conduits is an acceptable restart resolution for the major issue regarding the compliance of the existing conduits and supports with the design criteria requirements. As a post-restart corrective action item, TVA will re-evaluate the conduits at these two supports and additional samples to be selected from the remaining conduit systems using seismic loads based on a 5% damped ARS.

To resolve the remaining six issues, TVA applied the earthquake experience data developed by its consultant, EQE, Inc., and concluded that the existing conditions are adequate for restart. This evaluation was summarized in the EQE report, "Seismic Evaluation of Specific Issues for Conduit Systems at Sequoyah Nuclear Plant, Unit 2," Revision 0, August 28, 1987 (B25 871106 018). The staff did not find the EQE earthquake experience data a sufficient basis and TVA was required to base their evaluation on plant-specific analyses and/or test data. In response to the staff concern, TVA provided new information for review. The staff evaluation of this information is discussed in the following:

Issue (1) - The staff had a concern that no test data existed to confirm the capacity of one-hole finger clamps to resist axial loads due to clamping friction. TVA performend preliminary calculations which demonstrated that all conduit sizes except the 4 and 5 inch diameter met restart criteria without using the clamping friction. The staff concurred with this preliminary

evaluation and requested TVA to provide a more conclusive pre-restart resolution for those 4" and 5" conduit runs containing one-hole clamps. Subsequent to the inspection, TVA performed a four-activity program to demonstrate the adequacy of 4" diameter and 5" diameter conduits at SQN that contain one-hole clamps. In activity (1), TVA re-confirmed that for all conduit sizes except for 4" diameter and 5" diameter, the axial loads can be resisted by the first one-hole clamp beyond a 90° elbow with sufficient margin. The allowables adopted in this evaluation were 0.7 times the ultimate lateral load capacities established previously from testing conducted by TVA. In activity (2), TVA performed a 100% walkdown of the auxiliary building floor at elevation 690'-0" which was believed by TVA to contain the greatest concentration of large size conduits, i.e., 4" diameter and 5" diameter conduits. Of the 122 4" diameter conduit runs identified from the walkdown, only eight runs had two or more one-hole clamps in series on straight runs. This walkdown confirmed TVA's assumption used for the test that the 50' of straight run of the 4" diameter conduit with six one-hole clamps was a bounding configuration. In activity (3), TVA evaluated the three worst cases out of the eight 4" diameter conduit runs with two or more one-hole clamps in series assuming that all clamps provided three directional restraints. The evaluation results showed that all three worst cases met the accepted restart criteria. In activity (4), TVA established axial load capacity of one-hole clamps for 4" diameter conduits based on seven static tests of a 50' straight conduit run containing six in-line clamps at 10' spacing. All tests stopped at an applied axial load of 2500 lbs. except for the first run in which the test was stopped prematurely at 1800 lbs. The tests did not result in failure of the clamps. The tests demonstrated that the one-hole clamps, when installed to the standard TVA requirements (finger-tight plus 1/8 to 1/4 turn), can develop sufficient axial load capacity and can be relied upon as a three directional support on conduit runs.

The staff reviewed the information on the results of the four activity program and concludes that it is a sufficient restart resolution for the issue concerning the adequacy of conduit runs contain one-hole clamps.

Issue (2) - TVA provided test information on conduits containing straight run and 90° elbow couplers made of cast iron. The tests were performed for application to Bellefonte Nuclear Plant. The test data gave an average ultimate strength of 30.5 ksi for the cast iron couplers, which represented a minimum margin of safety about 1.75 with respect to the maximum conduit stresses within the 60 worst case sample of conduit supports. The staff accepted this information as a sufficient resolution for the issue of cast iron conduit bodies.

Issue (3) - The staff was informed that TVA's previous walkdown of the plant confirmed that all Category I conduit supports, except two, are rigid supports, and that the two flexible supports were of the rod hanger type and had already been replaced. TVA documents SCR SQN MEB8610-R1, ECN L5599, FCR 4636 and Work Plan 12186 verified that the replacement of the two rod hanger supports were completed. Thus, TVA concluded that the only remaining concern of this issue

was the seismic interaction between Category II conduit and siesmic Category I conducit (two over one or II/I). TVA presented sample analyses showing that Category II conduits supported by rod hangers would not fail and become free-falling missiles. Regarding the potential for the Category II conduits to become swinging missiles, TVA indicated that this issue was resolved via their resolution of Employee Concern Element 22600, SQN-02 and -03, Interaction Item TPW/734/005. The staff reviewed the action items and found that TVA's resolution for Issue (3) is adequate.

Issue (4) - The staff was informed that only Unistrut hardware have been used for Category I conduit supports at SQN, as stated in TVA document NCR W-387-P. In addition, during its walkdown of the plant TVA verified that for some supports which were not originally designed for resisting axial loads, there was no washer installed between clamps and Unistrut sections. Because of this construction error, these supports have to resist 3-directional loadings. This was documented in NCR SQNCEB8502, Revision 3, and SCR SQNCEB8612, Revision 1. The axial capacity of one-hole clamps was addressed by TVA during its resolution for Issue (1). The axial capacity of 2-hole Unistrut clamps has been accepted by the staff when reviewing TVA's investigations for Employee Concern Element 228.0-SQN. Since TVA's evaluation of the 60 worst case conduit supports was based on the supports being 3-directional, the staff believes that TVA's resolution for Issue (4) is adequate because in resolving Issue (1), TVA had demonstrated that the one-hole clamps also provide sufficient 3-directional support with respect to the restart criteria.

Issue (5) - TVA provided sample analyses to show that Category I conduits would not be overstressed when subjected to the loading due to the relative displacement between structures and/or equipment on which the conduits were rigidly supported. Only one non-Category I conduit, 1" in diameter, was identified as the worst case in which the conduit was overstressed. The staff found the analyses acceptable and hence Issue (5) is adequately resolved.

Issue (6) - TVA identified the worst case differential movement to be about 0.072" for a 3" diameter conduit running between the auxiliary and shield building at Elevation 705.25'. TVA evaluated the conduit taking into account the effects of both differential movement and inertia loads, and found the conduit stress to be within the allowable. The staff found the evaluation acceptable and hence concludes that TVA's resolution of Issue (6) is acceptable.

The staff considers the issue related to conduits and supports closed.

(Closed) CEB-17, CEB Corrective Action Program Description

Inspection Report 87-27 opened this item to track the TVA's response to the concern with the adequacy of the TVA civil engineering calculation program. TVA's response to this concern (Reference 31) provided an update to the status of the issues identified in the inspection report. In addition, TVA provided

updated information on the calculation program (Reference 19). The adequacy of the civil program plan was addressed in the staff's safety evaluation of the Sequoyah Nuclear Performance Plan. Based on the staff's safety evaluation report, this observation is closed.

TABLE A.1

DESIGN CALCULATION ISSUES

Observation	Inspection Report Number		
	87-06	87-27	87-64
GEN-1	O	O	C
GEN-2	O	O	
MEB-1	O	C	
MEB-2	O	C	
MEB-3	O	O	O
MEB-4	O	C	
MEB-5	O	C	
MEB-6	O	O	O
MEB-7	O	C	
MEB-8	O	O	C
MEB-9	O	O	C
NEB-1	O	O	C
NEB-2	O	O	C
NEB-3	O	C	
EEB-1	O	O	C
EEB-2	O	O	O
EEB-3	O	O	C
EEB-4	O	C	
EEB-5	O	C	
CEB-1	O	T	
CEB-2	O	O	O
CEB-3	O	O	O

Observation	Inspection Report Number		
	87-06	87-27	87-64
CEB-4	O	O	O
CEB-5	O	O	O
CEB-6	O	O	O
CEB-7	O	C	
CEB-8	O	C	
CEB-9	O	C	
CEB-10	O	C	
CEB-11	O	O	C
CEB-12	O	T	
GEN-3		O	C
MEB-10		O	O
EEB-6		O	C
EEB-7		O	O
EEB-8		O	C
EEB-9		O	O
EEB-10		O	O
EEB-11		O	O
CEB-13		O	O
CEB-14		O	C
CEB-15		O	O
CEB-16		O	O
CEB-17		O	

O - Item is discussed as open issue in the Inspection Report
C - Item is closed in the Inspection Report
T - Item is closed in the Inspection Report based on licensing review

APPENDIX B

LICENSEE ACTION FOR PREVIOUS DBVP INSPECTION FINDINGS

INSPECTION REPORT NO. 86-27

(Closed) Deficiency D3.2-2, USQD Requirement

Inspection Report 86-27 stated that ECN L5500 added extension operators and covers to Sequoyah Unit 1 and 2 valves 67-507A installed in the essential raw cooling water system. The inspection report identified that TVA did not have seismic qualification documentation for these new valve stem extensions. TVA's response (Reference 5) to the inspection report stated that approximately 300 valves with remote operators were affected by this deficiency and that SCR SQNCEB8621 was written to address the issue. Inspection Report 86-55 identified that remote valve stem operators and associated piping would be seismically qualified for rigorously analyzed piping prior to restart and that alternately analyzed piping would be evaluated for the additional concentrated weight effects after restart. Inspection Report 87-14 addressed the review of TVA's corrective actions for SCR SQNCEB8621 and closed this deficiency. Although Inspection Report 87-14 closed this deficiency, the inspection report noted that TVA's decision to evaluate the added mass of extended valve operators for alternately analyzed piping after restart had been previously submitted to the NRC. The evaluation of TVA's alternately analyzed piping program is contained in Section 2.4 of the staff's safety evaluation of TVA's Sequoyah Nuclear Performance Plan (Reference 44). For alternately analyzed piping systems, the torsional effects of large motor-operated and pneumatic-operated values were evaluated as pre-restart items whereas TVA's evaluation of the effects of large concentrated weights as a post-restart effort was considered acceptable. Based on the staff's safety evaluation report this deficiency is closed.

(Closed) Deficiency D3.3-1, Pipe Support Friction

Deficiency D3.3-1 identified that TVA had not considered friction forces for pipe support designs as required by the USAS B31.1.0 - 1967 Code. TVA stated that the effects of friction due to thermal loads had not been considered at Sequoyah and proposed to evaluate the effects of friction on pipe supports on a sample basis (References 5, 6) after restart. TVA's proposed corrective action was discussed in Inspection Report No. 50-327/86-55. TVA's response (Reference 8) to the inspection report provided additional information on the scope of the evaluation. Inspection Report 87-14 left the deficiency open pending TVA's completion of the evaluation. Subsequent to this inspection report, TVA initiated a program to regenerate missing pipe support calculations for rigorous piping analyses (Reference 45). The criteria used for these support evaluations, SQN-DC-V-24.2, included the effects of friction. The staff review of regenerated pipe supports verified that friction was being

considered in the pipe support calculations. In addition, for alternately analyzed piping, TVA has committed to perform a study of the effects of friction forces as part of the post-restart program. This study is discussed in the staff safety evaluation of Sequoyah's Nuclear Performance Plan (Reference 44). Based on review of the regenerated pipe support calculations and TVA's commitment for the post-restart alternate analysis program this deficiency is closed.

(Closed) Deficiency D3.3-4, Alternate Pipe Support Criteria

Inspection Report 86-27 identified that supports for field routed piping may not have been properly evaluated for the reactions due to piping system thermal loads. The inspection report also identified two nonconformance reports prepared in 1982 dealing with alternately analyzed piping. Field routed piping is generally two inches and smaller in diameter and uses typical supports. Alternately analyzed piping includes larger piping sizes and uniquely engineered supports. Field routed pipe was included as part of TVA's alternately analyzed piping program. TVA's response (Reference 5) to the inspection report referenced the alternately analyzed piping program as addressing the specific issue of thermal expansion flexibility. TVA's response also stated that resolution of the thermal expansion issue was not a restart item. Inspection Report 86-55 closed Deficiency D3.3-4 based on a separate licensing review of TVA's alternately analyzed piping program. The evaluation of TVA's alternately analyzed piping program is contained in Section 2.4 of the staff's safety evaluation report of TVA's Sequoyah Nuclear Performance Plan (Reference 44). Alternately analyzed piping systems with operating temperatures greater than 200°F were evaluated prior to restart. Based on the staff's safety evaluation of TVA's alternately analyzed piping program this deficiency is closed.

(Closed) Deficiency D4.3-3, Steam Generator Access Platform Design

Inspection Report 86-27 identified that the steam generator lower supports were not evaluated for permanently attached platform loads added by ECN L5034. TVA's response (Reference 5) stated the calculations would be revised after restart. TVA's revised response (Reference 6) to the inspection report identified an additional concern with the documentation of the loads for attachments to the steam generator lower supports. Inspection Report 86-55 stated that a TVA walkdown of these supports identified additional pipe supports that were attached to these steam generator supports which were not accounted for in the original design.

Inspection Report 87-14 stated that Westinghouse completed a re-evaluation of these supports using the TVA walkdown information and the re-evaluation showed that the supports are structurally adequate to carry the additional loads (B45 861219 601). The inspection report stated TVA was still evaluating the attachment of the supports to the concrete. Inspection Report 87-64 stated TVA

completed the analysis of the attachments using the load information obtained from the Westinghouse evaluation. The inspection report stated that the calculations by TVA, B25 8711120 452, showed that the attachment stresses are within FSAR requirements. In addition, the inspection report identified that TVA had evaluated the crane wall for the additional loads obtained from the Westinghouse analysis. This calculation, B25 870903 454, showed that the crane wall is adequate to carry these additional loads.

The inspection report identified a concern that the walkdowns performed on the steam generator support were not in accordance with the TVA QA requirements. TVA committed to perform walkdowns in accordance with their QA requirements to obtain the as-built information as a post-restart effort. The inspection report held the deficiency open pending TVA's entering this commitment on the CCTS. TVA's response (Reference 25) stated that this walkdown would be performed by Unit 2 cycle 4 refueling outage. During this inspection it was verified that this commitment was on CCTS control number NCO-88-0008-001. This commitment is acceptable to the staff and therefore this deficiency is closed.

(Closed) Unresolved Item U5.3-2, Sizing Calculations

Inspection Report 86-27 identified that TVA did not have adequate calculations for the sizing of the 125v station batteries, the battery charger and the 120v vital ac inverter. TVA's response (Reference 5) stated that the sizing of these components had been reviewed as part of the program to upgrade the electrical calculations and that the components had been determined to have adequate capacity for the existing loads. Inspection Report 86-55 closed this item based on a licensing review that was addressing the adequacy of TVA's electrical calculations. The adequacy of the 125v dc vital instrument power system voltage calculations was addressed in Section 2.3.3.2.2 of the staff's safety evaluation of the Sequoyah Nuclear Performance Plan (Reference 44). Based on the staff's safety evaluation report this item is closed.

(Closed) Unresolved Item U5.3-4, Diesel Generator Loading Calculations

Inspection Report 86-27 identified several errors with the assumptions used by TVA in the diesel generator loading analysis. TVA's response (Reference 5) stated that the diesel generator analysis had been revised to correct the concerns and that a new procedure for the preparation of the diesel generator loading calculation would be prepared as part of the electrical calculation program. Inspection Report 86-55 closed this item based on a licensing review that was addressing the adequacy of TVA's electrical calculations. The adequacy of the diesel generator loading calculations was addressed in Section 2.3.3.2.1 of the staff's safety evaluation of the Sequoyah Nuclear Performance Plan (Reference 44). Based on the staff's safety evaluation report this item is closed.

(Closed) Unresolved Item U5.3-5, Loss of Control Power Annunciation

Inspection Report 86-27 identified that there was a lack of control room annunciation for the loss of control power tc the auxiliary feedwater pump. The inspection report cited the requirements provided in Regulatory Guide 1.47, Bypass and Inoperable Status Indication for Nuclear Power Plant Safety Systems. TVA's response (Reference 5) stated they were preparing a design concept for the implementation of Regulatory Guide 1.47 requirements. Inspection Report 86-55 closed this item based on a licensing review that was addressing TVA's implementation of Regulatory Guide 1.47. The implementation of Regulatory Guide 1.47 was addressed in a separate safety evaluation report previously transmitted to TVA (Reference 46). Based on the staff's safety evaluation report this item is closed.

(Closed) Deficiency D6.3-1, Specification of Hydrostatic Test to Demonstrate Instrument Pressure Boundary Integrity After Seismic Qualification Testing

Inspection Report 86-27 identified that TVA had not specified a design performance test for hydrostatic pressure integrity following the seismic qualification test for instruments purchased for recent plant modifications. The inspection report referenced the requirements of TVA's procedures OEP-06 and OEP-09. TVA's stated position in its response (Reference 5) was that the requirements for seismic testing and hydrostatic testing are totally separate and independent of each other and that separate hydrostatic test following the component seismic qualification was not required. However, TVA did commit to additional actions to test the onsite pressure switches to the rated overrange of the units. Inspection Report 86-55 accepted TVA's corrective actions for the onsite pressure switches as demonstrating pressure integrity based on a review of the test data but still identified a concern with the future procurement specifications for other instruments. TVA submitted a revised response to this issue (Reference 11). TVA's response stated that a review of environmental qualification binders had revealed that the other instruments had been pressure tested. In addition, TVA stated that standard procurement specifications require hydrostatic tests to meet the requirements of ANSI B31.1. TVA still did not agree with the position that separate hydrostatic tests were required after the seismic qualification. Inspection Report 87-31 closed this issue and referred it to licensing for review. The current staff position on the seismic qualification of mechanical and electrical equipment is contained in Section 3.10 of the Standard Review Plan (NUREG-0800). This position requires tests and analyses to confirm operability during and after a seismic event including loads from normal and accident conditions. These normal loads include the system operating pressure. However, the staff position does not specify a hydrostatic test be performed during the qualification. Therefore, the staff accepts TVA's position and previous corrective actions as adequate. This deficiency is closed.

INSPECTION REPORT NO. 86-38

(Closed) Observation 3.2, Margins of Safety for Restart

Inspection Report 86-38 identified that TVA was using interim criteria to determine whether hardware modifications had to be made prior to the restart of Sequoyah. These interim criteria involved piping systems, cable tray systems, pipe supports and concrete anchorages. Inspection Report 86-55 closed this item based on a licensing review that was addressing TVA's restart design criteria. The review of these criteria are contained in Sections 2.3.2, 2.4 and 2.5 of the staff's safety evaluation of the Sequoyah Nuclear Performance Plan (Reference 44). Based on the staff's safety evaluation report this observation is closed.

(Closed) Observation 6.3, Instrument Sense Line

Inspection Report 86-38 identified a concern that the walkdown inspections of the auxiliary feedwater system turbine instrumentation and control was not consistent for Sequoyah Units 1 and 2. Inspection Report 86-55 indicated that this observation was related to Observation 5.1 which involved the scope of the walkdowns for the electrical and I&C areas. Observation 5.1 was closed in Inspection Report 87-14. Inspection Report 86-55 also identified a specific concern with the scope of the instrument line walkdowns. TVA's response (Reference 7) to Inspection Report 86-38 Observation 5.1 identified that 200 instruments had been inspected by the walkdowns. Based on the results of these walkdowns Inspection Report 87-14 recommended a more complete walkdown of safety-related HVAC instrument connections. Inspection Report 87-31 documented that TVA was performing additional walkdowns and that sketches were being made of the installation of HVAC sensors that performed a protective or control interlock function. The inspection report stated that TVA needed to confirm the adequacy of the as-built installation shown on the sketches and provide a schedule for issuing applicable design drawings. Inspection Report 87-64 noted that TVA was performing a technical adequacy review of the sketches and that TVA had stated the sketches would be converted into formal drawings when the review was completed. The inspection report left the observation open pending TVA's submittal of a schedule for completing the HVAC instrumentation drawings. TVA's response (Reference 25) stated that they would issue the Unit 2 Phase 1 HVAC instrument line drawings by the Unit 2 Cycle 4 refueling outage. This schedule is acceptable to the staff and, therefore, the observation is closed.

INSPECTION REPORT NO. 86-45

(Closed) Observation 8.1, Anchor Point Movement Loads

Inspection Report 86-45 identified the concern that anchor point movement loads associated with a double ended guillotine break in the reactor coolant loop were not included in Sequoyah's pipe support design criteria SQN-DC-V-24.1.

The inspection report noted that these loads had been included in the Watts Bar Design Criteria WB-DC-40.31.9 that had been previously used for the design of Sequoyah supports. The inspection report also noted that a NRC letter (Reference 47) was sent to TVA requesting additional information on this issue. The NRC letter requested TVA provide documentation of the basis for concluding that the anchor point movements associated with the DBA are sufficiently small to produce secondary, self-limiting type stresses. Inspection Report 86-55 closed the observation based on the licensing review of the issue. TVA's response to the NRC request for additional information (Reference 48) stated that Sequoyah's FSAR had no direct reference to a requirement to evaluate reactor coolant loop branch lines for the pipe break anchor point motions. TVA's response also stated the basis for the conclusion that these effects were small at Sequoyah were the results of the Watts Bar analysis. The Watts Bar results cited by TVA in their response were movements up to .5 inches for the broken loop and .25 inch for the unbroken loop.

Based on subsequent discussions with the NRC staff TVA developed a new set of design criteria, SQN-DC-V-24.2, for the evaluation of pipe supports at Sequoyah. This criteria was developed to obtain one set of design criteria that was applicable to supports at Sequoyah and that met FSAR criteria. The review of this criteria is contained in Section 2.3.2 of the staff's safety evaluation of the Sequoyah Nuclear Performance Plan (Reference 44). SQN-DC-V-24.2 does not require an evaluation of reactor coolant loop branch connections for pipe break anchor motions. The staff agrees with TVA's position that if the movements are sufficiently small they can be considered secondary and self-relieving for the pipe break evaluation. The movement of .25 inch for the unbroken loop reported by TVA is considered sufficiently small that this does not pose a safety concern. In addition, the staff review of the Sequoyah FSAR did not identify any commitment to analyze the reactor coolant pipe branch lines for pipe break anchor point motions. Based on the preceding evaluation this observation is closed.

(Closed) Observation 8.2, Conformance to GDC for Containment Isolation

Inspection Report 86-45 identified the concern that Sequoyah was not in compliance with the general design criteria for containment isolation. Inspection Report 86-55 closed the observation based on a licensing review that was being performed. The licensing review of Sequoyah's containment isolation design is addressed in Section 3.6.1 of the staff's safety evaluation of the Sequoyah Nuclear Performance Plan (Reference 44). Based on the staff's safety evaluation this observation is closed.

(Closed) Observation 8.3, Cable Tray Systems

Inspection Report 86-45 identified a number of concerns with cable tray support systems. Inspection Report 86-55 closed the observation based on a licensing review that was being performed. The licensing review of cable tray supports

is addressed in Section 2.5 of the staff's safety evaluation of the Sequoyah Nuclear Performance Plan (Reference 44). The staff safety evaluation included detailed reviews of TVA's cable tray support analyses. Based on the staff's safety evaluation this observation is closed.

(Closed) Observation 8.4, Piping and HVAC Systems

Inspection Report 86-45 identified a concern with unrestrained large motor-operated valves on small lines and with the interaction of non-seismic piping with safety systems. Inspection Report 86-55 closed the observation based on a licensing review that was being performed. Both of these issues were addressed by TVA's alternately analyzed piping program. The review of TVA's alternately analyzed piping program is addressed in Section 2.4 of the staff's safety evaluation of the Sequoyah Nuclear Performance Plan (Reference 44). Based on the staff's safety evaluation this observation is closed.

INSPECTION REPORT 86-55

(Closed) Observation 3.8, Solenoid Valve Mounting Seismic Qualification

Inspection Report 86-55 identified five items related to ECN L6487, Revision 1. These items involved deficiencies in the documentation and seismic qualification of a solenoid valve which was supported by control air tubing. TVA's response (Reference 8) identified the corrective actions that would be taken to address the deficiencies. Inspection Report 87-14 found that TVA's corrective actions were sufficient to document the adequacy of the solenoid valve and closed the observation. However, the inspection report noted a possible discrepancy between TVA's Sequoyah Alternate Analysis Review Program Description SQN-AA-001 and TVA's Sequoyah Nuclear Performance Plan on the method of handling large concentrated weights for restart. The inspection report also noted that the alternate analysis program was the subject of a separate staff review. This issue is similar to deficiency D3.2-2. The evaluation of TVA's alternately analyzed piping program is contained in Section 2.4 of the staff's safety evaluation report on TVA's Sequoyah Nuclear Performance Plan (Reference 44). For alternately analyzed piping systems, the torsional effects of large motor-operated and pneumatic-operated valves were evaluated as prerestart items whereas TVA's evaluation of large concentrated weights as a post-restart effort was considered acceptable. Based on the staff's safety evaluation report this observation is closed.

(Closed) Observation 6.15, Periodic Functional Test of Agastat Timer Relays in Pump Motor Start Circuits

Inspection Report 86-55 identified a concern that the .5 second time delay relays, Agastat model 7012-PBL had not been periodically tested or calibrated.

TVA's response (Reference 8) stated that the .5 second reset timer would be calibrated prior to Unit 2 restart and would be included in Sequoyah Standard Practice SQE-8 for periodic calibration. Inspection Report 87-31 contained a review of TVA's corrective actions and identified concerns with the test equipment, and method of testing. Inspection Report 87-64 contained a discussion of TVA's method of calibrating the reset timers which involved disconnecting the wiring leads. The inspection report stated that TVA should verify the entire circuit on either an integrated or overlapping basis. TVA's response (Reference 25) stated that the 22 relays identified by the observation would be functionally tested in-circuit prior to Unit 2 Mode 2. Based on this commitment this observation is closed.

INSPECTION REPORT NO. 87-14

(Closed) Observation 3.14, Evaluation of Masonry Block Walls

Inspection Report 87-14 identified that the DBVP project did not appear to be evaluating unreinforced concrete masonry block walls in proximity to safety-related piping and equipment in a consistent manner. TVA's response (Reference 15) referenced a TVA Final Report to the NRC for IE Bulletin 80-11 as evidence that adequate evaluations of block walls had been performed and stated that the regeneration of these calculations would be performed as a post-restart effort in accordance with the essential calculation verification program. The resolution of issue of masonry block wall evaluations is discussed in detail in Inspection Report 88-13, Deficiency D4.3-9. Based on the resolution of the issue in Inspection Report 88-13 this observation is closed.

(Closed) Observation 6.16, HVAC Flow Switch Calibration Data Records and System 30 Surveillance Instruction Procedures

Inspection Report 87-14 identified inconsistencies with the calibration records for HVAC flow switches 2-FS-30-200 and 207. In addition, the inspection report identified a concern that no system level surveillance instruction existed to test the various control logic interlocks developed by these sensors. TVA's response (Reference 15) provided a discussion of TVA's surveillance requirements for the switches and the tests performed. Inspection Report 87-31 found the additional information provided by TVA sufficient to close the issue of the calibration data inconsistencies for the two identified switches but still expressed a concern that a surveillance instruction procedure was needed for the HVAC system. Inspection Report 87-64 also identified that TVA had not prepared or performed an appropriate surveillance instruction procedure. TVA's response (Reference 25) committed to test switches 2-FS-30-200 and 207 prior to Mode 4 and to evaluate other control loops identified by the Restart Test Program Function Matrix to determine which control loops should be added to the periodic test program. TVA committed to complete this evaluation by June 30, 1988. Based on TVA's actions and commitments this observation is closed.

(Closed) Observation 6.17, Diesel Generator Building Ventilation Fans Control Logic and Surveillance Instruction Procedure

Inspection Report 87-14 identified drawing errors in the logic diagrams and control circuits that were not tested. The inspection report stated that additional field inspection data was required to resolve the installation configuration with the design. TVA's response (Reference 15) stated that CAQR SQP 870171 was written to resolve the items prior to restart. TVA stated that design drawing changes were to be accomplished by ECN-L6898 and under field change request FCR 5351. TVA has also issued a CAQR SQT 871016 to resolve the concern regarding periodic testing of these switches. Inspection Report 87-31 identified a concern that TVA did not intend to prepare a surveillance instruction (SI) to test the HVAC controls and interlocks and that the CAQR corrective action had been changed to post-restart. Inspection Report 87-64 acknowledged the TVA response to Inspection Report 87-14. However, the inspection report restated the concern with the SI and testing of these components. TVA's response (Reference 25) stated that the control loops would be added to the periodic test program post-restart as stated in the response to Observation 6.16. In addition, TVA stated that the functions of 2-FS-30-448, 450, 452 and 454 were evaluated under the restart test program. Based on this program evaluation, TVA has determined that these switches were tested between March and August, 1987. TVA's position was these functions did not require testing again prior to restart. Based on TVA's corrective actions and commitment this observation is closed.

INSPECTION REPORT NO. 87-31

(Closed) Observation 3.17, Solenoid Valve Mounting Support

Inspection Report 87-31 identified that ECN 5457 had resulted in the replacement of solenoid valves in several piping systems that had variances from standard typical drawing 47A054-33. The inspection report identified that CEB was unable to retrieve seismic qualification calculations for these variances. TVA's response (Reference 22) stated that no calculations could be found for the variances. Inspection Report 87-64 noted that TVA was generating a calculation package to qualify the support variances. The inspection report stated that this calculation would be completed prior to Unit 2 restart and held the observation open pending the confirmation by TVA that the calculation was completed. TVA's response (Reference 25) stated the calculation was complete and issued under RIMS No. B25 871110 803. Based on TVA's completion of the seismic qualification documentation this observation is closed.

(Closed) Observation 4.8, Radiation Monitoring System

Inspection Report 87-31 identified an inconsistency between SCR SQNNEB8615 and (QIR) NEB 86241. The inspection report identified that punchlist item 4426 which had been written in response to SCR SQNNEB8615 had been reclassified from

pre-restart to post-restart. Punchlist item 4426 identified corrective action to provide safety-grade (seismically qualified) auxiliary control air to System 90 radiation monitor supply valves in order to meet the requirements of Regulatory Guide 1.45. TVA's response (Reference 22) stated that the NRC's original safety evaluation report (NUREG-0011) had identified that the airborne particulate monitoring system had not been specifically designed to remain functional when subjected to an SSE and that Sequoyah's degree of compliance to Regulatory Guide 1.45 constituted an acceptable basis for satisfying the requirements of General Design Criterion 30. Based on TVA's response, Inspection Report 87-64 agreed with the system design and the post-restart classification of the punchlist item. The inspection report left the observation open pending TVA's CCTS commitment to complete the corrective action. TVA's response (Reference 25) documented that the QIR has been revised. Based on this response, this observation is closed.

(Closed) Observation 6.21, Change in Corrective Action for PAM Isolation

Inspection Report 87-31 identified a concern that TVA was changing the previously agreed upon corrective action for SCR SQNNEB8722. The original corrective action called for separation of one post-accident monitoring channel from non-safety-related wiring. TVA's response (Reference 22) stated that an EEB disposition of SCR SQNNEB8722 had determined that the separation was consistent with the original design basis and acceptable. TVA also determined that no qualified to non-qualified isolation problems are evident. TVA's proposed corrective actions were to clarify the electrical separation requirements in DIM-SQN-DC-V-19.9-1 and Section 7.5 of the FSAR. In addition, TVA committed to upgrade the post-accident monitoring loops to meet Regulatory Guide 1.97, Revision 2 requirements in accordance with their previous commitments by the end of the Cycle 4 outage for Unit 2. Inspection Report 87-64 found TVA's interim and final implementation plans acceptable and held the issue open pending TVA's submittal of the plan as a formal commitment. TVA's response (Reference 25) documented that the FSAR would be revised in the 1989 update. Based on TVA's commitment to update the FSAR this observation is closed.

(Closed) Observation 6.22, Auxiliary Control Air System Design Criteria

Inspection Report 87-31 identified a concern with the separation of the auxiliary control air (ACA) headers from interactions with high and moderate energy lines. TVA's response (Reference 22) described the previous TVA evaluations for interactions and committed to perform an additional evaluation to address the loss of ACA due to a small break LOCA. Inspection Report 87-64 reviewed TVA's additional evaluation and requested that TVA verify the time required for operator action based on higher heat loads in the 480v shutdown board rooms and that TVA review the operating procedures used by the control room operator for the ventilation system process-auto control switches. TVA's response (Reference 25) stated these issues were addressed by a review of the

control building HVAC design. In this review, TVA has considered the AOI-10 to determine the operator actions and the higher heat load and has determined that all equipment in the control building required for safe shutdown of Unit 2 remain functional to perform their safety function. Based on TVA's revised evaluation this observation is closed.

TABLE B.1

DESIGN BASELINE ISSUES

Deficiency (D) Observation (Obs) Unresolved Item (U)	Inspection Report Number						
	86-27	86-38	86-45	86-55	87-14	87-31	87-64
D2.1-1	O			C			
D2.3-1	O			C			
D3.1-1	O			O	C		
D3.2-2	O			O	T		
D3.2-3	O			O	C		
D3.2-4	O			C			
D3.3-1	O			O	O		
D3.3-2	O			C			
D3.3-3	O			C			
D3.3-4	O			T			
D3.3-5	O			C			
D4.3-1	O			O	C		
D4.3-3	O			O	O		O
D4.3-4	O			C			
D4.3-5	O			C			
D4.3-6	O			C			
U4.3-7	O			C			
D5.3-1	O			O	C		
U5.3-2	O			T			
U5.3-3	O			O	C		
U5.3-4	O			T			
U5.3-5	O			T			
D6.1-1	O			O		C	
D6.1-2	O			O		C	
D6.1-3	O			O		C	

Deficiency (D) Observation (Obs) Unresolved Item (U)	Inspection Report Number						
	86-27	86-38	86-45	86-55	87-14	87-31	87-64
D6.2-1	O			C			
D6.3-1	O			O		T	
U6.3-2	O			C			
Obs 1.1		O		O		C	
Obs 1.2		O		O		C	
Obs 1.3		O		O	O	C	
Obs 1.4		O		C			
Obs 2.1		O		C			
Obs 2.2		O		C			
Obs 3.1		O		C			
Obs 3.2		O		T			
Obs 3.3		O		C			
Obs 4.1		O		C			
Obs 4.2		O		O		C	
Obs 4.3		O		C			
Obs 5.1		O		O	C		
Obs 5.2		O		C			
Obs 5.3		O		C			
Obs 5.4		O		O	C		
Obs 6.1		O		C			
Obs 6.2		O		O		C	
Obs 6.3		O		O	O	O	O
Obs 6.4		O		C			
Obs 7.1		O		C			
Obs 2.3			O	O		C	
Obs 3.4			O	O	O	C	
Obs 4.4			O	O		C	
Obs 4.5			O	C			

Deficiency (D) Observation (Obs) Unresolved Item (U)	Inspection Report Number						
	86-27	86-38	86-45	86-55	87-14	87-31	87-64
Obs 4.6			O	C			
Obs 5.5			O	O	C		
Obs 5.6			O	C			
Obs 6.5			O	O	C		
Obs 6.6			O	C			
Obs 6.7			O	O	C		
Obs 6.8			O	C			
Obs 7.2			O	O	C		
Obs 7.3			O	O	C		
Obs 8.1			O	T			
Obs 8.2			O	T			
Obs 8.3			O	T			
Obs 8.4			O	T			
Obs 2.4				O	C		
Obs 2.5				O	C		
Obs 2.6				O	O	C	
Obs 2.7				O		C	
Obs 3.5				O	C		
Obs 3.6				O	C		
Obs 3.7				O	C		
Obs 3.8				O	T		
Obs 3.9				O	C		
Obs 5.7				O	O	C	
Obs 5.8				O	C		
Obs 6.9				O	C		
Obs 6.10				O	C		
Obs 6.11				O	C		
Obs 6.12				O	O	O	C

Deficiency (D) Observation (Obs) Unresolved Item (U)	Inspection Report Number						
	86-27	86-38	86-45	86-55	87-14	87-31	87-64
Obs 6.13				O	C		
Obs 6.14				O	O	O	C
Obs 6.15				O	O	O	O
Obs 7.4				O	C		
Obs 2.8					O	C	
Obs 3.10					O	C	
Obs 3.11					O	C	
Obs 3.12					O	C	
Obs 3.13					O	O	C
Obs 3.14					O		
Obs 3.15					O	C	
Obs 4.7					O	C	
Obs 5.9					O	C	
Obs 5.10					O	C	
Obs 5.11					O	C	
Obs 6.16					O	O	O
Obs 6.17					O	O	O
Obs 6.18					O	O	C
Obs 6.19					O	C	
Obs 6.20					O	O	C
Obs 3.16						O	C
Obs 3.17						O	O
Obs 4.8						O	O
Obs 6.21						C	O
Obs 6.22						O	O
Obs 7.5						O	C

O - Item is discussed as open issue in the Inspection Report
C - Item is closed in the Inspection Report
T - Item is closed in the Inspection Report based on licensing review

APPENDIX C

LICENSEE ACTION FOR PREVIOUS IDI FINDINGS

(Closed) Deficiency D3.3-3, Incorrect Pipe Support Allowable Stresses

Deficiency D3.3-3 identified a concern with the method used to evaluate the faulted condition allowable stresses for pipe supports. TVA had used the TPIPE piping analyses computer code which normalized loads to compare with allowable stresses. This procedure could result in pipe support stresses exceeding the allowable stresses for structural steel specified in the Sequoyah FSAR. Review of this deficiency was transferred to the Office of Special Projects in Inspection Report 87-74. The staff had previously identified a concern with the criteria used by TVA to evaluate pipe supports. This concern resulted in TVA's issuance of pipe support design criteria document SQN-DC-V-24.2 for the evaluation of all rigorously analyzed pipe support calculations. During the review of regenerated pipe support calculations, the staff confirmed that TVA was implementing the criteria that limits pipe support allowable stresses to .9 yield. Based on the results of the review, this deficiency is closed.

(Closed) Deficiency D3.4-3, CCW Heat Exchanger Calculation

During a NRC field walkdown of the component cooling water (CCW) heat exchanger a discrepancy between the "as-built" condition and vendor qualification documents was identified. TVA's evaluation of the CCW heat exchanger found the "as-built" condition acceptable, however, a detailed review of the qualification of other Category I heat exchangers identified that the containment spray heat exchanger required support modifications. The results of this review are discussed further in Inspection Report 50-327,328/88-13. This inspection report also identified the following three additional technical concerns requiring resolution.

1. TVA used damping values of 2% for OBE loads and 3% for SSE loads to evaluate equipment loads. TVA has argued that these damping values are consistent with the criteria specified in IEEE 344-1975 which is used for qualification of electrical equipment. IEEE 344-1975 specifies the same damping values that are contained in Regulatory Guide 1.61, 2% for OBE and 3% for SSE. However, Table 3.7.1-3 of Sequoyah's FSAR specifies damping values of 1% for OBE and up to 2% for SSE under the heading "Other Welded Steel Structures." TVA's proposed resolution of this item is to revise the FSAR to specify the higher damping values for equipment. Although TVA's proposed damping values are consistent with current regulatory criteria, the staff was concerned that the use of these values represented a relaxation of the original licensing basis for Sequoyah. In order to address the staff's concern with the conservation of the proposed damping values, TVA provided an industry survey of measured damping values, "Structural Damping Values as a Function of Dynamic Response Stress and

Deformation Limits" by J. D. Stevenson. This paper provides a survey of in situ tests of nuclear power plant equipment. Table 7 of the paper presents an average measured damping value of 7.7% for mechanical components at a stress level corresponding to Sequoyah's SSE allowab' l'mits. Based on this test data, this issue is considered resolved for restart. However, the staff still considers the resolution of this item for conformance to TVA's FSAR commitments an open post-restart issue (Unresolved Item URI 88-12-08).

2. The issue of SRSS vs. absolute sum is discussed in Section 3.5 of this inspection report. This issue is closed.

3. For the analysis of piping attached to the heat exchangers, TVA decoupled the heat exchanger analysis from the piping system analysis if the calculated heat exchanger displacement at the piping nozzle attachment point was less than 1/16 inch. This is consistent with the criteria for allowable pipe support deflections contained in TVA's pipe support design criteria, SQN-DC-V-24.2, and is acceptable. This issue is closed.

(Closed for restart) Deficiency D4.2-1, ERCW Pumping Station Access Cells

This deficiency was transferred to the Office of Special Projects in Inspection Report 87-74. The ERCW pumping station access cells (access cells) consists of six sheet pile cells and interconnecting cells which are filled with tremie concrete. The ERCW piping and essential Class 1E conduits are also supported by these cells.

The original seismic analysis of the access cells was based on the assumption that the six cells and the interconnecting cells will act as a single "J-shaped" unit. Contrary to this assumption, the design calculations predict that shrinkage will occur in the interior concrete fill. This will cause a gap between interior concrete and the exterior steel sheet piling. TVA design criteria SQN-DC-V-104.5 states that "the sheet pile sections serve only as forms for the tremie concrete; therefore, quality assurance is not required for these sheet pile sections." The calculations also predict that there will be vertical movement between adjacent cells. Beams have been designed to tie the cells together in the horizontal direction but not vertically. In fact compressible material has been placed above and below these beams to preclude load transfer in the vertical direction. TVA internal memorandum from J. H. Coulson, Principal Civil Engineer to the Civil Engineering and Design Branch files dated October 13, 1977, states, "cells A through F and the ERCW pumping station are individual rigid bodies capable of moving vertically with respect to each other."

The inability to transfer vertical shear between the cells makes the original assumption of a single "J-shaped" unit invalid. Furthermore, even if the assumption was valid, torsional loads should have been considered in the analysis and design since the "J-shaped" unit is not symmetrical. The

calculations also state the following: "RJH & RDG analyzed the cells as both individual cells and as a unit. The former case showed the cells were unstable and the latter case showed a stable unit acting as a rigid body." The calculations also show that cells are unable to transfer vertical shear therefore making the original assumption of a single "J-shaped" unit invalid. The calculation also state that the cells are not stable if they act as individual cells. Also cores taken in November 1977 in several cells indicated that the concrete at the bottom of these cells was soft, crumbly or contained gravel pockets and cavities. TVA reanalyzed the ERCW access cells using a non-linear seismic time history response analysis. The revised seismic analysis for the ERCW cell was based on a two-dimensional nonlinear time history analysis method in which the foundation was represented by discrete springs and dampers with no tension capability in the vertical direction (Reference 38). The staff's evaluation is discussed in the following:

1. Soil-Structure Interaction Model - In the initial analysis model, the upper bound modulus of tremie concrete was considered and the cell was represented by a 5-mass stick model with a rigid base. Hydrodynamic interaction between the submerged portion of the cell and the surrounding water during horizontal vibrations was taken into account by including tributary water masses in the lumped-mass structural model. The structural damping was taken to be 5% for the concrete cell. The rock foundation was represented by springs and dampers without tension capability for the vertical springs and dampers. The springs and dampers were derived from the CLASSI computer code and then distributed to the cell-foundation interface. Because the cell was partially submerged, the buoyant weight of the cell was used as the effective dead weight in the nonlinear seismic analysis. Since the initial analysis was not consistent with the as-built condition of the cell, the staff requested that the cells need to be reanalyzed. TVA revised both the structural model and the foundation impedances based on the lower-bound concrete modulus. The 4' of very soft concrete or gravel at the base of the cell was represented by discrete springs and dampers that were combined with the rock foundation springs and dampers.

   The staff reviewed the nonlinear soil-structure interaction models used in both the initial analysis (upper bound modulus of tremie concrete) and subsequent analysis (lower bound modulus of tremie concrete), and found them acceptable.

2. Computer Code - The computer code UPLIFT was applied for the nonlinear time history seismic analysis of the cell. The staff reviewed the verification manual of the computer code and found it acceptable for the uplift seismic analysis of the cell.

3. Analysis - For the initial analysis, the four sets of SSE artificial ground motion time histories as described in the FSAR were used as input. Each set of ground motion time histories contained one horizontal component and one vertical component. To assess the significance of the

vertical ground motion to the uplifting of the cell base from the foundation, four additional analyses were made with horizontal component of ground motion as the only input. The results showed that the maximum base uplifting and the maximum horizontal displacement at the ERCW pipe elevation were consistently about 76% and 0.18", respectively, for all different ground motion input. TVA also evaluated the possible chipping of the base concrete at the toe of the cell, and found that the maximum possible chipping of the concrete would not exceed 1 foot. Additional analyses considering the base dimension reduced by the 1 foot of concrete chipping showed that it had a negligible effect on both the stability and displacement response of the cell.

For the analyses using the lower-bound concrete modulus, the maximum base uplift and maximum lateral displacement at the ERCW pipe elevation were about 83% and 0.89", respectively. The maximum toe pressure was about 800 psi. The staff had concern on the magnitude of the seismic response toe pressure with respect to the potentially low strength of the soft concrete at the base of the cell.

TVA performed additional analysis which assume that the soil surrounding the cell and sheet pile interlock confine the soft concrete and gravels. The results of this analysis indicate a factor of safety of 1.05 against failure.

In a phone conversation, TVA committed to perform additional evaluations of the ERCW access cells concrete foundation after the restart of the plant. Special emphasis will be placed on determining the content and size of the gravel pockets.

An evaluation program will be submitted to the staff for review and approval (Unresolved Item URI 88-12-09). Once the as-built conditions have been determined, TVA will reevaluate the stability and deflections of the access cells. The intent is to confirm that the ERCW piping will not be overstressed.

Based on the above, TVA has provided reasonable assurance that the ERCW access cells can withstand the postulated SSE event. This deficiency is closed for restart.

(Closed Restart) Deficiency D4.2-3, Vertical Response Spectra of the Steel Containment Vessel

During the IDI review an issue with the adequacy of the vertical amplified response spectrum for the steel containment was identified. The issue involved the adequacy of the time step used to generate the original vertical response spectra which were used to evaluate piping and equipment. As part of the resolution of this issue, TVA identified two additional structures where the newly generated vertical response spectra exceeded the original response spectra. These structures are the reactor building interior concrete structure and the auxiliary control building. Inspection Report 88-13 discusses the

evaluation of the newly generated response spectra and the effect of these spectra on piping and equipment attached to the steel containment. TVA evaluated the effects of the newly generated spectra on a sample of piping and equipment attached to the interior concrete structure and the auxiliary building. The results of these evaluations are contained in a TVA letter to the NRC (Reference 53). TVA's sample of equipment anchorages included seven of the 60 items that were previously evaluated for IDI Deficiency 4.6-1. These seven were located at the highest elevations of the auxiliary building to evaluate the effects largest spectra changes. The results of these evaluations showed the new spectra had no effect on the anchorage qualification. In addition, TVA evaluated two heat exchangers that had the highest anchorage stresses; the containment spray and the component cooling water heat exchangers. For both cases the new spectra had lower accelerations than the input that was used in the qualification of these components. To evaluate the effects of spectra changes on piping systems, four piping systems were selected for evaluation. The results of these evaluations showed small increase in loads and stresses for the piping systems which did not affect the current qualification of the piping, equipment and supports. Based on the results of these sample evaluations, TVA's evaluation of the spectra changes for the interior concrete structure and the auxiliary building is considerd acceptable for restart. TVA should provide additional evaluations of the remaining piping and equipment as a post-restart effort (Unresolved Item URI 88-12-10).

During the inspection the staff requested that TVA address the staff concern over the impact of the time step on response spectra that had been developed for piping attached to the reactor coolant loop. The response spectra for the reactor coolant loop had been generated by EDS Nuclear, Inc. in January 1974. TVA determined that EDS had used a .01 second time step with an EDS in-house computer program to develop these response spectra. To assess the potential impact of the time step on the reactor coolant loop spectra, TVA selected a sample of four lines attached to the coolant loop. The results of the assessment of these four lines are contained in a TVA letter to the NRC dated March 2, 1988 (Reference 56). This assessment addressed the nozzle attachment points and the first seismic restraint adjacent to each nozzle. The results of this evaluation showed that the nozzle stresses and supports met the allowable limits. Based on the results of these sample evaluations, TVA's evaluation of the potential effects of the time step issue on the reactor coolant loop attached piping is considered acceptable for restart. TVA should provide additional evaluation of the remaining attached piping systems as a post-restart effort (Unresolved Item URI 88-12-10).

(Closed) Deficiency D4.3-7, Vertical Seismic Load on Auxiliary Building Roof Truss

Inspection Report 88-13 discussed the resolution of the concern with the seismic vertical amplification of the auxiliary building roof due to its flexibility. As part of the resolution of this issue, a concern with TVA's use of 2/3 of the horizontal spectra to represent the vertical spectra was

identified. Three Category I structures were identified and reviewed by TVA for this issue. For one building, the diesel generator building, TVA generated a set of new floor response spectra using the 84th percentile site specific response spectra as input ground motion (Reference 54). The new vertical floor response spectra exceeded the original vertical floor response spectra. TVA evaluated the effects of this new spectra on piping systems located in the diesel generator building. This evaluation is contained in TVA calculation, "Evaluation of CAQRS879242, N2-870242-Misc, Revision 1, dated February 25, 1988 (RIMS B25 880226 800). The staff review of stress problem N2-82-3A identified that TVA used interim criteria from CEB-CI-21.89 to qualify hanger 17A586-01-001. The criteria used by TVA for this evaluation involved a modified fatigue evaluation for the secondary load case. This criteria is contained in Section 3.2.8 of CEB-CI-21.89. This criteria was not accepted by the staff for general use unless a case-by-case review and approval was obtained (Reference 51). The staff requested that TVA identify all other cases where similar criteria had been used without staff review and approval. TVA stated that this evaluation had only been used on four typical cases on the diesel generator exhaust lines. TVA used the criteria to evaluate a problem identified with insufficient pipe clearance at a thermal travel stop. The high stress occurred at the welded attachment and according to TVA the loading was one directional and would not result in a full stress reversal during heatup and cooldown. Therefore, TVA stated the application of the modified fatigue evaluation would be conservative. The staff agreed with TVA's statement that a thermal analysis that assumed a full stress reversal would be conservative for this case. However, the staff requested that TVA visually inspect these four diesel generator exhaust support attachments prior to restart for signs of distress. The staff informed TVA that if the results of the inspection did not show damage the post-restart modification of these supports would be acceptable. TVA should document the results of this inspection (Unrevolved Item URI 88-12-11).

The staff's review of the evaluations of the remaining piping systems in the diesel generator building for the new vertical response spectra did not identify any additional problems. Therefore, the piping evaluation performed by TVA for the vertical spectra issue was considered acceptable. This unresolved item is closed.

(Closed) Unresolved Item U3.5-1, Piping Code of Record

Unresolved Item U3.5-1 identified that TVA used stress allowable limits for piping specified in the ASME Code instead of the stress allowable limits in the ANSI B31.1 - 1967 Code that was specified in Table 3.9.2-3 of Sequoyah's FSAR. The B31.1 - 1967 stress limits are generally more conservative than the ASME Code stress limits for stainless steel materials. Review of this unresolved item was transferred to the Office of Special Projects in Inspection Report 87-74. TVA responded to this issue in a letter to the NRC (Reference 49). TVA's response provided an evaluation of the differences between the B31.1 -

7 Code and ASME Section III 1971 through the Winter 1972 Addenda. TVA's aluation concluded that the basic definition of criteria in both codes were dentical and the material requirements were similar. TVA's discussion ttributes the difference between the codes to a change in the definition of yield stress that was picked up by the later (1973) edition of ANSI B31.1.

TVA proposes to revise the FSAR to incorporate allowable stresses from ASME III, 1971 through Winter 1972 Addenda. Since the FSAR criteria used to define the stress allowable equations are based on the ASME Code criteria, the use of the allowable stress limits defined by the ASME Code provides a consistent design basis for piping stresses. Threfore, TVA's proposed FSAR revision is acceptable to the staff. This also resolves the open item URI 4.3.2 in Inspection Report 87-44 relating to the correct code allowable stresses used in the evaluation of small diameter piping for the material control issue. URI 4.3.2 had identified the same issue with code allowable stresses.

1967 Code and ASME Section III 1971 through the Winter 1972 Addenda. TVA's evaluation concluded that the basic definition of criteria in both codes were identical and the material requirements were similar. TVA's discussion attributes the difference between the codes to a change in the definition of yield stress that was picked up by the later (1973) edition of ANSI B31.1.

TVA proposes to revise the FSAR to incorporate allowable stresses from ASME III, 1971 through Winter 1972 Addenda. Since the FSAR criteria used to define the stress allowable equations are based on the ASME Code criteria, the use of the allowable stress limits defined by the ASME Code provides a consistent design basis for piping stresses. Threfore, TVA's proposed FSAR revision is acceptable to the staff. This also resolves the open item URI 4.3.2 in Inspection Report 87-44 relating to the correct code allowable stresses used in the evaluation of small diameter piping for the material control issue. URI 4.3.2 had identified the same issue with code allowable stresses.

APPENDIX D

POST-RESTART UNRESOLVED ITEMS

Unresolved Item URI 88-12-01, Thermal Monitoring of Supports

TVA's use of strain gage measurements to qualify supports 2-H63-2, 2-H63-3, 2-H63-4 and 2H63-5 to the long-term pipe support design criteria SQN-DC-V-24.2 is not acceptable unless TVA performs an evaluation of the entire piping analysis problem to obtain the correct distribution of loads for the qualification of all supports in the analysis. TVA should provide a response which specifies the method used to qualify these four supports to long term criteria.

Unresolved Item URI 88-12-02, Allowable Loads for Standard Component Supports

TVA has specified allowable loads for standard component supports in SQN-DC-V-24.2, Figure I-2 that allows the use of load rating provisions of the ASME Code to establish allowable limits. The staff has accepted the use of these allowable limits for restart (Reference 44) but the staff still has an open issue with TVA's demonstration that these allowable loads meet the Sequoyah FSAR allowable limits.

Unresolved Item URI 88-12-03, DBA ZPA Effects

The staff review of Employee Concerns Element Report 221.2(B) identified that TVA had not followed the recommendations in civil engineering report CEB 80-58 for evaluating ZPA effects on the piping for the containment DBA analysis. TVA addressed this concern for restart by evaluating a sample of five piping systems attached to the containment to demonstrate that restart design criteria were not exceeded. TVA should complete the evaluation of the remaining systems attached to the containment to demonstrate these systems meet the FSAR allowable limits.

Unresolved Item URI 88-12-04, Containment DBA Spectra

TVA requested the use of ASME Code Case N-411 damping for the analysis of piping. The staff accepted the use of this code case for the containment DBA analysis of piping provided the response spectra had been derived on a conservative basis (Reference 34). The staff's review of the containment DBA spectra raised concerns with the uncertainties involved in the analysis used to generate the spectra. TVA's analysis method was considered acceptable for restart. TVA was requested to confirm the adequacy of the double differentiation technique and the adequacy of cutting off the analysis at .9 seconds as post-restart items.

Unresolved Item URI 88-12-05, ERCW Pumphouse

During the review of the ERCW pumping station geophysical logs it was discovered that one of the cores indicated that approximately 7 feet of void exited between the two northern most intake liners. TVA provided an evaluation which was considered acceptable for restart. However, TVA was requested to provide additional evaluations as a post-restart effort.

Unresolved Item URI 88-12-06, Feedwater Waterhammer

During the design calculation review it was identified that TVA had performed an analysis of a waterhammer due to the feedwater check valve closure event but had not formally issued the report. TVA subsequently performed an additional analysis that was considered acceptable to the staff for restart. The staff has not resolved the issue as to the appropriate long-term criteria for this analysis.

Unresolved Item URI 88-12-07, HVAC Duct Support Calculations

CAQR SQT870843 was written by TVA to address concerns that had been identified during the review of regenerated HVAC support calculations. TVA's resolution of the CAQR was to evaluate the five worst case duct systems by computer analysis. The staff found the results of TVA's sample calculations acceptable for restart. TVA used interim criteria in the qualification of these duct supports. The staff considered the sample adequate for restart, however, the staff requests that TVA evaluate an additional sample of HVAC duct supports as a post-restart effort.

Unresolved Item URI 88-12-08, Component Damping Values

During the IDI review of the component cooling water heat exchanger calculation it was identified that TVA was using damping values for component qualification from Regulatory Guide 1.61 instead of the damping values specified in FSAR Table 3.7.1-3 for welded structures. The staff considered TVA's use of current licensing criteria acceptable for restart. However, the staff still considers the issue of appropriate damping values for mechanical components an open post-restart issue.

Unresolved Item URI 88-12-09, ERCW Pumping Station Access Cells

During the IDI review a concern was identified with TVA's assumptions used in the evaluation of the ERCW access cells. TVA performed additional evaluations to demonstrate the adequacy of the access cells for the SSE event. The staff considered the results of these evaluations acceptable for restart. The staff requested that TVA submit an evaluation program to evaluate the stability and

deflections of the access cells using as-built conditions as a post-restart item.

Unresolved Item URI 88-12-10, Seismic Analysis of the Steel Containment Vessel

TVA's review of steel containment vessel vertical response spectra for the time step issue evaluated the effects on a sample of piping systems attached to the affected structures including the reactor coolant loop. These samples were considered adequate for restart. The staff considers that TVA should complete the evaluation of the remaining piping systems as a post-restart item.

Unresolved Item URI 88-12-11, Diesel Generator Exhaust Piping

The staff review of TVA's evaluation of piping in the diesel generator building for the effects of the time step on the seismic response spectra identified that TVA had used interim criteria that had not been reviewed and approved by the staff. The staff considered the use of this criteria acceptable providing TVA visually inspect the affected support attachments on the diesel generator exhaust lines to determine if any damage had occurred. TVA should provide the results of this inspection to the NRC.

APPENDIX E

E.1 ENTRANCE MEETING - FEBRUARY 15, 1988

NAME	ORGANIZATION	TITLE
J. R. Fair	NRC/OSP	Team Leader
T. M. Cheng	NRC/OSP	Team Member
A. I. Unsal	NRC/Consultant	Civil/Structural
Bill Neely	TVA/CEB	Senior Civil Engineer
Jim Rochelle	TVA/CEB	Senior Mechanical Engineer
George Sanders	G/C	Project Engineer
Salah Azzazy	TVA/CEB	Senior Project Engineer
Wayne Massie	TVA/SQN Licensing	Licensing Engineer
Peter Gulko	Bechtel	Technical Specialist
Hubert Nugent	Bechtel	Engineering Supervisor
A. V. duBouchet	NRC/Consultant	Mechanical Components
Owen Mallon	NRC/Consultant	Civil/Structural
Tony Capozzi	TVA/DNE	EA Manager
Carlo Brilliante	TVA/CEB	Senior Mechanical Engineer
David Bogaty	TVA/EA	Civil/EA
L. Raghavan	SWEC	EMD
Terry C. Price	TVA/SQEP	Design Basis Program Manager
Frank E. Denny	TVA/DNE/EA	Senior Engineering Specialist
Roy E. Hoekstra	TVA/SQEP	Principle Civil Engineer
J. C. Key	TVA/SQEP	Assistant Project Engineer
L. A. Budlong	SWEC	Assistant Project Engineer
Jack B. Thomison	TVA/SQEP	Principal Civil Engineer
Alan Perkins	TVA/SQEP	Technical Supervisor
John Lockaby	SWEC	Lead Engineer
Orhan Gurbul	Bechtel	Engineering Specialist
C. N. Johnson	TVA/CEB	Lead Civil Engineer
J. A. Graziano	TVA/CEB	Senior Civil Engineer

Don L. Williams	TVA/DNLRA/ELB	Manager Engineering Licensing
Tom N. C. Tsai	NRC/Consultant	Civil/Structural
Kenneth L. Mogg	TVA/EMG/CEB	Lead Engineer EMG
Karl S. Seidle	TVA/DNE/CEB	Asst. Chief, Civil Engineering
Roy T. Holliday	TVA/DNLRA/ELB	Nuclear Engineer
Fred L. Moreadith	TVA/DNE	Engineering Manager
John K. McCall	TVA/CEB	Chief, Civil Engineering
Robert E. Serb	NRC/Consultant	Mechanical Components
G. Harstead	NRC/Consultant	Civil/Structural

E.2 EXIT MEETING - FEBRUARY 19, 1988

NAME	ORGANIZATION	TITLE
Roy T. Holliday	TVA/DNLRA/ELB	Nuclear Engineer
Daivd H. Level	TVA/DNLRA/ELB	Nuclear Engineer
Bill Roberts	TVA/DNE/CEB	Civil Engineer
Carlo Brillante	TVA/DNE/CEB	Senior Mechanical Engineer
Ken Mogg	TVA/DNE/ CEB	Lead Engineer (EMG)
Wayne A. Massie	TVA/SQN Site Licensing	Licensing
M. J. Ray	TVA/DNLRA	Deputy Director
Don L. Williams	TVA/DNLRA	Manager, Eng. Licensing
James M. Warren	TVA/DNE	Mechanical Engineer
F. L. Moreadith	TVA/DNE	Engineering Manager
L. G. Hersh	BWPC	Chief C/S Engineering
W. S. Tseng	BWPC/SF	Civil/Structural
J. A. Kirkebo	TVA/DNE	DNE Director
D. W. Wilson	TVA/DNE	Chief, NTB
S. E. Gibson	TVA/DNE	Assist to Chief, MEB
L. A. Budlong	SWEC	Asst Project Engineer
J. R. Fair	NRC/OSP	Team Leader
Robert A. Hermann	NRC/OSP	Chief, Engineering Branch
Robert E. Serb	NRC/Consultant	Mechanical Components
A. V. duBouchet	NRC/Consultant	Mechanical Components
A. I. Unsal	NRC/Consultant	Civil/Structural
Gunnar Harstead	NRC/Consultant	Civil/Structural
Thomas M. Cheng	NRC/OSP	Team Member
Tom N. C. Tsai	NRC/Consultant	Civil/Structural
Owen Mallon	NRC/Consultant	Civil/Structural
Karl S. Seidle	TVA	Asst. Ch., Civil Engineering
Ruben O. Hernandez	TVA	Asst. Ch., Civil Engineering
Bill Neely	TVA	Senior Civil Engineer

Joseph A. Graziano	TVA	Senior Civil Engineer
John McCall	TVA	Chief, Civil Engineering
C. N. Johnson	TVA	Lead Civil Engineer
S. E. Azzazy	TVA	Senior Mechanical Engineer
Peter Gulko	Bechtel	Technical Specialist
Roy Hoekstra	TVA	Principle Civil Engineer
Larry A. Katcham	TVA	Principle Engineer
J. C. Key	TVA	Assistant Project Engineer
T. E. Bostrom	Bechtel	Project Engineer Manager
H. S. Nugent	Bechtel	Engineering Supervisor
K. S. Jadeja	TVA	Dep. Ch., Civil Engineer
Frank E. Denny	TVA-EA	Sr. Engineering Specialist
David Bogaty	TVA-EA	Civil Engineer
A. P. Capozzi	TVA	Manager of EA
F. P. Carr	TVA/MEB	Engineering Specialist

E.3 REFERENCES

1. Inspection Report 50-327/86-27 and 50-328/86-27, forwarded by J. Taylor letter dated April 22, 1986.

2. Inspection Report 50-327/86-38 and 50-328/86-38, forwarded by J. Taylor letter dated September 15, 1986.

3. Inspection Report 50-327/86-45 and 50-328/86-45, forwarded by J. Taylor letter dated October 31, 1986.

4. TVA response to Inspection Report 50-327/87-06 and 50-328/87-06 (Domer to NRC) dated July 2, 1987.

5. TVA Response to Inspection Report 86-27 (Gridley to Grace), dated July 28, 1986.

6. TVA revised response to Inspection Report 86-27 (Domer to Grace), dated December 31, 1986.

7. TVA response to Inspection Reports 86-38 and 86-45 (Domer to Taylor), dated February 3, 1987.

8. TVA response to Inspection Report 86-55 and other Inspection Items remaining open (Gridley to Ebneter), dated April 22, 1987.

9. Inspection Report 50-327, 328/86-55, forwarded by J. Taylor letter dated February 3, 1987.

10. Inspection Report 50-327, 328/87-06, forwarded by S. Ebneter letter dated April 8, 1987.

11. TVA Additional Information in Response to Inspection Report 86-27, (Domer to Taylor), dated January 30, 1987.

12. Engineering Assurance Oversight Review Report, "Sequoyah Nuclear Plant Unit 2 Design Baseline and Verification Program, " EA-OR-001, issued April 29, 1987.

13. Sequoyah Nuclear Plant - Design Baseline and Verification Program Unit 2 Phase 1 Report, dated May 29, 1987.

14. Inspection Report 50-327, 328/87-14, forwarded by S. Ebneter letter dated June 4, 1987.

15. TVA response to Inspection Report 50-327, 328/87-14 (Gridley to NRC), dated July 16, 1987.

16. TVA revised response (Observation 5.7) to Inspection Report 50-327, 328/87-14 (Gridley to NRC), dated September 1, 1987.

17. TVA letter relating to control and processing of changes to the punch list (Gridley to NRC), dated August 20, 1987.

18. Inspection Report 50-327, 328/87-27, forwarded by S. Ebneter letter dated August 24, 1987.

19. TVA letter addressing SQN-DNE Design Calculation Efforts (Gridley to NRC), dated July 31, 1987.

20. TVA response to Inspection Report 87-27 (Gridley to NRC), dated October 21, 1987.

21. TVA letter addressing revised commitment date for interface guidelines (Gridley to NRC), dated November 20, 1987.

22. TVA letter is response to findings identified during the final NRC inspection of the DBVP (Gridley to NRC), dated October 27, 1987.

23. Inspection Report 50-327, 328/87-64, forwarded by S. Richardson letter dated February 23, 1988.

24. TVA response (Calculation Program Issues) to Inspection Report 50-327, 328/87-64 (Gridley to NRC), dated January 19, 1988.

25. TVA response (DBVP Issues) to Inspection Report 50-327, 328/87-64 (Gridley to NRC), dated January 20, 1988.

26. Inspection Report 50-327, 328/87-48, forwarded by S. Ebneter letter dated November 6, 1987.

27. TVA response to Inspection Report 50-327, 328/87-48 (White to NRC), dated December 29, 1987.

28. Inspection Report 50-327, 328/87-74, forwarded by S. Richardson letter dated February 22, 1988.

29. TVA response to Inspection Report 50-327, 328/87-74 (Ray to NRC), dated April 21, 1988.

30. Inspection Report 50-327, 328/88-13, forwarded by S. Ebneter letter dated May 26, 1988.

31. TVA letter providing additional information on the Design Calculation Review (Gridley to Keppler), dated July 31, 1987.

32. NRC Trip Report addressing the review of employee concerns (Liaw to Zwolinski), dated November 10, 1987.

33. TVA letter providing additional response (Observation MEB-3) to Inspection Report 50-327,328/87-27 (Gridley to NRC), dated February 18, 1988.

34. NRC Safety Evaluation on ASME Code Case N-411 damping forwarded by letter dated February 8, 1988.

35. TVA letter providing additional information on conduit and HVAC duct support calculations (Gridley to NRC), dated March 2, 1988.

36. TVA letter providing additional information on the Essential Raw Cooling Water (ERCW) Pumping Station concrete (Gridley to NRC), dated March 3, 1988.

37. TVA letter providing additional information on the Essential Raw Cooling Water (ERCW) Pumping Station concrete (Gridley to NRC), dated March 2, 1988.

38. TVA letter providing a supplemental response to IDI item D4.2-1 (Ray to NRC), dated March 2, 1988.

39. TVA letter providing additional inforamtion on piping support design criteria (Gridley to NRC), dated March 2, 1988.

40. TVA letter, "Effect of Zero Period Acceleration (ZPA) on piping during the design basis accident (DBA)" (Gridley to NRC), dated March 2, 1988.

41. TVA letter providing additional information on swing angle allowables, design basis accident spectra and U-bolt allowables (Gridley to NRC), dated March 2, 1988.

42. TVA letter providing additional information on the effect of square root of the sum of the square (SRSS) versus absolute sum (ABS) (Gridley to NRC), dated March 2, 1988.

43. TVA letter "Sequoyah Nuclear Plant (SQN) - NRC Commitments" (Gridley to NRC), dated February 29, 1988.

44. NUREG-1232, Volume 2, "Safety Evaluation Report on Tennessee Valley Authority: Sequoyah Nuclear Performance Plan," dated May 1988.

45. TVA Letter addressing the regeneration of pipe support calculations (Gridley to NRC), dated August 21, 1987.

46. NRC Safety Evaluation on Regulatory Guide 1.47 forwarded by letter dated June 2, 1987.

47. NRC letter requesting additional information on anchor point movement loads (Youngblood to White), dated September 29, 1986.

48. TVA response to the NRC request for additional information on anchor point movements (Gridley to NRC), dated October 31, 1986.

49. TVA letter providing a revised response for IDI item U3.5-1 (Ray to NRC), dated March 2, 1988.

50. TVA letter on the regeneration of Sequoyah Unit 2 pipe support calculations (Gridley to NRC), dated August 21, 1987.

51. NRC Meeting Summary on pipe support criteria dated September 4, 1987.

52. TVA letter providing supplemental information on the Sequoyah Unit 2 pipe support restart criteria (Gridley to NRC), dated November 17, 1987.

53. TVA letter providing additional information on IDI item D4.2-3 (Ray to NRC), dated March 2, 1988.

54. TVA letter providing additional information on IDI Item D4.3-7 (Ray to NRC), dated March 2, 1988.

55. NRC letter on damping values for analysis of conduits (Zech to White), dated February 18, 1988.

56. TVA letter providing additional information on the effect of the time step concern on the RCL spectra (Gridley to NRC), dated March 2, 1988.