U.S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

DIVISION OF REACTOR INSPECTION AND SAFEGUARDS

SPECIAL INSPECTION BRANCH

Report No.: 50-327/88-13 and 50-328/88-13
Docket No.: 50-327/328
Licensee: Tennessee Valley Authority
Facility Name: Sequoyah Nuclear Plant, Unit 2
Inspection At: TVA - Office of Nuclear Power, Chattanooga, TN
TVA - Division of Nuclear Engineering, Knoxville, TN
Sequoyah Nuclear Plant, Soddy Daisy, TN
Inspection Conducted: February 1-5, February 15-19, 1988
Inspection Team Members:

Team Leader	*E. V. Imbro, Section Chief, SIB/NRR
Mechanical Systems	*J. R. Houghton, Consultant, Hougnton Engineering
Mechanical Components	A. V. duBouchet, Consultant
	*V. P. Ferrarini, Consultant, EAS, Inc.
	*R. J. Masterson, Consultant, EAS, Inc.
Civil-Structural	T. M. Cheng, Structural Engineer, EB/OSP
	A. I. Unsal, Consultant, Harstead Engineering Associates, Inc.
	G. A. Harstead, Consultant, Harstead Engineering Associates, Inc.
	O. P. Mallon, Consultant, Gibbs and Hill, Inc.
Instrumentation and Control	*J. M. Leivo, Consultant, J. M. Leivo Associates
Electrical Power	*R. H. McFadden, Consultant, Science Applications International Corporation

Approved By: E. V. Imbro 5/5/88
Eugene V. Imbro, Chief
Team Inspection Appraisal and
Development Section 2
IDI Team Leader

*Personnel attenaing February 1-5, 1988

8806150024 880526
PDR ADOCK 05000327
Q PDR

SEQUOYAH NUCLEAR POWER PLANT

INTEGRATED DESIGN INSPECTION FOLLOWUP

INSPECTION REPORT 50-327/88-13 AND 50-328/88-13

1.0 INTRODUCTION AND BACKGROUND

The NRC conducted an Integrated Design Inspection (IDI) of the Sequoyah Unit 2 power plant between July 8 and September 11, 1987. The inspection report for this effort (50-327/87-48 and 50-328/87-48) was issued on November 6, 1987.

The major programmatic weakness discovered by the IDI team related to the technical adequacy of the structural calculations for safety-related buildings. The team noted fundamental omissions in structural calculations wherein certain design loads and design conditions were not considered. In addition, the IDI team found many cases where calculational assumptions had no factual basis when compared to the actual plant design. The team also found many nonconservative discrepancies between the analyzed configuration of the equipment supports and that shown on the detailed support drawings. Further, the IDI team found problems with the design of reinforced concrete, regarding the placement of reinforcing steel, and the seismic analysis of the steel containment vessel (SCV). As a result of the above concerns regarding the adequacy of the structural calculations, the IDI team could not reach a conclusion regarding the structural adequacy of the plant to withstand design basis events based on the calculations available for review during the inspection.

Another inspection was conducted prior to the receipt of TVA's formal response to the IDI report in order that the team could review additional information, related to the teams concerns regarding the technical adequacy of civil/ structural calculations, that was unavailable during the inspection. In addition, TVA stated that a substantial amount of the corrective action related to the IDI findings was already completed, therefore, the NRC felt this early inspection would expedite the closure of the IDI findings. The results of this inspection are documented in Inspection Report 50-327/87-74 and 50-328/87-74 issued February 22, 1988. As a result of this inspection, the team concluded that TVA did not need to conduct a broad scope generic review to assess the adequacy of the structural design.

2.0 PURPOSE

As a result of the inspection documented in report 50-327/87-74 and 50-328/87-74 the team was able to close 18 of the IDI findings. However, the majority of the IDI findings remained open because in most instances the corrective actions were not finalized by TVA. The purpose of this inspection was to review TVA's corrective action to the remaining IDI findings. These corrective actions were documented in a letter from TVA, Steven A. White to NRC, Stewart D. Ebneter, dated December 29, 1987.

3.0 SUMMARY OF FINDINGS

During the inspection conducted from November 2-10, 1987, the team requested that in certain specific areas TVA perform additional generic reviews prior to restart to assess equipment supports, minimum percentage of reinforcement steel in walls, vertical seismic loads, and the 274 retrieved shear calculations. The team also requested that TVA regenerate all missing calculations for both reinforced and unreinforced masonry walls prior to restart. The team's review of these items is summarized below, and the detailed evaluations are documented in Appendix A of this report in the team's evaluation of TVA's corrective action in response to the specific IDI finding.

In response to the team's concern regarding the adequacy of equipment supports, TVA classified the equipment at Sequoyah into three categories, namely; heat exchangers, tanks, other equipment. TVA has reanalyzed 11 seismic Category I heat exchangers and their supports against as-built information that was obtained from walkdowns. The team reviewed the reanalyses of two heat exchangers, the component cooling water heat exchanger and the containment spray heat exchanger and found these calculations to be acceptable. TVA also reviewed tank anchorages for 12 Category I tanks and found them to be adequate. The NRC team reviewed samples of these calculations (B25 871104 455). This review by NRC is covered under IDI Deficiency D4.6-2. TVA also selected 60 other component supports (including pumps, electrical equipment, etc.) and compared the information in calculations and on drawings with as-built data obtained from walkdowns to determine whether discrepancies exist.

The evaluations of the 60 component supports were performed in two stages. First, support loads were gathered from available vendor information. If such information could not be located, then additional analyses were performed to obtain the support loads. In the second stage, the 60 component supports were analyzed using the previously obtained support loads. The team selected six components and performed a review of the calculations involving both stages of this TVA evaluation. These reviews are discussed in more detail in IDI Deficiency D4.6-1. However, the team concluded, based on its review of the TVA analysis that no generic concern exists relating to the design of equipment supports.

Regarding the team's generic concern with respect to TVA's placement of the minimum percentage of reinforcing steel in walls in seismic Category I buildings, TVA performed a review of the calculations for structural slabs and walls in the auxiliary building, reactor building, ERCW pumping station and control building. As a result of this review, TVA performed additional calculations which show that the requirements of the ACI 318-63 Code are met. These additional reviews and calculations resolve the team's generic concern in this area. This is discussed in more detail under IDI Deficiency 4.3-6.

During the IDI, the team raised a generic concern regarding TVA's use of vertical accelerations equal to 2/3 of the accelerations obtained from the horizontal amplified response spectra rather than developing vertical amplified response spectra. In the generic reviews performed to resolve this deficiency, TVA found that 2/3 of the horizontal amplified response spectra was used as the vertical input for three Category I structures; the condensate demineralizer waste evaporator (CDWE) building, the emergency raw cooling water (ERCW) pumping station and the diesel generator (DG) building. This was shown to be acceptable for CDWE building and the ERCW pumping station, however, TVA evaluations for the DG building have shown that 2/3 of the horizontal amplified response spectra did not envelope the calculated vertical amplified response spectra. TVA was required to perform additional evaluations to show that safety-related equipment and piping located in the diesel generator building will meet the interim evaluation criteria during and after an SSE, considering the higher vertical amplified response spectra. These evaluations showed that the piping (including supports) can withstand the new seismic loads and that safety-related equipment would remain functional during and after an SSE. The team's generic concerns have been adequately resolved. This issue is discussed in more detail under IDI Deficiency D4.3-7.

During the November 2-10, 1987 inspection, the team requested that TVA review a sample of 274 shear calculations for structural elements such as walls and slabs, retrieved by TVA. TVA selected 30 sample elements to determine whether the shear calculations were performed in accordance with the ACI 318-63 Code requirements. The team reviewed the revised TVA Calculation B25 880118 451, which showed that in some of the original design calculations higher shear stress allowables were used than those required by the ACI 318-63 Code. However, additional analyses performed by TVA show that all shear stresses were within the code allowables. The team has no further concerns in this area. This is discussed in more detail under IDI Deficiency [illegible]-5.

TVA was also requested by the IDI team to regenerate all missing calculations for both reinforced and unreinforced masonry block walls prior to restart. TVA, in a letter dated March 2, 1988 (L44 880302 817), submitted the finalized calculations for the nine critical reinforced masonry walls. The review of these calculations (B25 880227 311 through B25 880227 314) showed that all the nine walls meet the allowable stress requirements for the SSE and tornado depressurization load combinations as shown in the NRC criteria. However, four walls failed to meet the allowable stresses for the OBE load combination specified in the NRC criteria. This evaluation is acceptable to the team for the restart, however. further evaluations or modifications are necessary so that all reinforced masonry walls meet the NRC criteria for long term operation. In response to the team's request, TVA committed in their March 2, 1988 letter to further evaluate post-restart, reinforced masonry walls that did not meet the NRC allowable stresses for the OBE load combination to ensure compliance with the NRC criteria. The team found this acceptable, since the walls were adequately designed to withstand the SSE and tornado depressurization loads. These loads represent the "worst-case" from a structural adequacy point of view.

The team also reviewed TVA calculations B25 880217 300, which include the evaluation for unreinforced masonry walls in accordance with the NRC criteria. The unreinforced masonry walls at Sequoyah Unit 2 are not seismic Category I walls since they are not load bearing and do not have any safety-related equipment or piping attached to them. The review of the above mentioned calculations showed that the unreinforced masonry walls will not collapse during extreme environmental and abnormal load conditions and therefore, will not jeopardize any safety-related equipment. The IDI team concluded that the reinforced and unreinforced masonry walls were acceptable for restart. This is further discussed under IDI Deficiency 4.3-9.

Another concern of the IDI team was that TVA had not performed an adequate review of vendor seismic qualification documents. In response to this concern, TVA established and implemented a comprehensive program to review a specified number of seismic qualification reports for compliance with their respective procurement document requirements prior to restart of Unit 2. In order to provide an acceptable breadth of review, TVA chose as their sample forty (40) seismic qualifications encompassing the following scope of safety-related equipment; air handling units, heat exchangers, pumps, valves, tanks and dampers. This review verified that the examined components are seismically qualified as specified in the procurement documents. Based on this sample, the team was able to gain sufficient confidence to conclude that there does not appear to be a generic problem with seismic qualification of components not being in accordance with their procurement documents. This is discussed in more detail under IDI Deficiency 3.6-1.

The IDI team reviewed TVA's corrective actions taken to prevent recurrence of specifying appropriate system design pressure. The team reviewed the following TVA documents; NEP-4.1, MEB-AI-17, and MEB-I-23.2. These are discussed below:

NEP-4.1, Revision 0, established that for procurement specifications, approved DNE standard specifications shall be used to the maximum extent possible.

MEB-AI-17, Revision 1, dated November 6, 1987, was issued to (1) provide control of changes to system design pressures and temperatures; (2) include requirements in standard specifications that design pressures and temperatures be specified at all system and component interfaces; and (3) require a table of system design conditions to be provided in all new or revised system design criteria.

MEB-I-23.2, Revision 2, dated November 6, 1987, was issued to establish requirements for system design temperature and pressure and abnormal system pressure as additions to the Design Calculations checklists.

These revisions to TVA procedures and instructions were determined by the IDI team as adequate assurance that design pressure and abnormal pressure have been included in the TVA Design Control program. Further discussion on ERCW design pressure can be found under IDI Deficiency 2.2-1.

Appendix A to this report summarizes each of the IDI findings that remained open following inspection 50-327/87-74 and 50-328/87-74 and indicates their status. The summary of each finding is self-sufficient in that it contains a description of the concern, the TVA corrective actions performed in response to the finding and the action taken by the IDI team to achieve closure. Therefore, it should not be necessary for the reader to refer to the previous NRC reports (50-327,328/87-74 and -48) to gain an understanding of the findings. In order to accomplish this objective, it was necessary to include information contained in the previous NRC reports.

Appendix B lists the persons contacted during this inspection.

4.0 PROGRAMMATIC FINDINGS AND GENERAL OBSERVATIONS

During the IDI exit meeting on September 11, 1987, the team identified programmatic concerns and made several general observations that were again re-emphasized in an NRC letter to Steven A. White (TVA) from Stewart D. Ebneter (NRC) dated November 6, 1987. In TVA's response to the IDI report dated December 29, 1987, Enclosure 2 separately addressed these items. Since the programmatic concerns relate to specific IDI findings, they are addressed by the IDI team as part of the resolution of that finding. The summary of each finding includes an assessment of TVA's corrective actions to generic implications as well as the specific deficiency cited. For example, programmatic concerns on the adequacy of TVA's review of vendor seismic qualification documentation or fluid system design pressure are addressed under Deficiencies D3.6-1 and D2.2-1, respectively, etc.

Several general observations were made by the IDI team that did not relate to specific findings but rather, resulted from a collective review of nature of the IDI findings. The IDI teams evaluation of TVA's response to these items is presented below.

Lack of Timely Implementation of Changes to Operating Procedures Resulting from Design Changes

In Enclosure 2 of the TVA response to the IDI, dated December 29, 1987, TVA identified positive actions taken to address the observed weakness in the engineering/plant interface (i.e., "temporary" changes not reflected in approved plant procedures, etc.). The seven actions listed by TVA to mitigate this concern included: implementation of programmatic changes in the design control process that improve both the engineering control and responsiveness to plant needs; enhancement of the DNE and Plant Operations Review Staff (PORS) interface; establishment of a DNE/Operations multidiscipline integrated systems engineering team; establishing DNE in an advisory role for the Plant Operations Review Committee (PORC); multidiscipline engineering coverage for plant evening shift activities; enhanced Operations and DNE management attention to team actions with improved communications between personnel; and multidiscipline engineering support and interactions in daily "War Room" meetings in support of modifications and maintenance activities supporting restart. The IDI team considers these corrective actions as a positive step to strengthen communications between the TVA design and operating personnel.

Lack of Timely Corrective Action

TVA addressed the apparent lack of timely corrective action in the Division of Nuclear Engineering (DNE) by establishing a controlled and standardized corrective action program with scheduled resolution and tracking for CAQs in the Tracking and Reporting of Open Items (TROI) system. In addition, TVA management has taken the following actions to increase overall management involvement in the CAQ resolution process; (1) escalation of CAQs to higher levels of management, if not resolved within procedure mandated timeframes; and (2) giving Engineering Assurance (EA) the responsibility to evaluate potentially generic concerns involving DNE organizations in a timely manner.

The IDI team considers these corrective actions responsive to this programmatic concern. This problem is one that TVA has been aware of for some time, since it was addressed in Volume 1 of the Nuclear Performance Plan. Apparently, problems with lack of timely corrective actions still exist at TVA, however, increased management involvement in the CAQ process should be an aid in correcting this programmatic weaknesses.

Lack of System Integration

TVA addressed the need to improve system engineering to assure multidiscipline interaction among design disciplines and plant organizations. TVA indicated that such a program is being developed and has made a commitment, CCTS NCO-87-0361-070 to fully update and transmit this "System Engineering" program to the NRC by April 1, 1988.

The IDI team considers this corrective action responsive to this programmatic concern. In particular, the team supports TVA's concept of the establishment of the discipline staffed systems engineering specialist in each technical branch to provide a systems integration review function.

Perceived Weakness in the Design Verification Process

TVA has provided the corrective action to ensure the technical adequacy of essential calculations in Volume 2 of the Nuclear Performance Plan. TVA feels that these programs provide the needed assurance for design changes and supporting calculations for restart. Programmatic improvements have been made by the issuance of reviewed procedures and instructions for the generation of calculations and for controlling changes to design documentation. The IDI team considers these corrective actions to be responsive to the programmatic concern.

In summary, the IDI team considers that TVA has taken responsible corrective actions to alleviate the above programmatic concerns. However, it is not possible to assess the effectiveness of these procedural and organizational changes at this time. The impact of these changes depends largely on their diligent implementation by TVA and can only be assessed after they have been in-place for a sufficient period of time. The IDI team recommends that the TVA management periodically assess the team's programmatic concerns to assure themselves that the corrective actions are being properly implemented and more importantly, are producing the desired end result.

APPENDIX A

MECHANICAL SYSTEMS

(Closed) Deficiency D2.2-1, Design Pressure of ERCW System

This deficiency documented the difference between the FSAR stated system pressure of 160 psig and the 150 psig rated pressure of components and piping.

TVA's justification for the lower design pressure relied solely on administrative control. The administrative control consisted of operationally limiting the ERCW pump discharge pressure to 124 psig which, as determined by dynamic flow calculations, limits the maximum pressure to 150 psig at system low points. The IDI team identified inconsistencies/nonconservatisms in this approach in that equipment outages due to maintenance were not considered; maximum plant flood level was not considered, the present system design pressure is 160 psig, therefore, components within the ERCW system that are rated at 150 psig are below the system design pressure of 160 psig; and the code-of-record, ANSI B31.1 - 1967, does not permit lowering the design pressure by relying on pressure reducing devices without providing relief valves.

The TVA response identified isolation of equipment and maximum flood level as abnormal conditions and provided a new calculation for abnormal conditions, using pump discharge pressure limited to 124 psig. This calculation established a maximum abnormal pressure of 175 psig at the system low point.

The IDI team agreed that this design pressure concern for piping and components under abnormal conditions would be resolved if TVA could provide assurance that the allowable stresses in piping and components are not exceeded. For piping, (ANSI B31.1), TVA performed a calculation which demonstrated that the entire ERCW system could safely withstand system pressures exceeding at least 245 psig. Since the maximum abnormal pressure was established by TVA to be 175 psig, the IDI team considered the piping to be acceptable. Components built to ASME Section VIII and manufacturer's standards whose maximum abnormal pressure exceeds the design pressure of 150 psig, would be considered acceptable if a stress analysis using the maximum abnormal pressure, performed by a TVA Professional Engineer (PE) and checked by an independent third party inspector, demonstrates that allowable stresses are not exceeded. Vendor certification that the components will withstand the higher pressure within allowable stresses was also requested. TVA was also requested to issue ECN L 7125 to lower the system design pressure to 150 psig. Limiting the ERCW pump discharge pressure to the TVA established value of 124 psig (see Deficiency D2.2-2) will provide additional assurance that the design pressure will not be exceeded.

TVA's generic review identified similar problems for the raw service water system, the chemical and volume control system, and the component cooling water system where components were verified to be incompatible with the system design pressure. The IDI team established that as part of their generic review, TVA failed to recognize the need for a relief valve downstream of a pressure reducing valve for the power stores air conditioning unit. Consequently, the IDI team requested that TVA re-review all components that rely solely on pressure reducing devices to provide overpressure protection. Additionally, TVA was requested to identify the new administrative controls that are in place to avoid similar problems in the future.

TVA was requested to confirm the following corrective actions are completed:

1. Assure by calculations (TVA PE; consultant PE) with third party verification and through vendor certification documents that components are adequately designed to withstand abnormal pressure of 175 psig (or lower pressure applicable to specific location/elevation of coolers).

2. Issue ECN L 7125 to lower ERCW System Design Pressure from 160 psig to 150 psig, including revision of applicable flow diagrams, calculations, design criteria, etc.

3. Review design pressure for other systems and components.

The IDI team reviewed corrective actions taken by TVA to address the team's concerns regarding design pressure.

TVA's Corporate Commitment Tracking System (CCTS) identified that TVA would perform stress calculations, with third party verification, for the Electric Board Room (EBR) Air Conditioning Unit coolers and the Shutdown Board Room (SBR) Air Conditioning Unit coolers to verify that the abnormal pressures are within the maximum allowable working pressure prior to Unit 2 restart. TVA performed these calculations with third party verification. The IDI team reviewed the third party verification and accepted this item as resolved.

ECN L 7125 was included in the CCTS as a design change required to lower ERCW System design pressure to 150 psig prior to Unit 2 restart. The IDI team reviewed the approved ECN and determined that it properly resolved this item.

In order to assure proper design pressure for the Centrifugal Charging Pump gear oil cooler, TVA replaced the cast iron head with one of higher rating. This design change, included in the CCTS and implemented by DCN X0076A, was reviewed by the team and found to be acceptable.

TVA prepared a draft revision to Design Criteria document SQN-DC-V-7.4 (Revision 3) to identify design pressure in ERCW System as 150 psig, except as noted and included the revision in the CCTS. The team reviewed the draft document and determined that these changes were consistent with the system design and appropriate.

The IDI team reviewed TVA's generic corrective actions related to system and component design pressure. The team noted that TVA had revised the initial PIR for the Power Stores Air Conditioning Unit included the need to provide a relief device. This PIR, together with PIRs written as part of TVA's initial generic review are included in TVA's TROI tracking system. The PIRs are applicable to non-safety-related systems or non-safety-related portions of the safety-related systems supplied by the ERCW System and are considered as post-restart items. The IDI team agrees with this assessment.

In TVA's letter on "IDI Generic Reviews for Design Pressure Concerns" (S. M. Jackson to R. E. Daniels, dated February 3, 1987), TVA summarized two generic reviews that were performed to address systems other than ERCW, applicable to the design pressure concern. The reviews performed were for improper component design ratings and improper use of pressure control valves or manual throttling valves for design pressure control. The review indicated that for safety-related systems, components were adequately protected or the system design was compatible. For non-safety-related systems, four PIR's were identified and included in the TROI tracking system.

The IDI team concluded from a review of the above documentation that TVA has adequately addressed the generic concerns with this deficiency.

The IDI team reviewed TVA's corrective actions taken to prevent recurrence of specifying appropriate system design pressure. The team reviewed the following TVA documents; NEP-4.1, MEB-AI-17, and MEB-I-23.2. These are discussed below.

NEP-4.1, Revision 0, established that for procurement specifications, approved DNE standard specifications shall be used to the maximum extent possible.

MEB-AI 17, Revision 1, dated November 6, 1987, was issued to (1) provide control of changes to system design pressures and temperatures; (2) include requirements in standard specifications that design pressures and temperatures be specified at all system and component interfaces; and (3) require a table of system design conditions to be provided in all new or revised system design criteria.

MEB-I 23.2, Revision 2, dated November 6, 1987, was issued to establish requirements for system design temperature and pressure and abnormal system pressure as additions to the Design Calculations checklists.

These revisions to TVA procedures and instructions were determined by the IDI team as adequate assurance that design pressure and abnormal pressure have been included in the TVA Design Control program. Therefore, the specific, generic, and programmatic corrective actions taken by TVA are considered as acceptable resolution to the IDI team's concerns relative to design pressure and this deficiency is closed.

(Closed) Deficiency D2.2-3, <u>Overpressurization of Auxiliary Air Compressor Coolers</u>

This deficiency identified the design pressures of components in the safety-related auxiliary air compressors (cylinder water jacket cooler and aftercooler) as being substantially lower than the ERCW system design pressure. The piping code of record, ANSI B31.1 - 1967, requires overpressure protection via relief devices where pressure reducing valves are used and system re-rating to the higher pressure has not been accomplished. TVA relied on pressure reducing valves only.

The TVA response identified use of compressor inlet valves to throttle flow and reduce pressure, with valve positions verified periodically by surveillance. They also committed to providing relief valves to prevent overpressurization of the components.

The IDI team reviewed several documents and calculations issued by TVA subsequent to the initial IDI team inspection, applicable to closure of this deficiency, as well as the procedure for throttling flow to the auxiliary air compressor. TVA issued ECN L 7297 to relocate and replace solenoid valves upstream of the compressors to provide a lower flow that was determined by TVA calculation as being necessary to meet relief valve capacity requirements. The solenoid valve, when wide open is an effective flow restriction, thus allowing use of a relief valve with lower rated capacity. The IDI team reviewed the calculation and found it acceptable. Further, the ECN includes the addition of relief valves (one for each compressor) with a set pressure of 75 psig and a capacity in accordance with the aforementioned TVA calculation to prevent overpressurization of components.

The calculations were based on the assumption that the design pressure for normal operation is 150 psig (see Deficiency D2.2-1) and that the cylinder jacket cooler design is 75 psig, not 67 psig as initially identified by TVA. For the latter, TVA has obtained vendor information concurring with the higher (75 psig) design pressure. This has been reviewed as a part of the reinspection of this deficiency by the IDI team and found acceptable. The use of 150 psig design pressure, as modified for higher elevation, resulted in a lower dynamic pressure for use in sizing relief valve capacity. The IDI team found the calculations and assumptions on which this lower pressure was based to be acceptable.

The IDI team reviewed the issued ECN L7297 design package and confirmed the installation of the relief valves during onsite inspection. Further, the team review of the TVA Design Criteria SQN-DC-V-7.4, Revision 3, identified inclusion of the pressure for this portion of the ERCW system as 75 psig (i.e., the relief valve setpoint). Therefore, this deficiency is closed.

(Closed) Deficiency D2.2-4, Overpressurization of Station Air Compressor Coolers

This deficiency was based on design pressures of components in the non-safety-related station air compressors (cylinder water jacket cooler and intercooler) identified as lower than ERCW system pressure. This deficiency is similar to D2.2-3 in that the code of record, ANSI B31.1 - 1967, requires overpressure protection via relief devices where pressure reducing valves are used and system re-rating to higher pressure has not been accomplished. TVA relied on pressure reducing valves only.

The TVA response included the assumption of a critical crack in the nonseismic station air compressor piping with detection and manual break isolation. From this TVA concluded the performance of safety-related "areas" (ERCW system) would not be affected. TVA also identified that they would throttle flow to reduce pressure and a provision to add relief valves would be made prior to restart.

The IDI team reviewed several documents and calculations issued by TVA subsequent to the initial IDI team inspection, applicable to closure of this deficiency. ECN L 7294B was issued to install relief valves (one for each compressor) with set pressure of 75 psig and a capacity in accordance with TVA calculation for relief valve capacity sizing to prevent overpressurization of components. The basis for use of "critical crack" in the calculation was questioned by the IDI team, both as a valid assumption to allow a critical crack in non-seismic piping in a non-seismic building (see Deficiency D2.2-5) and for applicability in sizing relief valve capacity during normal operating conditions.

The initial calculation, using the critical crack flow resulted in a lower capacity requirement, allowing the TVA selected relief valve to meet these requirements. Using the system design pressure of 150 psig, corrected for elevation and dynamic conditions and assuming complete severance of the pipe in lieu of the critical crack, TVA revised the calculation and committed to using a larger size relief valve to accommodate the increased capacity.

TVA obtained vendor information concurring with higher (75 psig) design pressure for the cylinder jacket water cooler (formerly 67 psig) and intercooler (formerly 50 psig), such that the relief valve setting of 75 psig is acceptable. The IDI team reviewed this memorandum and found this determination acceptable.

The IDI team reviewed the issued ECN L7294 design package and confirmed the installation of the relief valves during onsite inspection. Further, the team review of TVA Design Criteria SQN-DC-V-7.4, Revision 3, identified inclusion of the pressure for this portion of the ERCW system pressure as 75 psig (i.e., the relief valve setpoint). Therefore, this deficiency is closed.

(Closed) Deficiency D2.2-5, Evaluation of Failure of ERCW Non-Seismic Piping

This deficiency identified the lack of an evaluation of the consequences of failure of the non-seismically designed piping on the operability of the safety-related portion of the ERCW system. Specifically, TVA did not adequately justify that the safety-related portion of the ERCW system would receive the necessary cooling during the time period it takes the operator to isolate the non-seismic portion following a postulated double-ended guillotine rupture in the ERCW non-seismically designed piping.

TVA's October 29, 1987 response indicated that a seismic evaluation had been performed on the associated piping based on historical earthquake experience and concluded that no conditions have been identified which can lead to a credible failure that would result in a guillotine break of the piping. The IDI team did not accept this response since no quantitative analysis was performed to demonstrate that the subject non-seismic piping which is located in a non-seismic Category I building (i.e., turbine building) would not incur a guillotine break following the design basis seismic event. Also, the IDI team did not accept TVA's analysis which postulated a critical crack in lieu of the double-ended guillotine break, since a justified basis for the assumption was not presented. As a consequence, TVA committed to provide automatic isolation of the non-seismic ERCW piping to the station air compressors. The team requested that these valves be installed and functional prior to restart.

The IDI team reviewed the TVA issued DCN X00113A design change document which provides automatic closure for the isolation valves to the Station Air Compressors on a coincident high flow and low pressure signal. The team determined that the setpoints for both flow and pressure were conservative and acceptable. The team also reviewed the draft change to FSAR Section 9.2.2, as modified by TVA memorandum dated February 3, 1988, and found the description of automatic closure and for detection of smaller flowrate associated with a crack (whereupon manual action would be taken for isolation) as acceptable. The commitment to make the FSAR change was included in the CCTS.

Generically, TVA had committed in their October 29, 1987 response to the IDI restart items to perform a review of safety and non-safety related system interfaces. TVA has completed that review and the results are documented in a memorandum from J. E. Pilgrim to R. E. Daniels dated October 22, 1987. Therefore, TVA is requested to provide, prior to restart, a confirmatory letter to the NRC documenting that all associated corrective actions have been implemented or provide a justification for not doing so.

Although the installation of the automatic isolation had not been fully implemented during the follow-on inspection, TVA confirmed in their letter to NRC dated April 21, 1988 (L44 880421 805), that the automatic isolation is installed and is functional. The IDI team verified that the systems design considerations have been appropriately considered, therefore, this deficiency is considered closed.

(Closed) Deficiency D2.2-6, Inadequate Procedure for Determination of Safety Class Boundaries for Fluid Systems

This deficiency identified the lack of a TVA procedure for determining suitable boundaries (safety class breaks) between system quality group classifications (TVA Classes) when transitioning from a higher class to a lower class. Several examples of inappropriate boundaries were identified by the IDI team.

The TVA response indicated that the experience of the engineers was relied on along w... limited data available at the time of the original SQN design for class boundaries. They also indicated that current practice in the design of class boundaries had not resulted in any situations which could have a significant impact on the safe operation of the plant as presently designed.

TVA further committed to some drawing clarification related to flow diagrams for the ERCW interfaces with the ice condenser RCW supply and AERCW and CCW pumping station (two examples of those identified by the IDI team). In addition, TVA committed to perform a survey of other AE's to determine methods used for plants of SQN's vintage and those currently used, with a commitment to follow current industry practices for any future design changes. TVA also committed to review other class break boundary interfaces between safety and non-safety-related systems and examine the application of single failure criteria to these interfaces. Lastly, TVA committed to perform a generic review to identify deficiencies at all TVA nuclear plants if the AE survey identifies inadequacies in TVA practice of designing class breaks.

The IDI team reviewed the TVA response and in particular the specific response to the three examples included in the deficiency with the following determination:

1. Example 1, Class Break at Piping Anchored at Auxiliary-Turbine Building Wall

The class break is acceptable since the system boundary was not adversely affected. However, it is an example of why a specific procedure/criteria is necessary. In addition, use of the wall as the class break in lieu of at the downstream end of the isolation valve added a level of confusion to the determination of the interface between the safety-related and nonsafety-related, non-seismically designed portions of the ERCW system.

2. Example 2, Class Break at ERCW System With Raw Cooling Water (RCW) Supply to Ice Condensers

The location of safety class boundary shifts from the flanged closure beyond the manual valve to the downstream side of the manual valve when the spool piece is connected (not as shown in the response). With the safety class break at the valve, normally TVA, by FSAR commitment, would be required to seismically qualify piping through the first seismic restraint beyond the defined boundary such as a valve. This however was not done in this situation because the spool piece connecting the safety and non-safety-related piping is only installed during a design basis flood.

However, as a seismic event is not postulated after a design basis flood and a conservative approach by TVA to postulate a critical crack and calculate its effects was performed, the approach is acceptable. Again, as in Example 1, this is another example of why a specific procedure/criteria is necessary. Although this turned out to be an acceptable configuration it is not clear that this was considered in the original plant design.

3. <u>Example 3</u>, Class Break Between ERCW System Piping and AERCW and CCW Pumping Station

The TVA resolution to identify class breaks at these interfaces is acceptable. However, these obsolete systems have been erroneously classified as safety-related since startup of SQN-2. The example, therefore, is applicable to any present or future system safety class downgrades and reinforces the need for a procedure/criteria.

The IDI team agreed with the TVA response with regard to the survey of industry practice and the commitment to follow current industry practice for future design. However, the team requested that TVA develop criteria to address the design provisions necessary to transition between safety classes in accordance with the requirements of 10 CFR 50 Appendix B relating to design control.

The IDI team determined that TVA has included in the CCTS commitments to perform the following corrective actions: (1) declassification of AERCW and CCW through flow diagram revision (with component classification change included in design criteria); (2) survey industry practices regarding specification of safety-class interface criteria and generation of TVA guides or procedures following the survey, and perform a generic review of safety class boundaries on all TVA plants and document any deficiencies by the CAQR process; and (3) clarify the class break boundary connection for ERCW supply to Ice Condenser chiller packages during flood mode on flow diagram. These items are scheduled as post-restart with completion by June 1, 1988.

The IDI team determined the above corrective actions to be acceptable and this deficiency is closed.

(Closed) Deficiency D2.2-8, <u>ERCW Supply Temperature Limitation</u>

This deficiency identified a statement in the Design Criteria document for the ERCW System (SQN-DC-V-7.4) that implied the plant could be operated at a reduced power level when the ERCW inlet temperature is in excess of the Technical Specification limit of 83°F. The TVA response identified a revision to the design criteria limiting the temperature to Technical Specification limit.

The IDI team reviewed the draft revision (Revision 3) to design criteria SQN-DC-V-7.4 and considered the reference to Technical Specification limits acceptable. The team further reviewed the CCTS commitment to issue the design criteria revision by April 1, 1988. This deficiency is closed.

(Closed) Deficiency D2.3-1, <u>Inadequate Substantiation of Design Commitments For ERCW Piping (Code Basis)</u>

This deficiency identified that piping systems were improperly identified in the FSAR as being designed to ASME Section III, when they were actually designed to ANSI B31.1 - 1967, with ANSI B31.7 used for component procurement, installation and testing. In addition, the FSAR commits to the use of the equations and service limits of ASME Section III, Subsection NC-3000 1971 Edition through Winter 1972 Addendum to determine the applicable stress intensity levels. The FSAR, therefore, does not clearly and consistently define the piping codes of record.

The TVA response indicated that the FSAR will be revised to clarify the Codes utilized, i.e., ANSI B31.1, ANSI B31.7, and portions (NC-3000) of ASME III, Winter 1972. However, there was no indication in this response that the Design Criteria which identify ASME Section III in lieu of ANSI B31.1, ANSI B31.7, etc., will be revised. In addition, Deficiency D3.5-2, "Use of Selected B31.1 Code Rules" identifies concerns with use of ASME Section III, Subsection NC-3000, Winter 1972 Addenda as "equivalent" to ANSI B31.1 - 1967. The IDI team concurs with the TVA response insofar as properly identifying the code of record and its use of other codes with specific identification to their application.

The IDI team reviewed the following TVA documents: (1) CCTS commitment to provide revised draft FSAR Sections 3.2 and 9.2.2.8 in the next annual update to correct discrepancies related to Code commitments (ANSI B31.1 and ASME Section III); (2) CCTS commitment to review various sections of the FSAR to the revised Section 3.2; (3) draft revised FSAR Sections 3.2 and 9.2.2.8; (4) Design Criteria SQN-DC-V-3.0, Revision 3; (5) CCTS commitment to revise SQN-DC-V-7.4, Revision 3; and (6) the draft of Design Criteria SQN-DC-V-7.4, Revision 3.

The team determined that the draft FSAR sections addressed and provided acceptable clarification to the design basis codes. The revisions and commitments to design criteria documents was also determined as acceptable. This deficiency is closed.

(Closed) Deficiency D2.3-2, <u>Inadequate PE Certification</u>

This deficiency identified a lack of recertification by Professional Engineer (PE) for design specifications reviewed as part of the IDI team inspection of the ERCW system ASME Section III components. The review identified five component specifications where design information in the procurement documents was revised without revision and PE certification of the design specifications.

TVA's response agreed that these examples were deficient and identified corrective action for ERCW pumps, clarification of TVA procedures and evaluation of generic implications as part of the CAQR generic review. Also, TVA provided a memorandum for review and upgrade of certified design specifications. The IDI team reviewed the actions by TVA and the documents included and determined that TVA has responded adequately.

The IDI team reviewed the TVA's CCTS commitment for implementation of the corrective actions for CAQR SQF870157. The corrective action called for a review and listing of certified design specifications with corrections to comply with NA-3250 of the ASME Code. The corrective action was scheduled for completion by April 1, 1988 and was determined to be acceptable by the IDI team. Therefore, this deficiency is closed.

(Closed) Deficiency D2.3-3, ERCW Screenwash Pump not Included in ASME XI Program

This deficiency identified the inclusion of the safety class ERCW screenwash pump in the TVA ASME Section XI Pump Inservice Testing (IST) Program. The IDI team determined that these pumps perform a safety-related function during normal plant operation and therefore should be included in the ASME XI Pump IST Program.

The TVA response identified that these pumps will be included in the ASME XI IST Program and, as this program is described in the FSAR, these pumps will be added to the FSAR tabulation of ASME Sectin XI components. The IDI team concurs with this response. The IDI team determined that there are no generic concerns with the balance of the ASME XI Pump IST Program.

The IDI team reviewed the completed surveillance testing data packages for the four ERCW Screenwash Pumps (SI-45.9, SI-45.10, SI-45.11 and SI-45.12), as well as the draft FSAR submittal, Section 6.8, including the ERCW Screenwash Pumps in the ASME Section XI Pump IST Program (submitted to NRC by TVA letter from R. Gridley, dated November 17, 1987). The IDI team determined that these corrective actions were acceptable and this deficiency is closed.

(Closed) Deficiency D2.3-4, ERCW Screenwash Pumps not Produced to ASME Section III

The ERCW screenwash pumps were identified as ASME Section III, Class 3 in the FSAR, Design Criteria, and from the Certified Design Specification 2653. However, the pumps were actually procured to non-ASME Section III, manufacturer's requirements (ANSI B58.1), with a quality assurance program to portions of ANSI N45.2, with seismically qualified 1E motors, and seismic qualification of the pumps.

TVA's response identified their position that the ERCW screenwash pumps procured to the above meet the requirements of TVA Class C and that corrections to the FSAR and Design Criteria documents will be made to remove erroneous references to ASME Section III. The IDI team concurs with this response.

The IDI team reviewed the draft FSAR revisions to Sections 3.2 and 9.2.2.8, the draft revision to Design Criteria SQN-DC-V-7.4 (Revision 3) and the inclusion of these commitments in the CCTS and found them acceptable. Therefore, this deficiency is closed.

(Closed) Deficiency D2.4-1, Improper Application of Critical Crack Criteria

This deficiency identified two items: (1) the lack of inclusion in the FSAR of revised criteria allowing break exclusions, based on stress criteria, for postulating critical crack locations in piping seismically analyzed to ANSI B31.1 Code; and (2) clearly limiting the design criteria's applicability to seismically analyzed piping.

TVA's response identified that a revision to the design criteria by design input memorandum (DIM) will include the reference to seismically analyzed piping for its application of crack exclusion for item (2) above. However, the response did not address the FSAR changes needed. Subsequent discussion between the IDI team and TVA has resolved this item with the team's review of the associated proposed FSAR revision.

The IDI team reviewed the draft FSAR submittal, which revised Section 3.0 of CEB Report 72-22 (Revision 4), and the CCTS commitment to incorporate this revision in the report prior to Unit 1 restart and subsequently formally transmit a comprehensive revision to CEB Report 72-22 to the NRC. The team also reviewed the inclusion of seismic considerations for the application of crack exclusion in two design criteria changes, DIM-SQN-DC-V-1.1.11-3 and DIM-SQN-DC-V-2.13-4. The team determined that these documents and commitments were acceptable and this deficiency is, therefore, closed.

(Closed) Deficiency D2.4-2, Containment Integrity During Design Basis Flood

This deficiency identified that TVA had not formally submitted to the NRC for review and acceptance, the concept of cutting a hole in the steel containment vessel during a design basis flood. Cutting a hole in the steel containment vessel was considered necessary by TVA to prevent an external buildup of water pressure on the steel containment vessel due to flooding of the annular space between shield building and containment vessel during a design basis flood. This action has an extremely low probability of occurring since it is predicated on the failure of one or more upstream dams in combination with the dams storing enough water to cause a flood that would exceed plant grade. However, TVA has committed that the containment be designed to withstand the effects of natural phenomena such as floods, without loss of capability to perform its safety functions.

The IDI team reviewed the original TVA CCTS commitment contained in their December 29, 1987 response, to submit a revision to FSAR Section 2.4A.2.1 for inclusion of cutting hole in the containment during the pre-flood preparation period to allow seepage from the annulus to reach the reactor building sump. The team also reviewed the draft FSAR Section 2.4A.2.1 and determined that it adequately described the action to be performed, procedural controls, and why the action needed to be performed.

In a letter to NRC dated April 21, 1988 (L44 880421 802), TVA indicated that they are further reviewing the Sequoyah Nuclear Plant flood plan to possibly eliminate the need to cut a hole in the steel containment vessel during the design basis flood. Therefore, they do not intend to revise the FSAR in this year's amendment as previously committed since their evaluation is ongoing.

This item is considered closed for the purpose of the IDI team follow on inspection. Cutting a hole in the steel containment vessel to mitigate the effects of the design basis flood is a licensing issue that must be resolved by TVA with NRC's Office of Special Projects.

(Closed) Deficiency D2.5-1, Incorrect Operational Modes Data for ERCW

This deficiency identified the incorrect translation of data from the environmental data drawings to the ERCW operational modes calculation. Specifically, the operational mode calculation identified the ERCW piping to the lower containment ventilation cooler as having an ambient temperature of 160°F for the LOCA condition. However, this 160°F temperature was incorrectly translated from the environmental data drawings, in lieu of a value of 259°F which should have been specified for the maximum ambient temperature during a LOCA in the lower containment for a dead-end compartment. Additionally, since this ERCW piping is only isolated during a Phase B containment isolation it may not come to equilibrium with the containment ambient temperature. This error had no technical consequences since no thermal piping analysis is required for the faulted condition, however, it is an example where an adequate design verification process should have identified and corrected the discrepancy.

The IDI team reviewed the TVA revision (Revision 3) to drawing 47E235-44 which corrects the lower compartment temperature discrepancies by providing separate curves for LOCA and HELB. The correct temperature peak at 327°F during HELB was reflected in TVA calculation B44 870831 018 (which superseded calculation B44 851105 021 with its erroneous definition of lower compartment ventilation cooler peak temperature of 160°F). TVA re-reviewed the superseding calculation and identified that no other errors of this nature had been made. A PIR (PIR SQNMEB87126) was issued by TVA on November 30, 1987, that will be tracked by the TVA TROI system. This PIR documented minor inconsistencies found in the ERCW OP-Mode calculation B44 871027 005, Revision 1, during evaluation of the OP-Mode drawings (47B466-67 series).

The IDI team reviewed the above documents and commitment tracking of the PIR by TROI and determined that the TVA corrective actions were acceptable and therefore, this deficiency is closed.

(Closed) Deficiency D2.5-2, Kerotest Packless Y-Pattern Valves Used For Throttling

This deficiency is based on the use of certain Kerotest valves in a throttling application without consideration of the restriction that the vendor has placed on such usage. The valve manufacturer has stated that Kerotest packless Y-pattern globe valves are not recommended for throttling but did provide guidance that permits throttling in certain regions of percent-open versus flowrate. TVA was initially unaware of these vendor recommendations and that noncompliance could result in cavitation damage to the valves and piping. Failure of valve internals could result in flow restriction to safety-related components. During the IDI inspection, TVA performed a review of all ERCW system valves that were throttled in accordance with surveillance instruction SI-682 and observed that although the four valves were the type with throttling restrictions, all were being operated in the acceptable range. However, TVA needed to establish administrative controls to ensure other similar valves were used in accordance with the vendor's recommendations.

TVA's response of October 29, 1987 agreed with the deficiency and identified the following root causes for the misapplication of these Kerotest valves:

1. Designers were unaware of the unique limitation on throttling.

2. Designers failed to review the specification and depended on the bill of materials which did not identify these valves to be used only for shutoff or drain applications.

3. Vendor supplied these valves before 10 CFR Part 21 was promulgated so no notification was provided.

Subsequently, TVA reviewed the safety-related systems required to mitigate an FSAR Chapter 15 event. As a result of this review, it was determined that 167 Kerotest valves were installed. Three of these valves were being used in an unacceptable throttling application. The three valves were evaluated per TVA's condition adverse to quality report (CAQR) process. The results of this review concluded that one valve located on the discharge of the penetration room cooler 1B1 in the ERCW system needed to be replaced prior to Unit 1 restart. The remaining two Kerotest valves subject to misapplication are located in the discharge piping for the gross failed fuel detectors which have been out of service due to reliability problems. Since TVA is currently performing routine sampling of the reactor coolant system via the chemistry lab and the gross failed fuel detectors (GFFD) are out of service, the IDI team concurs that replacement of these valves is not required prior to restart. However, if TVA intends to utilize the GFFDs, the associated Kerotest valves should be replaced prior to its use on both Unit 1 and Unit 2. Additionally, TVA revised GOI-6 on November 13, 1987 to establish the administrative measures to ensure that all associated Kerotest valves are operated in accordance with the vendor's recommendations.

The IDI team reviewed the CCTS commitment to replace three kerotest valves with valves suitable for throttling service, as part of CAQR SQP871490, after Unit 2 restart (valves not required to support Unit 2 restart and are tagged out). These three valves resulted from a review of Kerotest valves included in the TVA generic review of Chapter 15 safety-related systems. In addition, TVA completed a review of nonsafety-related systems (Memorandum from J. B. Hosmer to S. J. Smith, dated December 9, 1987) which identified two additional valves to be included in the CAQR.

The IDI team determined that the generic reviews by TVA for safety-related systems and nonsafety-related systems, with commitment in the CCTS to replace the submit Kerotest valves is acceptable and therefore, this deficiency is closed.

(Closed) Deficiency D2.5-3, Environmental Qualification (Mild) ERCW Pump House Components

This deficiency identified non-conservative discrepancies between environmental temperature data on the design specifications and the mild environmental data drawings, for various motor operated components located within the ERCW pump house. Since the initial data reviewed indicated that the ambient environmental conditions exceeded the vendor's environmental qualification for the ERCW pumps, strainers, screen wash pumps and traveling screens, the IDI team was concerned that the associated equipment may not function during all operational conditions.

TVA responded to this concern by performing calculation TI-505, dated September 4, 1987, which established the maximum temperature limit in the ERCW pump house at Elevation 720 feet as 120°F in lieu of the previous limit of 130°F as shown on the environmental data drawings. This upper temperature limit is verified through implementation of surveillance instruction SI-606 which monitors the temperature indicators in the ERCW pump house every 8 hours to assure that the temperature is equal to or less than 120°F. Also, TVA reviewed the vendor data for the motors in question and determined that these motors are all qualified for an effective ambient temperature rating of 122°F which exceeds the environmental ambient requirements. The IDI team verified the motor rating data and concurred with TVA conclusion on 3 motors, but took issue with the strainer motor which must be qualified for 110°F since it is on a lower floor in the ERCW pump house (i.e., El. 704). The IDI team noted that TVA had incorrectly reviewed an obsolete data sheet for the strainer motors and had failed to identify that the original Westinghouse motors with insulation Class H had been replaced with Reliance motors with insulation Class B, which are only qualified to 104°F. The 104°F strainer motor vendor qualification meets environmental drawings requirement for normal operation but fails to meet the 110°F limit associated with LOCA maximum temperature when the strainer is operated in continuous backwash. Since the vendor temperature limits for the strainer motor is 6°F below the LOCA required limit of 110°F, TVA was requested to justify the selection of this motor.

From a generic perspective, TVA sampled 20 motors located in a mild environment, to ensure that the motor nameplate data was compatible with the environmental maximum temperature limit. All of the sampled motors data were reviewed by the IDI team and all were determined to meet the maximum environmental temperature requirements.

The IDI team reviewed the revised environmental data drawings (47E235-34, -35, and -36; all Revision 3, dated January 28, 1988) and determined that they correct initial discrepancies applicable to temperature limits. These drawings have all been formally issued. TVA's measurement of load to verify the adequacy of strainer motors resulted in a load of only 71 percent of their nameplate rating. The TVA conclusion that this lower loading will result in a lower temperature rise and thus the 110°F ambient does not compromise the proper operation of the motors is an acceptable evaluation for this specific case.

For the generic issue of Equipment Qualification in Mild Environments, TVA committed that (1) in order to provide better internal documentation, DNE will further document its technical position on mild environmental qualification by April 1, 1988 and (2) TVA will reevaluate its methodology for establishing the maximum and minimum temperatures for mild plant areas by June 1, 1988, as a post-restart activity. The IDI team confirmed that these commitments have been entered in the CCTS and that these commitments by TVA are acceptable. This deficiency is, therefore, closed.

(Closed) Deficiency D2.5-4, Inadequate Substantiation of Procedure For ERCW Screenwash Pump Manual Operation

This deficiency identified the lack of an approved procedure for manual operation of ERCW screenwash pumps to provide an alternative method for automatic control. Since the automatic control using the "bubbler type" differential pressure transmitter could not be incorporated into the design, a temporary change was utilized. This change removed the wiring and logic for the automatic screen wash function from the system, necessitating manual operation to perform the screen wash function. The IDI team was concerned by the lack of issuing approved procedures, in a timely manner, when "temporary" changes are utilized in lieu of design changes.

TVA has issued and approved Revision 30 to SOI 67.1 for instructions and surveillance applicable to manual operation of the ERCW screenwash pump. They have also addressed the generic concern regarding the need to issue procedures when temporary changes are utilized. These procedures are controlled via the USQD (Unreviewed Safety Question Determination) forms.

The IDI team reviewed TVA's CCTS commitment to review 20 percent of all open TACF's by March 30, 1988. TVA further committed in this CCTS item to increase the percentage of TACFs to 100 percent, if problems were noted in the sample reviewed. The IDI team reviewed the draft FSAR Section 9.2.2, for manual operation of the ERCW Screenwash pumps, as well as the commitment in the CCTS to include the revision to the FSAR Section 9.2.2 in the next FSAR update.

The IDI team determined that the corrective actions applicable to the generic issuance of temporary changes and the specific FSAR changes and CCTS commitments acceptably address the team's concerns. Therefore, this deficiency is closed.

MECHANICAL COMPONENTS

(Closed) Deficiency D3.2-1, Nozzle Thermal Displacements of Containment Spray Heat Exchanger 2B

Deficiency D3.2-1 documented TVA's inconsistent evaluation of the nozzle thermal displacements which containment spray heat exchanger 2B imposes on the connecting piping.

CEB's Rigorous Analysis Handbook does not specify threshold magnitudes of nozzle thermal displacements to be coded in rigorous piping analysis. However, CEB indicates that nozzle thermal displacements less than 1/16-inch are not considered significant.

TVA has confirmed that piping calculations performed by EDS (now Impell) evaluated nozzle thermal displacements greater than 1/16-inch in a consistent manner. TVA also noted that Welding Research Council Bulletin 300, dated December 1984, confirms CEB's use of 1/16-inch as the threshold magnitude for consideration of nozzle thermal displacements.

In order to provide an auditable record of the evaluation of nozzle thermal displacements for each piping analysis, TVA has revised the Rigorous Analysis Handbook to require that thermal and seismic anchor point movements be evaluated for any new analysis or reanalysis, or that justification for omitting anchor point movements from the analysis model be documented in the piping analysis. Deficiency D3.2-1 is closed.

(Closed) Deficiency D3.2-2, ERCW Cold Thermal Mode.

Deficiency D3.2-2 identified a TVA operating modes table which did not specify the 35°F cold thermal mode for the ERCW pipe from header 2B to containment spray heat exchanger 2B. As a consequence, TVA did not rigorously analyze the affected piping segment and associated supports for the cold thermal mode or thermal range.

TVA notes that only piping subsystems analyzed after January 1, 1985 have issued operating modes drawings. TVA has reviewed all issued operating modes drawings and associated piping analyses for piping segments subject to thermal conditions below 70°F, and concluded that the affected ERCW and CCW piping analyses can be revised post-restart. The IDI team concurs in this post-restart determination. TVA has revised Mechanical Design Guide DG-M5.1.1 to require identification of minimum operating temperatures in order to address cold thermal mode design. TVA has issued a variance to Nuclear Engineering Procedure 3.2 to require that the minimum operating temperatures be tabulated on the operating modes drawings. TVA has committed in their December 29, 1987 IDI response to upgrade Mechanical Design Guide DG-M5.1.1 to a mandatory design standard. TVA's commitment to reanalyze the ERCW piping from header 2B to containment spray heat exchanger 2B to address the cold thermal mode has been entered on TVA's CCTS. The IDI team concurs in TVA's determination that upgrading Mechanical Design Guide DG-M5.1.1 to a design standard and reanalysis of the piping from the ERCW header to the containment spray heat exchanger can be accomplished post-restart. At the team's request, TVA has revised CAQR SQP871496IDI to track the post-restart revision of the additional ERCW and CCS piping analyses identified in TVA's generic review. Deficiency D3.2-2 is closed.

(Closed) Deficiency D3.2-3, Control of Design Drawings

An area on piping physical drawing 47W450-24 did not agree with the piping isometric drawing or the analysis of record. TVA has indicated that the area of piping in question was shown correctly on full plan drawings 47W450-21 and 25, and therefore, was not a deficiency. However, TVA will add clarifying notes on piping drawing physical 47W450-24 to ensure that future design changes are not affected by confusing details. TVA CEB discussed this issue with the IDI team at length and concluded that detail A-24 showing the incorrect pipe routing was an isolated drafting error and would not have been identified by the newly implemented CCD system.

The IDI team confirmed that the corrective actions have been placed on the CCTS. Based upon these commitments, the team considers this deficiency closed.

(Closed) Deficiency D3.2-4, Piping Modeling Error

A length of 4 inch Schedule 40 pipe was rigorously analyzed as a 3 inch Schedule 40 pipe. TVA agrees with the deficiency, but considers the safety significance of the modeling error to be minor, based on the following observations:

1. The error is an isolated computer coding error affecting less than 2 feet of pipe.

2. The analyst performed only this one piping analysis for the Sequoyah Nuclear Plant.

3. The maximum stress ratio for all Code equations is 0.5.

4. The stresses in the miscoded area were conservatively shown to be acceptable.

The team reviewed TVA's response to the deficiency and finds the issuance of a Condition Adverse to Quality Report (CAQR) an acceptable resolution to the issue. The team also agrees that adequate procedures are in place to prevent recurrence. The team confirmed that this item was placed on the CCTS for resolution as a post-restart function and considers this item closed.

(Closed) Deficiency D3.2-5, Design Drawing Inconsistencies

The piping isometric drawing for Problem N2-67-IIR and the accompanying as-constructed physical drawing Section M24 were revised. These revisions were not incorporated on the as-designed piping physical drawing. TVA issued a CAQR to address this deficiency by correcting the as-designed physical drawing.

The team reviewed TVA's response to the generic aspects of this issue, which indicated TVA's commitment to establish, in the long-term, a "one drawing concept" for piping physical drawings to prevent recurrence. The team agrees with the proposed TVA resolution and has confirmed that the corrective action for this item has been placed on the CCTS for resolution as a post-restart function. This item is considered closed.

(Closed) Deficiency D3.2-6, Missing Pipe Clamp

During a field walkdown the IDI team noticed that a Unistrut pipe clamp was not installed on the return line from the Upper Containment Vent Cooler 2B. TVA agreed that this item was a deficiency.

The team reviewed the technical basis for TVA's response, which essentially concluded that the clamp was not needed based upon the criteria stipulated in CEB Report CEB-76-5. Additionally, the team reviewed calculation N2-ERCW IDI-MISC which presented a computer analysis substantiating the flex-hose boundary condition criteria stated in Report CEB-76-5. Despite this, TVA replaced the clamp on August 29, 1987, and stated that the alternate piping analysis Phase 2 program will provide assurance that this type of condition is detected and corrected.

The team finds the TVA disposition acceptable, and confirmed that this item has been placed on the CCTS for resolution as a post-restart function. This item is considered closed.

(Closed) Deficiency D3.2-7, ERCW Piping Spool Pieces

Deficiency D3.2-7 summarized TVA's ongoing corrective actions to replace two spool pieces to be installed in the ERCW line from header 2B to the component cooling water surge tank in SQN Units 1 and 2 during the flood mode. The spool pieces were apparently fabricated to the nominal dimensions shown on the piping physical drawings rather than to the as-built dimensions of the installed piping. However, TVA could not verify that the remaining spool pieces to be installed in the ERCW system during flood mode had been similarly evaluated.

TVA has measured the 22 spool pieces required to be installed during flood mode, and determined that 13 of the spool pieces did not fit. TVA has refabricated and bolted the 13 spool pieces in place to ensure proper fit. TVA has additionally placed a commitment on CCTS to replace the 22 spool pieces post-restart with flexible spool pieces which will remain bolted in place, and to revise the flood protection maintenance instructions to reflect this change. Deficiency D3.2-7 is closed.

(Closed) Deficiency D3.2-8, Valve Operator Fundamental Frequencies

Deficiency D3.2-8 identified a Masoneilan valve operator with a fundamental frequency less than 25 Hz that had not been modeled as a flexible cantilever in the piping analysis as required by FSAR Section 3.9.2.5.2.

TVA has completed a generic review of all Masoneilan valves and all diaphragm control valves supplied by other vendors that are installed in piping subsystems necessary for accident mitigation and safe shutdown. TVA has completed a review of all identified valves for possible impact on pipe stresses, support loads, valve accelerations and equipment loads. TVA has compiled and incorporated a list of non-rigid valves into the Rigorous Analysis Handbook to model valve stiffness characteristics. TVA has also placed a commitment in TVA's CCTS to address the effects of non-rigid valves within the DBVP Phase 2 post-restart scope. Deficiency D3.2-8 is closed.

(Closed) Deficiency D3.3-1, ERCW System Pipe Support Calculation N2-67-2A

Deficiency D3.3-1 identified a common W10x25 support beam for pipe hangers 1ERCWH-71 and -134 which was not evaluated for the combined support loads. Deficiency D3.3-1 also noted that pipe support 1ERCWH-133 was modeled in the piping analysis as an axial restraint, but had insufficient lateral clearance to accommodate the computed lateral movement of the pipe.

TVA agrees that the design evaluation of pipe support 1ERCWH-71 did not address the load applied to pipe support 1ERCWH-71 by pipe support 1ERCWH-134. TVA also agrees that the inadequate lateral clearance for pipe support 1ERCWH-133 is an unanalyzed condition. However, TVA indicates that these deficiencies would have been addressed as part of TVA's pipe support calculation regeneration program.

TVA has regenerated the calculation for pipe supports 1ERCWH-71 and -134, and pipe support 1ERCWH-133, and has placed a commitment on TVA's CCTS to revise Design Criteria SQN-DC-V-24.2 after restart to include supports on alternately analyzed piping.

The team questioned the lack of a stress check in the calculation for pipe support 1ERCWH-71. TVA revised the pipe support calculation to incorporate the stress check in order to ensure satisfactory resolution of Deficiency D3.3-1 prior to heatup (Mode 4) of SQN Unit 2. Deficiency D3.3-1 is closed.

(Closed) Deficiency D3.3-2, Pipe Support Discrepancies

Ten pipe support analyses for piping problems N2-67-10R and N2-67-11R were reviewed for compliance to CEB design criteria and FSAR commitments. Three of these pipe support calculations were found to have errors relating to technical assumptions and incorrect dimensional data. These conditions are being tracked by CAQR SQP871498IDI. For one support TVA determined that the calculation documentation was not updated to record the acceptability of subsequent construction configuration changes during the Support Modification Request (SMR) process.

To prevent recurrence of the documentation discrepancies identified for pipe support 47A450-25-344, SMRs are no longer used at Sequoyah. TVA has committed to address the generic aspects of this deficiency as they apply to other pipe supports within the scope of the Rigorous Pipe Support Calculation Regeneration Program and the Alternate Analysis Review Program. The team reviewed TVA's re-evaluations of the identified pipe supports and found the calculations acceptable. TVA has indicated that the team's generic concerns are being addressed as part of TVA's pipe support calculation regeneration and alternate analysis programs. In conjunction with these programs, TVA has also issued Design Criteria SQN DC-V-24.2 which reflects revisions as a result of findings by various TVA quality and technical review programs as well as previous technical meetings with the NRC's Office of Special Projects (OSP).

In order to determine whether this Design Criteria revision together with the implementation of the Pipe Support Calculation Regeneration Program has adequately addressed the IDI concerns identified above, the team reviewed a random sample of twenty (20) pipe support calculations. The team's reviews concentrated in the areas of concern as identified in the IDI report.

Based upon the review of the 20 pipe support calculations, the team concludes that the 20 regenerated calculations generally meet the requirements of TVA Design Criteria SQN DC-V-24.2 Revision 2 dated November 30, 1987. Although, several minor errors were discovered such as incorrect structural model dimensions and missing design information.

The team confirmed that the Alternate Analysis Program was placed on the CCTS for resolution as a post-restart function for Phase II piping and supports and that the TVA Rigorous Pipe Support Calculation Regeneration Program and Alternate Analysis Review Program will adequately address generic concerns with regard to design of pipe supports, if properly implemented. This item is considered closed.

(Closed) Deficiency D3.3-5, Incorrect NCR Corrective Action

Test data for Unistrut pipe clamps, commonly used at Sequoyah on small bore piping, was originally based on one direction of loading. TVA designers, however, used the allowable loads based on the one directional tests for piping loads in multiple loading directions. An NCR written to address the condition incorrectly used an elliptical interaction equation to qualify previously used clamps. TVA agreed with the deficiency and stated that the previous method of interacting the combined effects of loads in three orthogonal directions was incorrect.

The team reviewed TVA's response to this deficiency and found it acceptable. CAQR SQT871487IDI has been written to track the resolution of this issue. Also, a Quality Information Release has been issued to Civil Engineering Branch Lead Engineers requiring the use of the straight-line interaction method for future evaluation of Unistrut pipe clamps. It should be noted that the acceptability of the straight-line interaction method is addressed under IDI Deficiency D3.5-3.

TVA confirmed that Unistrut clamps in rigorously analyzed piping have been reanalyzed using straight-line interaction as part of the Pipe Support Calculation Regeneration Program, that Unistrut clamps in alternately analyzed piping (Phase I) have been reanalyzed using straight-line interaction as part of the Alternate Analysis Review Program, and that TVA's commitment to reanalyze the Unistrut clamps installed in the alternately analyzed piping to be evaluated during the Phase II portion of TVA's Alternate Analysis Review Program has been placed on TVA's CCTS.

The IDI team reviewed at random ten (10) pipe support calculations that were included in TVA's Pipe Support Calculation Regeneration Program and Alternate Analysis Program for the purpose of confirming the use of the straight-line interaction equation for Unistrut pipe clamp analysis. The team verified that the correct Unistrut allowable loads (based upon straight-line interaction) as presented in CEB Design Criteria SQN-DC-V-24.2 were used to qualify the Unistrut clamps as part of the pipe support design. Based upon this review and confirmation that TVA's commitment to check the remaining Unistrut clamps installed in alternately analyzed piping subsystems post-restart has been placed on CCTS, this item is considered closed.

(Closed) Deficiency D3.4-1, Motor-Operated Valve Design Pressure

Deficiency D3.4-1 identified a vendor seismic qualification calculation for motor operated valves 47W427-6 and -7 which used an incorrect design pressure of 50 psi instead of the 150 psi system design pressure.

TVA has requalified valves 47W427-6 and -7 using the correct 150 psi design pressure and has also completed a generic review which identifies incorrectly qualified valves. TVA's commitment to revise incorrect documentation post-restart has been entered into TVA's CCTS. TVA's commitment to revise the FSAR post-restart to allow seismic qualification of safety-related valves by testing or analysis has also been placed on TVA's CCTS.

TVA's generic review documented an NSSS-procured drain valve which was installed in a safety-class system and which appeared to lack seismic qualification. The team reviewed TVA's conclusion that the drain valve was seismically qualified by similarity to valves qualified in an ITT Grinnel valve seismic qualification report, to ensure satisfactory resolution of Deficiency D3.4-1 prior to heatup (Mode 4) of SQN Unit 2. Deficiency D3.4-1 is closed.

(Closed) Deficiency D3.4-2, Seismic Qualification of Turbine Driven Feedwater Pump 2A

Deficiency D3.4-2 identified an equipment nozzle axial load due to internal pressure in CEB Report 82-1 that was not addressed in the seismic qualification report for turbine-driven auxiliary feedwater pump 2A.

TVA has indicated that the TVA report specified the nozzle load to address the possible installation of an untied bellows, and that the nozzle axial load due to internal pressure was not applicable to the qualification of the turbine-driven auxiliary feedwater pump, which is a closed hydraulic system. TVA has revised CEB Report 82-1 to clarify the applicability of the nozzle axial load. This item is closed.

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

The component cooling water (CCW) heat exchanger was observed during an NRC field walkdown to have three supports. The vendor drawings and seismic qualification report only indicated two supports. TVA's response was that this was a documentation deficiency resulting from inadequate interface review of a design change initiated by TVA piping analysis engineers. TVA reviewed all piping analysis isometrics issued before August 29, 1987 to verify attachment to equipment and component supports modeled in the analyses. TVA's isometric review indicated that there were no similar supports which did not undergo the proper review. TVA performed a preliminary analysis of the CCW heat exchanger assembly which indicated that the heat exchanger and supports are or can be qualified for all loadings. A detailed review of the support and anchorage qualification for the CCW and 10 other Category I heat exchangers was initiated by TVA to ensure no impact on plant safety.

The IDI team selected the CCS and the containment spray (CS) heat exchangers for review. The CCW nozzle analysis was reviewed and found to be acceptable. Also reviewed and found to be acceptable was the effect of the additional support on the CCW shell. The effect of the nozzle loadings together with the other additive loading on the vessel supports and embedment plates was reviewed by the IDI structural discipline for adequacy. No additional modifications to the CCW heat exchanger shell or supports were identified.

The CS heat exchanger was reviewed in detail. The reanalysis, which included the effects of the support flexibility, resulted in increased loadings to the equipment supports and supporting structure. These loadings were due in part to the increased seismic loadings resulting from the consideration of structural stiffness. Structural modifications of the supporting structure were required to restore the FSAR safety margins. TVA confirmed by letter to NRC dated January 26, 1988, that these modifications were completed.

During the review of the CS heat exchanger calculation, several mathematical errors were discovered in the final fully checked calculation. In addition, a calculation for the stress induced into the heat exchanger shell by the lower support lug failed to incorporate the vessel internal pressure stress. Since these errors were detected in a final calculation which was performed essentially as a result of the previous IDI findings, an apparent weakness in the review/checking process was identified. A possible source of these errors could have been the Stone and Webster Engineering Corporation (SWEC) quality assurance procedures under which these calculations were performed which did not require a number by number calculation check. These procedures only required a review of the work performed which may or may not include a rigorous calculation check.

TVA requested SWEC to further review their 10 Category I heat exchanger calculations and as part of that review perform a rigorous calculation check. The IDI team reviewed Revision 3 to the CS heat exchanger calculation which was subject to this rigorous check. This calculation identified several additional areas where calculation mathematical errors were identified. Revision 3 of this calculation was reviewed and found to be adequate.

The IDI team considers this item closed. However, several areas of concern relating to the heat exchangers in particular and other structures in general have been referred to OSP for final resolution. These areas are discussed below.

1. The FSAR is not clear concerning the use of damping factors for equipment. TVA used 2 percent for OBE and 3 percent for SSE. The basis for these values is not clearly connected to the FSAR values. The team allowed TVA to begin heat up; however, the team made it clear to TVA that the acceptance was for heat up only and that this item was still an unresolved restart issue.

2. The issue of the use of SRSS vs. absolute sum for the combination of seismic loadings was referred to the OSP for final disposition.

3. The decoupling of the heat exchanger from the piping system when the heat exchanger was flexible was discussed. TVA felt that since the displacements were less than 1/16" at the piping attachment points, no further vessel/piping interaction consideration was required. The team accepted this position as far as heat up and restart were concerned; however, this issue will be reviewed further by OSP post-restart.

(Closed) Deficiency D3.4-5, Vendor-Supplied Flexible Hose

Deficiency D3.4-5 identified FLEXONICS series flexible metal hoses installed in the ERCW system that TVA did not procure to standard TVA Class C seismic criteria.

TVA has identified the installed hoses, and has inspected the hoses to confirm that none of the hoses exhibit excessive bulging, misalignment, or loose braids. TVA has also seismically qualified the hoses by analysis.

TVA's commitment to replace the 16 installed flex hoses post-restart has been placed on TVA's CCTS. TVA's commitment to review contract records and past procurement practices post-restart for other similar items has also been placed on TVA's CCTS. Deficiency D3.4-5 is closed.

(Closed) Deficiency D3.5-2, Use of Selected B31.1 Code Rules

On several piping problems, at elbows and tees, TVA incorrectly interpreted ANSI B31.1 - 1967. In these instances, TVA concluded that the additive stresses did not require the use of the stress intensification factor (i). TVA agreed with the NRC that the exclusion of the i-factor was inappropriate. Since this condition only existed in piping problems reanalyzed after OL, TVA reviewed all post-OL reanalysis problems. This review revealed a total of four cases which required requalification. TVA's requalification concluded that all four cases meet the FSAR commitments and require no hardware modifications.

TVA's response to Deficiency D3.5-2 contained in their December 29, 1987 letter to NRC was reviewed by the team. The response contained an explanation based upon the fact that elbows are the piping element most susceptible to collapse resulting from the fact that as bending moments are applied to the elbow, it ovalizes at a much faster rate than a straight piece of pipe. The addition of a branch connection on the outside of an elbow actually stiffens the elbow, and increases the moment that can be applied before collapse. Therefore, the use of the elbow stress intensification factor (.75i) for an elbow with a branch on the outside is conservative for the collapse mode considered in piping code equations (8) and (9) and therefore is acceptable.

The response also contained an explanation justifying the "i" values used for concentric reducers. The explanation clearly indicated that the "i" values used were in compliance with the code of record (ANSI B31.1-1967) and the 1983 ASME code. Since the code of record and the current ASME code both agree with TVA practice, it is therefore determined to be adequate and appropriate practice. TVA's response also stated that the usual method for calculating the stress intensification factor for an elbow with a branch is to use the lesser of "i" x "i", or "i" + "i" as defined in CEB Report 84-20, Revision 0.

TVA has committed to revise their Sequoyah Rigorous Analysis Section SQN-RAH-204 after restart to state that no stress reduction can be made by removing the 0.75i factor from the seismic or any other portion of the code equations. Incorporating this change post-restart is considered acceptable, since TVA has already reviewed all piping analysis performed post-OL for this deficiency and TVA has placed this item on their Corporate Commitment Tracking System.

Based upon this review of the TVA response, this deficiency is considered closed.

(Closed) Deficiency D3.5-3, Unistrut Clamp Load Testing

TVA has developed load ratings for Unistrut clamps using the design rules of ASME Section III, Subsection NF, 1974 Edition, Winter 1976 Addendum. The use of ASME Section III instead of the B31.1 - 1967 code of record is under current licensing review by the NRC's Office of Special Projects. The NRC IDI team raised several questions relating to the application of these load rating rules. Among them are TVA's failure to take the 10 percent reduction when only one sample is tested, the applicability of A307 bolts in a friction connection, TVA's failure to consider temperature effects, and the applicability of the data obtained from the test installation. TVA is performing additional testing to avoid the 10 percent reduction. Additional tests will be performed to establish a yield strength for the A307 bolting typically used in the Unistrut assemblies. In addition, TVA will establish load ratings as a function of temperature. TVA has indicated that interim use of the clamps without considering temperature effects is acceptable. Actual support verification of the temperature effects will therefore be accomplished post-restart. TVA also provided additional information concerning the actual test configuration and discussed configuration effects on the resulting load ratings.

TVA has documented the yield and ultimate strengths of A307 1/4" and 3/8" diameter bolts, and developed a bolt load vs. torque test using the actual clamp configuration for the 1/4" bolt.

The resulting impact of the above testing and additional documentation is that the allowable loading for two clamp sizes was reduced. The new loads were approximately 15 percent less than the previous loads and only pertained to one direction. TVA has committed to review all affected clamps post-restart and has placed this commitment on the CCTS. TVA has also placed its commitment to review the temperature effects on clamps post-restart on its CCTS. This item is considered closed.

(Closed) Deficiency D3.6-1, Design Review for ERCW Equipment

Some vendor seismic component qualification reports did not meet the Quality Assurance provisions of the procurement documents in that no evidence of the required design review could be found. TVA responded that at the time of acceptance of the seismic qualification reports, TVA performed a Design Review (as permitted by Paragraph 2.0 of Appendix A to the procurement documents) in those instances where the equipment vendor did not provide a Design Review. The IDI team was concerned that TVA's response did not provide adequate assurance that the TVA design review of the vendor seismic qualification reports met the procurement document requirement and intention of an independent design review.

The IDI team review of the documentation provided by the TVA response indicated that the TVA design review is in the form of an internal TVA memorandum which "reviews and accepts" the seismic qualification report. It was not apparent that this review was meant to be the missing design review or whether it was simply part of the acceptance cycle. In addition, TVA has reviewed three additional equipment seismic qualification reports which apparently focus on potential calculation errors. From this review TVA concluded that, since the calculation errors discovered were not significant, no deficiency was identified.

The team concluded that TVA's response was unacceptable, since the lack of committed Design Reviews was not satisfactorily addressed.

As a result, the IDI team requested TVA to establish and implement a comprehensive program to review a specified number of seismic qualification reports for compliance with their respective procurement document requirements prior to restart of Unit 2. In order to provide an acceptable breadth of review, TVA chose as their sample forty (40) seismic qualifications encompassing the following scope of safety-related equipment; air handling units, heat exchangers, pumps, valves, tanks and dampers.

Impell Corporation was retained by TVA as the independent design reviewer for the componemt seismic qualification review. An equipment list of TVA Class A, B and C components was developed consisting of seven (7) components within the Westinghouse NSSS scope of supply and thirty-three (33) for the balance of plant (BOP). During its review Impell documented the component qualification by analysis through the completion of a five page, six part, detailed checklist. In those cases where an unsatisfactory response was high-lighted on the checklist, Impell provided comments to explain the condition. Any assumptions used during the review and evaluation were specified. At the conclusion of the technical review, conclusions are stated and recommendations, if any, are made. A similar format was employed for the documentation/quality review for each component. The IDI team reviewed all seven Westinghouse component seismic qualification report reviews and eight from the BOP. During the review of the eight BOP components, the team requested additional clarification and/or explanation on five of the Impell independent reviews. After several discussions, TVA and Impell provided the team with satisfactory resolution of all questions. Impell also provided the team with Technical Report 3-0060-1145, Revision 0, dated February 5, 1988 which makes a statement concerning the seismic qualifications of the 33 BOP components within the scope of their review. This report concludes that in all cases verification of the seismic qualification of the components was confirmed by Impell. However, during its review of BOP components, Impell concluded in its Technical Report 3-0060-1145, Revision 0, dated February 5, 1988, that two technical concerns with respect to valve and/or damper application should be addressed on a generic basis. Impell also pointed out that TVA is planning to establish a retrieval program for vendor furnished component documentation.

During its review of the seven Westinghouse components independently reviewed by Impell, the team discovered that Impell could not come to any conclusions with respect to the seismic qualification of the components, since Westinghouse had not submitted documented evidence of this qualification to TVA. However, Westinghouse stated that all seismic qualifications for NSSS equipment under

Westinghouse scope of supply were qualified in accordance with their document WCAP-7700 Revision #1 titled, "Seismic Analysis of Nuclear Power Plant Auxiliary Equipment." Because WCAP-7700 Revision 1 was not a TVA design document that specified criteria and was not referenced in Section 3.2 of the Sequoyah FSAR, no documentation could be produced to verify this assertion. Both Westinghouse and TVA indicated that Westinghouse maintained NSSS component seismic qualification responsibility based upon their contractural agreement. However, a TVA audit of Westinghouse was performed on May 23, 1973 during which WCAP-7700 was reviewed. Since WCAP-7700 provided a generic seismic qualification for valves, tanks, etc., using a worst case enveloping technique, the TVA audit team attempted to review a specific seismic qualification report from one of Westinghouse's vendors. The audit report noted that Westinghouse was not requiring equipment vendors to submit seismic design documentation on many Category I components and that TVA urgently needed to establish if this is a requirement for a licensable plant. TVA could not provide any documentation that this open issue from the May 23, 1973 Westinghouse audit had ever been addressed and resolved by TVA.

This item is considered closed based on the following actions taken and commitments made by TVA in their revised IDI response dated March 2, 1988 (L44 880302 808).

1. TVA has received a Certificate of Compliance (COC) from Westinghouse stating that all NSSS scope of supply equipment requiring seismic qualification meets the provisions of WCAP-7700 Revision 1 and Section 3.7.2.1 of the Sequoyah FSAR.

2. TVA confirmed that WCAP-7700, Revision 1, has been reviewed and approved by TVA. As a post-restart commitment, TVA will require Westinghouse to provide documentation to demonstrate that they (Westinghouse) have audited their vendor seismic qualification reports for some of the cases where the vendor has provided only a COC to Westinghouse as evidence of seismic qualification.

3. TVA has committed to address the three concerns raised in Section 5.0 of Impell's Technical Report 3-0060-1145, Revision 0, dated February 5, 1988 with respect to developing a formal documentation retrieval program and generic concerns with valve extended structure flexibility and valve orientation post-restart.

CIVIL/STRUCTURAL

(Closed) Deficiency D4.2-2, Seismic Analysis of Shield Building and Steel Containment

The review of the original seismic analyses showed that they were not signed by the preparer or the checker. The technical position cited by TVA was that CEB reports which summarized the seismic analysis results were signed by checker and approved.

In response to this deficiency, TVA revised the seismic analysis of the shield building (B41 870917 008). The review of these calculations by the team showed that the calculations still contained information that was incorrect or unsupported. The team requested that TVA make a thorough review of the calculations and clarify the necessary information and results and also eliminate information and results which have no significance to the final results or correct information as appropriate.

In addition, TVA report CEB-80-22-C titled, "Dynamic Earthquake Analysis and Static Wind-Tornado Analysis of the Shield Building", also reflected incorrect and unsupported information from the shield building seismic calculations. The team believes that this report should also be similarly revised.

The following discrepancies, inconsistencies, and errors were noted by the team:

1. Mode shapes shown in Figure 5, Report CEB-80-22-C, were not supported by calculation B41 870917 008.

2. Calculation B41 870917 008 (pages 9 thru 11) uses the same formula as the original calculations (pages 19 thru 22) for mass moment of inertia. This property is used as input to DYNANAL computer program. The formula used was in error since no mass or weight was considered.

3. Table I of Report CEB-80-22-C does not list all the data that were used as input to DYNANAL.

4. Item 4 and Table III of Report CEB-80-22-C are based upon unchecked conclusions with no calculations available.

5. There is an inconsistency in Report CEB-80-22-C. Item B states that the use of shell theory is necessary for the dome, however, vertical response spectra are based on a stick model.

6. Figure 2 in Report CEB-80-22-C is based on page 177 of calculations B41 870917 008, which is unchecked and stamped "INFO ONLY."

7. Figure 3 in Report CEB-80-22-C is based upon page 178 thru 181 of calculation B41 870917 008, which is stamped "INFORMATION ONLY NO CHECKING REQUIRED."

8. In Table IV of Report CEB-80-22-C, values are listed for the vertical natural periods as 0.067 and 0.022 seconds. On page 235 of calculation B41 870917 008, a handwritten value of 0.067 seconds is shown. The value of 0.022 seconds was not found in the calculation. (Note that it is recognized that a period of 0.022 seconds is in the rigid range.)

9. Horizontal periods for modes 1 and 2 listed in Table 11 of Report CEB-80-22-C correspond to modes 2 and 4 shown on page 217 of calculations B41 870917 008. Output containing data for modes 1 and 3 are marked with a handwritten note: "This torsional mode not used."

The IDI team requested that the documentation be revised so that all necessary design data are supported and documented and that unnecessary calculations, tables, etc., be removed from the body of these documents.

The nine discrepancies noted above have been resolved by TVA by a reorganization and correction of the shield building calculations and a deletion of miscellaneous calculations not used in the final analysis. In addition, the final report (CEB-80-22-CR1) is undergoing revision to resolve the discrepancies.

A brief discussion of the resolution of the nine specific discrepancies noted above are as follows:

1. Figure 5 of Report CEB-80-22-C will be removed in the next revision.

2. The values for weight-moment-of-inertia as shown on sheets S17 and S18 of calculation B41 870917 008 were corrected. The original error was on the conservative side and was not a significant property in the analysis. Therefore, there was no effect on the results of the seismic computer analysis.

3. Table I of Report CEB-80-22-CR1 will be revised to reflect corrected data including the weight-moment-of-inertia.

4. Table III of Report CEB-80-22-C which summarized a study of soil-structure interaction will be removed. The information summarized was not used in the computer analysis.

5. The description of results in Item B of Report CEB-80-22-C will be clarified to indicate that a shell model was used in the analysis of the dome.

6. Figure 2 of Report CEB-80-22-C, a flow chart of steps in the analysis, will be removed.

7. Figure 3 of Report CEB-80-22-C will be reidentified as Figure 2 and will include reference to checked TVA drawings 41N700-2 and 6.

8 & 9. Table IV of Report CEB-80-22-C will be removed but pertinent data will be included in Table II and the mode numbering will be clarified.

The NRC team considers this item closed.

(Closed) Deficiency D4.2-3, Seismic Analysis of Steel Containment Vessel

The original calculations for the seismic analysis of the steel containment vessel contained newly generated vertical amplified response spectra issued in June 1987, which showed increased responses in the high frequency range between 20 and 25 Hz.

Prior to 1979, the vertical amplified response spectra were established as simply being 2/3 of the horizontal amplified response spectra at the elevation under consideration. During 1979-1980, TVA calculated vertical amplified response spectra for the steel containment vessel (SCV) in order to reduce conservatism. During 1986, TVA noted that at some elevations the vertical amplified response spectra had unexplainable variations from those at adjacent elevations. As a result of these discrepancies, TVA issued problem identification report PIR SQNCEB8652 and a corrective action was initiated.

Using earthquake "A", one of the four artificial time histories of ground motion specified in the FSAR, several comparison analyses by TVA were initiated. Both a beam model and an axisymmetric finite element model were prepared. The ANSYS computer program was used for both the beam and finite element models for the seismic analysis and calculation of amplified response spectra. An integration time step of 0.001 seconds was assigned for the ANSYS analysis for both the beam and axisymmetric finite element models. The beam model was also analyzed using the STARDYNE computer program which generated floor response time histories. These time histories later were used as input to the RESPONSE computer program for the calculation of the amplified response spectra. For STARDYNE, no time step of integration needs to be assigned for the calculation of floor response time histories or for calculating amplified response spectra directly because the appropriate time step is determined internally. However, TVA assigned both a 0.01 and 0.005 second time step of integration for calculations of amplified response spectra using the RESPONSE computer program. The peaks of the vertical amplified response spectra at the dominant vertical frequency of the SCV were different depending on whether the time step of integration was 0.01 or 0.005 second.

TVA supplied comparisons to the team which indicated that the vertical amplified response spectra developed entirely using STARDYNE compare very well with the combinations of STARDYNE and RESPONSE where the time step of integration in RESPONSE was 0.005 second. If the time step of integration was selected as 0.01 second, the peak of the vertical amplified response spectra was reduced by 30 percent or more. While these comparisons indicate the validity of RESPONSE, they also indicate that an appropriate small time step of integration must be established for structures with high dominant frequencies. While the vertical amplified response spectra developed from STARDYNE and RESPONSE using the time step of integration of 0.005 second exceeded the vertical amplified response spectra generated by ANSYS using 0.001 second, the peaks obtained from RESPONSE using a time step of 0.01 second did not exceed the vertical amplified response spectra obtained from ANSYS.

Because the time step of integration originally used for generating the amplified response spectra with RESPONSE was 0.01 second, the amplified response spectra may not be conservative for the analysis of piping systems with dominant frequencies between 20 and 25 Hz. The use of a time step of integration of 0.005 second in the RESPONSE computer program is considered acceptable to the team for the development of all vertical amplified response spectra for the SCV.

In order to assure that the piping systems and equipment supported by SCV will withstand the postulated earthquake loads, TVA used the vertical amplified response spectra regenerated by STARDYNE and RESPONSE Codes with a time integration step of 0.005 second to reanalyze the four worst-case piping systems of the 10 supported by the SCV and sampled equipment (including electrical penetrations) attached to the SCV. The team reviewed the results of the analysis of these four pipe systems. These analyses showed that the stresses in the piping and supports are within the allowables specified in TVA's piping interim criteria and therefore, are acceptable for restart. The team also reviewed five sample equipment evaluation results and found them acceptable for restart. NRC's Office of Special Projects has required that, after restart, TVA reanalyze all piping systems against the regenerated amplified response spectra and the final design criteria, and upgrade them as necessary.

The team requested that TVA generically examine the effect on high frequency response of the shortened time step of integration on other safety-related structures. TVA identified two other structures which have dominant frequencies in the high frequency (20-30 Hz) range and also have a spectral peak higher than the original amplified response spectras used for the piping system design in this frequency range as determined by the newly generated amplified response spectras. These two structures are reactor building internal concrete structure and auxiliary control building.

For these two buildings, TVA selected a total of four piping systems (two from each of the two buildings) and reanalyzed the piping and supports using the regenerated amplified response spectra. As a result of review of the reanalysis results, the team found that TVA's evaluation showed these systems met the interim criteria and are acceptable for plant restart. Therefore, the team considers this deficiency to be closed. For the detailed review of these piping reanalysis results, see Design Calculation Review Inspection Report 50-328/88-12.

(Closed) Deficiency D4.3-4, Load Combination For Concrete Slab

The review of the original design calculations for the auxiliary building slab at elevation 669.0' showed that the construction load combination was used as the most critical case. However, the team noted that if the live loads as shown on TVA drawing 41N704-1 were used, then the most critical load combination to design the slab would have been the normal operating condition. The team was concerned that the worst load combination was not used in the original design calculations.

In response to this deficiency, TVA has performed a review of drawing 41N704-1 to determine whether the live loads that are shown on this drawing were actually used in the original design calculations of the Category I buildings. This review by TVA has shown that there are discrepancies between the live loads shown on this drawing and live loads used in the design calculations. TVA has issued a problem identification report PIR SQNCEB8780 to track this problem. TVA has also performed additional calculations (B25 870918 450) to determine the adequacy of the floor slabs for the live loads shown on the drawing, whenever such live loads were different in the original design calculations. These reevaluations by TVA have shown that the slabs are structurally adequate, however, TVA used Ultimate Strength Design (USD) methods to qualify certain slabs. This is contrary to the FSAR commitment that the original design of various Category I buildings use the Working Strength Design (WSD) for concrete. Therefore, the approach taken by TVA to qualify certain slabs by the use of USD was not acceptable to the NRC team.

TVA has reanalyzed those slabs that were qualified by the use of the Ultimate Strength Design (USD) method. The revised calculation, B25 880114 451, showed that the slabs are structurally adequate when the Working Strength Design (WSD) methods were used. This satisfies the TVA's FSAR commitment for the original design.

The team was advised that TVA will evaluate the generic implications of this deficiency in conjunction with the live load reconciliation and reinforcing bar cut programs that are being performed as a part of the employee concerns program. These evaluations, as stated by TVA, will include the reactor building and other Category I buildings. However, the team notes that these evaluations can be performed post-restart.

TVA has placed a commitment on the CCTS that the evaluation of the generic implications of this deficiency will be performed in conjunction with the live load reconciliation and reinforcing bar cut programs. These two actions taken by TVA satisfy the team's concerns and, therefore, this deficiency is closed.

(Closed) Deficiency D4.3-5, Shear Calculations for Slabs and Walls

The review of the original design calculations for the auxiliary building roof slab and the walls on column line A1 and A15 showed that evaluations for shear forces were not performed. Failure to check shear forces in critical sections is in violation of the ACI 318-63 code requirements as stated in sections 1201 and 1207. The NRC team was concerned that shear stresses could have been exceeded at critical sections of certain structural elements.

In response to this deficiency, TVA has performed a review of shear calculations for 13 Category I buildings required for safe shutdown, except the ERCW pumping station. A total of 294 structural elements including walls, floors, roof and base slabs, beams and columns were selected. These elements were reviewed to determine whether shear stresses were checked in the design calculations. The review of these calculations associated with the selected samples showed that the shear calculations existed for 274 cases, as documented in TVA calculation B25 870917 450. TVA performed additional calculations to show that the remaining 20 cases had shear stresses which were within the FSAR commitments. The IDI team performed a cursory review of these additional calculations and agrees with the TVA approach. The team also reviewed the shear calculations performed for the auxiliary building roof slab at elevation 778.0 and the A1 and A15 line walls and found them to be acceptable.

The generic review performed by TVA on the 274 elements did not check whether the shear calculations were performed in accordance with the ACI-318 Code requirements. Therefore, the team believed that TVA should select some additional samples from the 274 elements to determine the adequacy of the original shear calculations. The team recommended that at least 30 sample elements including walls and slabs be selected from these 274 elements and evaluated.

TVA selected 30 sample elements to determine whether the shear calculations were performed in accordance with the ACI 318-63 Code requirements. The team reviewed the revised TVA calculation B25 880118 451, which showed that in some of the original design calculations higher shear stress allowables were used than those required by the ACI 318 Code. However, additional analyses performed by TVA show that all shear stresses were within the code allowables. Therefore, the IDI team considers this deficiency closed and no further action by TVA is required.

(Closed) Deficiency D4.3-6, Minimum Reinforcement for Walls

The review of the original design calculations for some auxiliary building walls showed that the minimum horizontal reinforcement provided was less than the ACI 318-63 Code requirements. TVA provided a horizontal steel area ratio of 0.0020 whereas the ACI 318-63 Code section 2202 (f) requires this amount to be 0.0025. The same TVA calculations also showed that the effective depth "d" instead of the thickness "t" was used to calculate the minimum steel area. The IDI team was concerned that minimum steel areas, less than what is required by the ACI 318-63 Code, could have been provided for the Category I buildings.

In response to this deficiency, TVA performed a review of the calculations for structural slabs and walls in the auxiliary building, reactor building, ERCW pumping station and control building, as documented in TVA calculation B25 870916 453. This review identified approximately 78 cases where the effective depth "d" was used to calculate the minimum reinforcement. TVA has performed additional calculations to determine the actual amount of steel required in accordance with ACI 318-63 Code. Review of the corresponding as-built drawings has shown that for all cases the provided reinforcement was within the Code requirements. The NRC team believes that no further work is required from TVA for this aspect of the deficiency.

In the auxiliary building, the design of the A1 and A15 line walls for minimum horizontal steel used the TVA Temperature and Shrinkage Standard. The use of this standard for these two walls resulted in a minimum percentage of horizontal steel of 0.20 percent in the upper portions of the walls, and 0.55 percent in the lower portions. The additional calculations (B25 870911 450) performed by TVA on the A1 and A15 walls showed that an average of 0.27 percent and 0.34 percent horizontal steel were provided, respectively. These amounts of steel would meet the ACI 318-63 Code requirements. However, the team requested that additional samples of walls be evaluated in a similar fashion.

TVA has performed additional calculations to show that the reinforced concrete walls at Sequoyah Unit 2 meet the requirements of the ACI 318-63 Code Section 2201. Section 2201 states that: "The limits of thickness and quantity of reinforcement required by Section 2202 (in this case the use of a minimum horizontal steel of 0.25 percent) shall be waived where structural analysis shows adequate strength and stability." The TVA calculations performed in response to the IDI show that reinforced concrete walls meet the requirements of Section 916 of the ACI 318-63 Code when stability is considered. Therefore, the NRC team believes that these walls meet the requirements of the ACI 318-63 Code Section 2201 and considers this deficiency to be closed.

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

The auxiliary building roof at elevation 791.75' is supported on structural steel framing made up of girders spanning between trusses. The review of the original calculations showed that the trusses were assumed to be rigid in the vertical direction and unamplified vertical accelerations were used in design. The team was concerned that the roof system was not rigid in the vertical direction and the use of unamplified vertical accelerations would lead to an unconservative design.

In response to this deficiency TVA issued CAQR SQP871386 and agreed that the auxiliary building roof would not be rigid. Additional calculations (B41 871023 001) performed by TVA show that the roof was originally designed for a total uniform load of 275 psf. However, TVA reduced the live load from 50 psf to 30 psf, as per FSAR commitments. Also, a careful review of the roof drawings showed that there was no insulation on the roof and the steel decking dead load used in the original design was too high. Revising all these loads and including a higher seismic load due to roof flexibility, TVA calculated that the actual total load on the roof would be 254.5 psf. This is less than the original design load of 275 psf, leading to the conclusion that the roof is structurally adequate to carry the higher seismic load due to the roof flexibility considerations. The NRC team agrees with this TVA conclusion on the auxiliary building roof.

As a part of generic implications of this deficiency, TVA reviewed other Category I structural steel framing to determine whether the flexibility of roof and floor slabs was considered in the original design calculation (B25 871106 452). This review identified that the condensate demineralizer waste evaporator building roof and various floors of the control building would have similar problems, since the original designs did not consider vertical flexibility. TVA performed additional calculations (B25 871106 451) to determine whether these identified structural elements are adequate to withstand the higher seismic loads obtained when flexibility is considered and the components (piping and equipment) are affected by the additional earthquake induced load. The review of this calculation by the NRC team showed that TVA used 2/3 of the horizontal amplified response spectra instead of the vertical amplified response spectra for the condensate demineralizer waste evaporator building roof evaluation. The team believes that this approach might not be conservative since 2/3 of the horizontal amplified response spectra were used instead of the vertical amplified response spectra. In order to resolve the team's concern regarding the condensate demineralizer waste evaporator building roof and other seismic Category I structures, systems and components, TVA was requested to either review the FSAR to ascertain their commitment regarding vertical input to seismic analyses of subsystems or demonstrate that the use of 2/3 of horizontal amplified response spectra for the vertical input is more conservative than the use of actual vertical amplified response spectra.

In the generic reviews performed to resolve this deficiency, TVA found that 2/3 of the horizontal amplified response spectra were used as the vertical input for three Category I structures. These structures are the condensate demineralizer waste evaporator (CDWE) building, the emergency raw cooling water (ERCW) pumping station and the diesel generator (DG) building.

For the CDWE, FSAR Section 3.7.2.2.3 commits to the use of 2/3 of the horizontal amplified response spectra for the vertical input as the original design basis for the subsystems (piping and equipment). Also, TVA response to NRC IDI inspection report 50-327/87-48 and 50-328/87-48 (L44 871229 810) shows that the ERCW pumping station is rigid in the vertical direction and, therefore, the use of 2/3 of the horizontal rock spectra is conservative for this building.

However, TVA evaluations for the DG building have shown that 2/3 of the horizontal amplified response spectra do not envelope the calculated vertical amplified response spectra. TVA has performed additional seismic analysis to show that the calculated vertical amplified response spectra would be enveloped by the original amplified response spectra if soil-structure interaction was considered by the use of finite element methods. This study is contained in an interim report which was provided to the NRC team during this inspection. The team reviewed this interim report and had the following concerns on this study:

1. A structural damping ratio of 7 percent was used for concrete for the SSE seismic analysis. This is greater than the FSAR commitment of 5 percent. Seven percent damping ratio for concrete structures is not acceptable, unless it can be shown that the stresses in reinforced concrete are near yield strengths.

2. The total soil damping ratio used in the analysis appeared to be greater than the FSAR requirement limiting to a maximum value of 10 percent.

3. There were no amplified response spectra developed for a damping ratio of 1/2 percent to show that the original amplified response spectra were more conservative.

During the inspection, TVA presented the preliminary results of the revised seismic analysis of the diesel generator building which used the 84th percentile site specific earthquake ground motion as input, which is higher than the ground motion used in the original design, and is an analysis approach currently accepted by NRC for new plants. The use of this higher amplitude ground motion combined with the current analysis approach was acceptable to the IDI team.

The SHAKE computer program was used to generate the amplified ground motion at grade and the SASSI computer program was used to perform the soil-structure interaction analysis using the SHAKE output as the input ground motion. The preliminary report, however, did not show the shale material properties used in the SHAKE analysis, and TVA was requested to include such properties in the final report.

These preliminary results showed that the original vertical amplified response spectra were exceeded at frequencies between 7 to 11 Hz. TVA was required to perform additional evaluations to show that safety-related equipment and piping located in the diesel generator building will meet the interim evaluation criteria during and after an SSE, considering the higher vertical amplified response spectra.

TVA in a letter dated March 2, 1988 (L44 880302 814) submitted to the NRC the final version of the report (B41 880227 002) for the diesel generator building seismic analysis and amplified response spectra development. TVA also submitted to the NRC the results of the evaluations performed on the equipment and piping located in the diesel generator building.

The submittal by TVA on equipment qualification shows that the equipment purchased for Sequoyah was qualified to an amplified response spectra that enveloped both the ARS's for the Sequoyah and Watts Bar nuclear plants. These amplified response spectra are greater than those obtained from the ground response spectra, resulting from the 84th percentile earthquake, except in the frequency range between 1 to 3 Hz. However, the difference between the amplified response spectra calculated from the 84th percentile site specific ground motion and that calculated from the design ground motion in this range is minimal and will not affect the functional capability of the safety-related equipment. The design adequacy of piping systems located inside the diesel generator building was reviewed and closed in Inspection Report 50-328/88-12. Therefore, the NRC team concludes that the actions taken by TVA to resolve this deficiency are adequate and considers this deficiency closed.

(Closed) Deficiency D4.3-8, Overturning of Tanks Located on the Auxiliary Building Roof

The auxiliary building roof at elevation 791.75 feet supports four non-safety-related tanks weighing approximately 90 kips to 135 kips. The original design calculations for the structural steel members supporting the tanks did not consider the overturning moments due to horizontal seismic loads. The team was concerned that the allowable stresses for these members could be exceeded if such loads were considered.

In order to resolve this deficiency, TVA performed a coupled seismic analysis of the auxiliary building roof and the tanks (B41 871026 002). This was a linear elastic analysis where the support loads obtained resulted from seismically induced loads, as well as the dead weight of the tanks. These support loads were later used to check the anchorages of the tank to the roof (B41 871103 021). The review of this calculation performed for the demineralizer and the cask washdown tanks showed that the anchor bolts for the tanks would yield under the SSE loading. The same calculation showed that the bolts have sufficient ductility so that failure of the anchorage would not occur. The NRC team requested that TVA extend their analysis to evaluate the consequences of failure of the tanks since there is yielding in the anchor bolts.

TVA also performed an evaluation of the structural steel members supporting the tanks using the loads obtained in calculation B41 871026 002. The NRC team reviewed a portion of TVA calculation B41 871103 008 related to the raw service water tank and concurs that the stresses in the supporting elements were all within the FSAR committed allowable stresses. TVA further evaluated the reinforced concrete corbels that support the 80' long trusses for the increased loads due to the overturning moments. TVA used USD methods for this reevaluation. The use of USD methods deviates from FSAR commitments, and that such reevaluation should use the WSD methods as committed in the FSAR.

TVA has performed additional calculations, B41 871118 013, to show that the rupture of the tanks does not jeopardize the auxiliary building roof. TVA has considered that even with the rupture of the four tanks simultaneously, the loads on the roof would be within the original total design load.

TVA also reevaluated the corbels supporting the roof trusses by the use of the WSD methods, as committed in the FSAR. This reevaluation, B25 880112 450, shows that the corbels are adequate to carry the additional loads imposed by the overturning of the tanks.

The NRC team reviewed both of these calculations and found the results to be acceptable. Therefore, this deficiency is closed and no further TVA action is required.

(Closed) Deficiency D4.3-9, Masonry Block Wall Evaluation for Bulletin 80-11

TVA calculations for the reinforced and unreinforced masonry wall evaluation in response to NRC Bulletin 80-11 could not be located. Although TVA had already identified that these calculations were missing, they did not schedule the regeneration of these calculations until post-restart. The team did not agree with this TVA position because the structural adequacy of the masonry walls could not be assessed without these calculations.

TVA submitted to the NRC team various documents relating to masonry walls during the reinspection performed to close the IDI items. The team reviewed this documentation which were grouped into three categories:

1. Documents relating to the NRC Information Request on masonry walls.

2. Documents relating to NRC Bulletin 80-11.

3. Miscellaneous calculations performed by TVA related to masonry walls.

The review of these documents showed that the masonry wall evaluations have been reviewed by NRC and found to be acceptable based on NRC interim criteria. This is stated in SER Supplement No. 5. However, there is an original license condition that required TVA to evaluate all seismic Category I masonry walls to final staff criteria prior to startup following the first refueling. The team could not locate any documents showing that such an evaluation was made by TVA and submitted to NRC. The team also did not see any documentation showing that the calculations for IE Bulletin 80-11 were reviewed by NRC. Therefore, the team requested that the masonry block wall calculations should be generated prior to restart.

The team review of the TVA design criteria for reinforced concrete block walls (SQN-DC-V-1.1.1, Revision 3) and unreinforced masonry walls (SQN-DC-V-1.1.1.1, Revision 1) showed that there are differences between these criteria and the criteria required by IE Bulletin 80-11 for safety-related masonry wall evaluations. These differences in allowable stresses and load combinations made the masonry walls at Sequoyah less conservative.

TVA performed calculations on nine worst case reinforced concrete block walls to show that they meet the NRC criteria for extreme environmental and abnormal load conditions. These preliminary calculations reviewed by the NRC team showed that the stresses in these nine worst cases due to SSE and tornado depressurization loads were within the allowables set by the NRC criteria. On this basis, the masonry block wall designs were found to be acceptable only for heat up of Sequoyah Unit 2.

Subsequently, the team reviewed the finalized TVA calculations B25 880216 362, for the nine worst case reinforced masonry walls. The review of these calculations showed that all the walls met the NRC criteria for extreme environmental and abnormal load conditions except for one group of walls, where the allowable stresses were exceeded for the OBE load condition. The team requested that further evaluations be made for those walls which do not meet the allowable stress limits of the NRC criteria for the OBE load condition. These evaluations, however, could be performed post-restart.

In addition to these calculations, nine other reinforced masonry walls with openings were selected by TVA in the auxiliary/control building for reevaluation in accordance with the NRC criteria. At the time of the NRC inspection, this reevaluation was still on-going. However, the team reviewed the available preliminary calculations for two walls and found the methodology to be acceptable except that axial and bending stresses were not combined as required by the ACI 531-79 Code. The team requested that the results of this evaluation be submitted to the NRC prior to restart.

TVA, in a letter dated March 2, 1988 (L44 880302 817), submitted the finalized calculations for the nine critical reinforced masonry walls. The review of these calculations (B25 880227 311 through B25 880227 314) showed that all the nine walls meet the allowable stress requirements for the SSE and tornado depressurization load combinations as shown in the NRC criteria. However, four walls failed to meet the allowable stresses for the OBE load combination specified in the NRC criteria. This evaluation is acceptable to the team for the restart, however, further evaluations or modifications are necessary so that all reinforced masonry walls meet the NRC criteria for long-term operation. In response to the team's request, TVA committed in their March 2, 1988 letter to further evaluate post-restart, reinforced masonry walls that did not meet the NRC allowable stresses for the OBE load combination to ensure compliance with the NRC criteria. The team found this acceptable, since the walls were adequately designed to withstand the extreme environmental and abnormal loads. These loads represent the "worst-case" from a structural adequacy point of view.

While performing walkdowns to evaluate the reinforced masonry walls, TVA identified 15 walls that had missing top restraints. TVA reanalyzed these walls to assure that they met the NRC criteria for allowable stresses for tornado depressurization and SSE load combinations. In a letter to NRC dated April 21, 1988 (L44 880421 805), TVA confirmed that missing top restraints had been installed for those walls that did not meet the allowable stresses specified in the NRC criteria for the tornado depressurization and SSE load combinations prior to Unit 2 restart.

The team also reviewed TVA calculations B25 880217 300, which include the evaluation for unreinforced masonry walls in accordance with the NRC criteria requirements. The unreinforced masonry walls at Sequoyah Unit 2 are not seismic Category I walls since they are not load bearing and do not have any safety-related equipment or piping attached to them. The review of the above mentioned calculations showed that the unreinforced masonry walls will not collapse during extreme environmental and abnormal load conditions and therefore, will not jeopardize any safety-related equipment.

In summary, the total of 18 worst case reinforced masonry walls selected by TVA all met the NRC criteria for allowable stresses for the SSE and tornado depressurization load combinations. On this basis, the reinforced masonry walls at Sequoyah are acceptable for restart of Unit 2. TVA has committed to perform further evaluations, post-restart, so that all reinforced masonry walls will meet the NRC criteria for long-term operation which includes the load combination with OBE. Therefore, the team considers this deficiency closed.

Note:

The closure of this deficiency by the IDI team also closes Observation 3.14, "Evaluation of Masonry Block Walls," identified during a previous NRC inspection of TVA's DBVP (50-327/87-14, 50-328/87-14). Observation 3.14 noted that the design baseline and verification program evaluations of engineering change notices were not examining unreinforced masonry block walls in a consistent fashion. The TVA reevaluation which has been performed in response to NRC concerns raised during the IDI regarding masonry block walls adequately addresses the generic aspects of this Observation, therefore, Observation 3.14 is considered closed.

(Closed) Deficiency D.4.4-1, Design of ERCW Pumphouse Structure to Resist Tornado Missiles

The original tornado missile protection calculations for the ERCW pumphouse roof considered only the bending mode of failure. The ductility ratios that were calculated for the steel beam missile protection system exceeded industry standards.

The original calculations did not include the following elements.

- Critical angle of impact. Only 45 degree angle was considered.
- Critical missile impact locations. Only the missile impact at the center of the beam was considered.

- Critical spectrum of missiles for both missile penetration and missile load.
- Analysis and design of the end connections.
- Ductility ratios in accordance with industry standards. Local buckling, lateral and web crippling.

The revised calculations addressed three angles of missile impact, namely parallel to the axis of beam which is 45 degrees from the vertical, vertical and perpendicular to the axis of the beam. The vertical missile appears to be the most critical.

The new calculations also address the critical missile impacting the roof at several locations including the end of the beam which are critical for the analysis and design of the connections.

The revised calculations addressed all of the missiles listed in Table 3.5.5-4 of the FSAR for both missile penetration and missile load. The 3" diameter pipe and the 6" diameter pipe were the critical missiles for missile penetration and the 12" diameter pipe was critical for missile load.

Also the revised calculations address the analysis and design of connections, local buckling, lateral buckling and web crippling.

The maximum ductility ratio used in the revised calculations was 20. This ductility ratio is consistent with Topical Report, BC-TOP-9 Revision 1, "Design of Structures For Missile Impact," Prepared by Bechtel Power Corporation, July 1973.

In general, the revised calculations were found to be acceptable with two exceptions:

The calculations predict that the beams will have large deflections and rotations when impacted by the 12" diameter steel pipe. The vertical deflection of the center of gravity of one of the beams is approximately 19 inches and the rotation is approximately 45 degrees. Subsequently, TVA analyzed the beams and the beam connections. These analyses show that the system can withstand these large deflections and rotations without failure.

Also, the calculations did not adequately demonstrate that the beam connections can resist the 700 kip load predicted by the 12" diameter pipe missile impacting at the end of the beam.

Subsequently, TVA was able to show by calculation that if the beam connection should fail the beams will not become secondary missiles.

The calculations adequately demonstrate that the roof system can resist the loads predicted for the spectrum of missiles listed in Table 3.5.5-4 of the FSAR without catastrophic failure.

This item is considered closed.

(Closed) Deficiency D4.4-2, Analysis of Pile Supports for the ERCW Pipeline

The original ERCW access dike calculation did not consider the vertical earthquake in the stability analysis of the dike. Also earthquake induced deformation of the dike and the relative displacement at the access dike - access cell interface were not computed.

The original analysis of the buried piping did not include the effect of the vertical earthquake in the stress analysis of the piping.

The seismic analysis of this system was performed in two phases. The first phase considered the horizontal analysis of the system and the second phase considered the vertical analysis of the system.

In the area of the ERCW access dike the ERCW pipes are supported on a concrete slab. The slab is supported by steel H-piles driven thru the access dike to refusal.

The steel piles are relatively flexible when compared to the stiffness and mass of the ERCW access dike. Therefore, the piles were analyzed by assuming that the piles conformed to the deformed shape of the dike in the direction transverse to the centerline of the dike.

Revised calculations were prepared to compute the approximate deformations which might be expected to occur as a result of the stresses caused by a seismic event. This approach used the laboratory triaxial shear test data on the rock fill material to predict strains associated with the stress levels.

Results from the calculation indicate that the post-earthquake deformation from one cycle of seismic loading would result in a vertical consolidation of the critical wedge of 1.4 inches. The design earthquake at Sequoyah has six cycles. Assuming that each cycle produces an equal strain, an upper bound deformation settlement of eight inches is computed. Assuming the deformation settlement occurs only on one side of the dike, the differential lateral force is not enough to cause movement of the support structure.

At the dike to access cell interface the dike completely encases the access cells such that the cell and dike must move in phase. Therefore, there cannot be any significant forces applied to the piping at the dike to access cell interface.

The analysis of the piles also assured that the dike would settle and the upper three feet of the piles would not have lateral support. The moment on the piles was then computed using the horizontal acceleration at this elevation and the mass that the piles are supporting.

The slab was analyzed vertically as a continuous slab supported at intervals by piles. No contact is assumed between the slab and the rockfill under it. The slab is designed to resist the computed vertical accelerations in addition to the dead load of rockfill above the slab, the ERCW piping, and the ERCW electrical conduit bank which it supports. The vertical acceleration was taken as 0.3g which is 2/3 the horizontal acceleration.

The ERCW piping was analyzed to include the effects of the vertical earthquake component calculated as described above. The results of this analysis indicate that the stresses in the piping are well below the 2.4 S_h allowable.

The revised analysis demonstrates that the ERCW piping in the ERCW access dike is adequately designed and will remain functional following an SSE.

This item is considered closed.

(Closed) Deficiency D4.6-1, Discrepancies Between Design Calculations and Construction Drawings

The review of design calculations and drawings of various safety-related mechanical component foundations showed that there were discrepancies between the calculations and drawings. The team was concerned that the embedded plates and anchors could be unconservatively designed, and may lead to the failure of mechanical equipment supports.

In response to this deficiency, TVA has prepared a plan which describes the actions that would be taken to resolve the specific and generic concerns relating to equipment supports. With regards to the specific IDI findings, TVA reanalyzed the component cooling water heat exchanger (B25 880131 359) and the containment spray heat exchanger (B25 880131 357) for dead weight, pressure and seismic loads. These calculations, which determine the support loads, were reviewed by the NRC team and found to be acceptable. The loads obtained from these calculations and as-built information were later used to reanalyze the supports for the component cooling water heat exchanger (B25 880202 305) and the containment spray heat exchanger B25 880131 350). The team reviewed both of these calculations and found them to be acceptable. In conjunction with the component cooling water heat exchanger support reanalysis, the team also reviewed TVA calculation B25 870519 300, which is related to the concrete floor slab that supports this heat exchanger. The team found that this calculation was not revised to include the latest loading from the heat exchanger. The team believes that this calculation should be revised to evaluate the slab for the recent heat exchanger load. Also, periodic inspections should be performed on the unreinforced middle pier that supports the component cooling heat exchanger to ensure that cracking of concrete does not occur. TVA's letter to NRC dated March 2, 1988 (L44 880302 813) addressing Deficiency D3.4-3 committed to revise the floor slab calculations and perform the periodic inspections of the unreinforced middle pier.

The third specific IDI finding was related to the component cooling water surge tank anchorage. TVA performed additional calculations (B25 871104 455) which demonstrate that the as-built condition of this tank's support is adequate to resist all seismic loads without exceeding the allowable stresses.

For generic evaluations, TVA has classified the equipment at Sequoyah into three categories, namely; heat exchangers, tanks, other equipment. TVA has reanalyzed 11 seismic Category I heat exchangers and their supports against as-built information that was obtained from walkdowns. The team reviewed the reanalyses of the two heat exchangers described above, namely the component cooling water heat exchanger and the containment spray heat exchanger and found these calculations to be acceptable. TVA also reviewed tank anchorages for 12 Category I tanks and found them to be adequate. The NRC team reviewed samples of these calculations (B25 871104 455). This review by NRC is covered under IDI Deficiency D4.6-2. TVA also selected 60 other component supports (including pumps, electrical equipment, etc.) and compared the information in calculations and on drawings with as-built data obtained from walkdowns to determine whether discrepancies exist.

The evaluations of the 60 component supports were performed in two stages. First, support loads were gathered from available vendor information. If such information could not be located, then additional analyses were performed to obtain the supports loads. In the second stage, the 60 component supports were analyzed using the previously obtained support loads. The team selected six components and performed a review of the calculations involving both stages of this TVA evaluation. These are discussed below.

<u>Reactor Coolant Pump Support</u>

The support loads were documented in TVA calculation B41 871123 007, which were provided by Westinghouse. The details of Westinghouse's support load generation was not available for the team's review. However, the SSE loads were much smaller than the OBE loads, and TVA was requested to obtain Westinghouse's justification. In a letter dated March 2, 1988 (L44 880 302 801), TVA provided the justification of the differences between the SSE and OBE loads. A conference call took place on March 3, 1988 between NRC, TVA and Westinghouse since the Westinghouse justification was not clear. Westinghouse stated that for the critical support column, the contribution of the SSE loads and the OBE loads to the total design load was minimal since the LOCA loads are the dominant design loads. For example, the contribution to the uplift load on this column for OBE, SSE and LOCA were stated to be 67 kips, 11 kips and 1694 kips respectively. Similarly for bending, the moments were stated as 83 kip-inches for an OBE, 79 kip-inches for SSE and 2778 kip-inches for a LOCA.

On this basis, the team believes that the support evaluation performd by TVA is acceptable for restart. However, TVA was requested to justify the relative magnitudes of the SSE and OBE seismic support loads post-restart.

The evaluation of the reactor coolant pump support was documented in TVA calculation B25 880231 457. TVA's evaluation showed that the support did not meet the design requirements specified in Attachment A to Design Input Record SCG1S173X-1, Revision 1, but would meet the NRC Standard Review Plan criteria. TVA has committed that after Sequoyah Unit 2 restart, the support of the reactor coolant pump will be further evaluated to ensure that it meets the design criteria requirements for the extreme load combinations. Since these extreme load combinations are associated with low probability events, e.g., combined SSE and LOCA, the team believes that this evaluation of the reactor coolant pump support can be performed post-restart.

Compressor, Condenser Unit Support

The team reviewed TVA calculations B41 871103 022 and B25 880129 489. The team believes that both the support load generation and support evaluation were adequate. However, calculation B41 871103 022 identified that a nut was missing from the support when it was inspected. TVA was therefore requested to confirm that the missing nut has been replaced. In a letter dated March 2, 1988, TVA submitted documents to the NRC stating that the nut was installed on January 15, 1988. Therefore, this support evaluation is acceptable to the team.

Anchorage for Air-Cooled Refrigerant Condenser

The team reviewed TVA calculations B41 871118 027 and B25 880129 490 relating to this equipment and found these calculations to be adequate. Therefore, the support evaluation for this item is acceptable to the team.

Lower Component Cooling Unit C-A

The team reviewed TVA calculations B41 871207 012 and B25 880130 468 which evaluate this component's support. The review showed that these calculations are acceptable to the team except that TVA was requested to justify the equipment frequencies used in calculation B41 871207 012 to determine the seismic loads. In a letter dated March 2, 1988 TVA has committed to revise calculation SCG-4M-00177, Revision 1, post-restart to incorporate this justification. Therefore, the team considers this support evaluation to be acceptable.

Residual Heat Removal Pump

The team reviewed TVA calculations B41 880107 001 and B25 880201 300 which both relate to the support evaluation of this component. During the review of calculation B41 880107 001, the team could not determine whether the nozzle forces were included in the load combination with seismic loads. Also, the team could not determine whether the vertical seismic loads used in the above mentioned two calculations were consistent. In a letter dated March 2, 1988, TVA has committed to revise calculations SCG-4M-00210, after the restart of the plant to provide better documentation for the nozzle loads used. TVA also has committed to revise calculations SCG-15173X-082, post-restart, to provide better documentation showing the consistency of the vertical seismic loads used in the support calculations. Therefore, the team believes that the evaluation of this support including the TVA commitments are acceptable.

Item #122 - 480 Volt Shutdown Board Transformer 2B1-B

The team reviewed TVA calculations B41 871218 009 and B25 880129 456 which are related to the support evaluation of this equipment. These calculations are acceptable to the team except that TVA should document the vendor qualification of the 3/4" diameter bolts shown in calculation B25 880129 456. In a letter dated March 2, 1988, TVA committed to revise calculation SCG-1S29X1293, post-restart, to provide a calculation qualifying the 3/4" diameter holddown bolts. The evaluation of this support and the commitment by TVA is acceptable to the team.

In conclusion, the evaluations performed by TVA to resolve this deficiency are acceptable to the team. Therefore, this deficiency is closed.

(Closed) Deficiency D4.6-3, Seismic Analysis of Steel Tanks

The review of the original seismic calculations for certain steel tanks showed that shear stiffness was neglected in the frequency calculations. The omission of shear stiffness in the seismic analysis of tanks could result in an over-estimation of the frequency such that the tank would incorrectly be assumed to be rigid.

The team reviewed calculations for 11 representative seismic Category I tanks which were regenerated or compiled by TVA in response to this deficiency. The 7-day diesel generator fuel oil tank, diesel generator starting air tank, control air receiver and the UHI surge tank were determined to be rigid, therefore this deficiency is not applicable to these tanks. The waste gas tank, boron injection tank, safety injection tanks, diesel generator day tank, refueling water storage tank and the UHI water and gas accumulator tanks were determined to be flexible. The team reviewed newly regenerated natural frequency calculations, the seismic load generation and the supports (TVA Calculation B25 880131 367) for these tanks and found them acceptable except for the diesel generator day tank and the refueling water storage tank.

The team reviewed a new TVA calculation B25 880208 301, in which the results of the diesel generator day tank were documented. A vertical seismic analysis was performed using a solution routine for large displacements of the ANSYS computer program. The results of the analysis indicate that a membrane action mechanism developed, which enabled the tank to withstand the vertical forces due to the dead load and peak amplified vertical response spectra load for the SSE. This calculation was acceptable to the team.

The team also reviewed the analysis of the Sequoyah refueling water storage tank (RWST). The RWST is unique in that it is the only seismic Category I tank that is supported by a soil foundation.

During the inspection the team reviewed the dynamic analysis, the buckling analysis and the tank anchorage analysis performed by TVA on the RWST, which are included in calculation B25 880208 302. The dynamic analysis was performed using a stick model with lumped soil springs and dampers corrected for soil layering effects (i.e., soil over rock). The final response was performed limiting the composite modal damping to 10 percent. The buckling analysis was based upon the methodology of Baker and supplemented by the ASME Code Case N-284. The method took into consideration the effect of hydrostatic pressure and conservatively ignored the presence of tank stiffeners.

The anchorage of the RWST is provided by embedded anchor bolts and shear keys. The anchor bolts resist the tensile forces resulting from the seismic overturning moment and participate to some extent in resisting base shear through shear friction. The shear keys carry most of the seismic base shear based on a conservative value of bearing stress. The calculation showed that the seismic forces are effectively transferred to the concrete foundation.

The team found the dynamic analysis, buckling analysis and anchorage calculations performed by TVA to be acceptable. In conclusion, the TVA actions taken to resolve this deficiency are acceptable to the team. Therefore, this deficiency is closed and no further action from TVA is required.

INSTRUMENTATION & CONTROL

(Closed) Deficiency D5.2-1, Inconsistency of ERCW Safety Classification in FSAR

This item identified inconsistencies in the FSAR regarding safety classification of certain ERCW components presented in FSAR Tables 3.2.1-2 ("Summary of Criteria - Mechanical Systems Components") and 3.11.1-1 ("Electrical and Mechanical Equipment Required to Function During and/or after an Accident"). The team, however, did not find any misclassification of safety-related instrumentation and control systems, functions, or components in the ERCW instrumentation. The team requested that TVA review the generic implications of this deficiency.

In their response, TVA agreed that FSAR Table 3.2.1-2 had an incorrect TVA classification for the ERCW strainers, although the correct classification (TVA Class C) had been identified in FSAR 9.2.2.8. TVA's proposed revision of Table 3.2.1-2 to correct this discrepancy was reviewed by the IDI I&C and Mechanical Systems disciplines and appropriately addressed the inconsistency.

Regarding the screenwash valves and traveling screen drives in Table 3.2.1-2, TVA stated that the motors associated with these items are not considered "mechanical" components, therefore, it would be inappropriate to include these and other motors in FSAR Table 3.2.1-2 as they receive no mechanical classification. The team agrees. TVA further stated that the screenwash piping and valves are presently identified as TVA Class G on applicable design documents, but that corrective action had been initiated by TVA SCR SQNMEB8403 R3 prior to the IDI to verify that the existing design and hardware meet the intent of TVA Class C. TVA proposed a revision to the table to identify the correct safety classifications. Based on this scope interpretation for Table 3.2.1-2, TVA's corrective action cited above, and the CCTS commitment to revise the FSAR table (which includes the correct classification commitments for the traveling screens, screenwash valves, and ERCW station air compressor valves), the team concluded that the safety classifications presented in TVA's proposed revision of Table 3.2.1-2 resolve the team's concerns.

Regarding FSAR Table 3.11.1-1, TVA stated that this table is not intended as a detailed equipment list, therefore, they had not included a level of detail identifying specific loads such as the screenwash valves and traveling screen drives. Based on a review of the detail provided for other fluid systems presented in Table 3.11.1-1 and previously accepted by the NRC staff, the team agrees that greater detail in the FSAR is not required, provided that safety classifications for such individual components are clearly provided in the plant design basis and design documentation. As stated in our initial finding, the team did not find any deficient or ambiguous safety classifications in the ERCW instrumentation and control design documentation; the team concluded that Table 3.11.1-1 is acceptable on the basis cited above.

The team's generic concerns about equipment classification were also expressed in IDI findings D2.3-1 ("Inadequate Substantiation of Design Commitments for ERCW Piping") and D2.3-4 ("ERCW Screenwash Pumps not Produced to ASME III"). Based on TVA's generic responses to those findings as discussed elsewhere in this report and on the basis cited above, this item is closed on both a specific and generic basis.

(Closed) Deficiency D5.2-2, Inadequate Tag Identification of Control Switches in Control Room Panels

This item resulted from a walkdown in which the team found several examples in the rear of the ERCW main control room panel OM27A where the unit prefix identification had been omitted from the identification tag on the rear of the control switch module. This practice can result in duplicate tag numbers at the rear of the panel, and is a nonconformance to TVA Equipment Specification 678855 Revision 0 and name tag fabrication requirements contained in TVA Mechanical Instrument Tabulation 47B601-67 series, Revision 20. Apart from the specification nonconformance, the team was concerned that the absence of the unit prefix could increase the potential for a maintenance error that could affect ERCW operation for both units.

TVA's response noted that the panel specification 678855 cited by the team applied to other main control room panels, but not to panel OM27A; panel OM27A is governed by TVA Specification 678879. The latter specification is similar to specification 678855 but no requirement for rear panel labeling of devices was included. While the team agrees that technically there is no specification requirement for such labeling on panel OM27A, we note that rear labeling had been provided, and as a matter of good practice, all of the general tagging requirements of the TVA Instrument Tabulation should be applied throughout the panels. However, the team's primary concern was potential for human error that might result from omission of the unit prefix.

TVA evaluated the possibility of human error using human factor discrepancy assessment criteria similar to that used in their Control Room Design Review (CRDR) program; a Safety Evaluation Report for the CRDR was issued in August 1987. This assessment considered probability of occurrence, consequences of the error occurring, and time to recover from the error if it occurs. For the situation of interest, TVA postulated an error in removing the device from service at the rear of the panel (implicitly assuming that service personnel would only use the tag identification and would ignore other design/maintenance documentation). TVA then determined that the consequences of removal would not result in component or system damage (due to features inherent in the control circuits), although controls could be disabled until corrected. Finally, TVA determined that the time to recover would be brief, since an operator would notice the incorrect unit device being removed from the front of the panel (where the unit prefix is always shown), and would immediately instruct maintenance personnel to restore the device to service. TVA concluded that the CRDR assessment methodology would rate this as a low priority human engineering discrepancy not requiring corrective measures.

As a matter of uniform labeling practice, the team would prefer that the unit prefix be added to the rear panel device tags. However, based on the evaluation cited above, we agree with TVA's assessment that there is no significant adverse effect on safety if the unit prefix is missing on the rear tags, and that technically there is no specification violation; consequently, this item is closed.

(Closed) Deficiency D5.2-3, Ineffective ERCW Alarms

This item reflects the team's concern, based on the observed performance of the ERCW control room alarms during a walkdown, that excessive invalid or nuisance alarms exist in the ERCW system. The team believes that if this sample were representative of other plant systems, the annunciator system could be ineffective as an operator aid, particularly during multiple alarm plant transients. Consequently, any credit taken for operator action in response to an alarm may not always be valid.

TVA has stated in their response that no credit is taken for the annunciator in safety-related actions. The team does not agree with TVA's interpretation that IEEE-279 is not a valid basis for the finding; however, the team does find TVA's actions in resolving this finding responsive to our concern and acceptable, as discussed herein. Regarding interpretation, the team believes that since the ERCW system is a vital engineered safeguards support system that performs a protective function and embodies protection system signals (such as safety injection and loss of offsite power), that the IEEE-279 requirement for unambiguous alarms is applicable to certain ERCW and other alarms, albeit the alarm hardware and other design aspects need not be safety-related. We believe this item meets the restart criteria since operator response to a plant transient or safety system/protective action malfunction could be adversely affected by incoherent alarms.

In response to our concern, TVA has stated that the following action is being taken:

1. Obsolete alarms from the original ERCW pumping station will be removed prior to restart.

2. Alarms which can be cleared by performing maintenance will be cleared prior to restart.

3. The low ERCW flow nuisance alarms will be removed prior to restart; TVA has determined that because of the variety of normal system flow conditions that can exist in the ERCW, it is not practical nor necessary to detect system malfunctions with low flow alarms since better alarms/indications such as low header pressure exist. The team agrees with this assessment.

4. As a part of TVA's previous control room design review (CRDR) submittal that committed to detailed evaluation/corrective action regarding the

annunciator system, any remaining deficient control room alarms in either the ERCW or other systems will be addressed. Implementation of any corrective actions will be done in accordance with the schedule requirements of the NRC Safety Evaluation Report for the Sequoyah CRDR dated August 27, 1987.

The team agrees with TVA that action items 1, 2, and 3 above will eliminate a sufficiently substantial number of the problem alarms identified during the inspection. We also believe that proper implementation of TVA's existing CRDR commitments to the NRC should adequately address in a timely fashion any remaining concerns for the ERCW alarms or for other control room alarms. The team notes that the TVA submittal states that portions of the annunciator review are best done at power; the team agrees.

The team finds TVA's response as understood above to be acceptable. TVA was requested to confirm implementation of above actions 1, 2, and 3 prior to restart, and confirm that action 4 had been entered in the SQN CCTS. The team confirmed that actions 1, 2, and 3 had been entered in the CCTS for completion prior to restart, and that action 4 was an existing CCTS commitment. In a letter to NRC dated April 21, 1988 (L44 880421 805), TVA confirmed the completion of corrective actions 1, 2, and 3. This deficiency is closed.

(Closed) Deficiency D5.2-4, Inadequate Electrical Isolation of Non-Class 1E Traveling Screen Speed Switch

This item identified four isolation fuses having inadequate coordination with the upstream control power fuses for the traveling screen control circuits; consequently, a seismic event could render all traveling screens inoperable by shorting the non-1E devices and causing both the isolation fuses and the control power fuses to clear.

As with deficiency D5.2-3, TVA does not agree that IEEE-279 is a part of the basis for this finding. While the team does not agree with this aspect of TVA's interpretation of IEEE-279, the team finds TVA's responses in resolving this finding responsive and acceptable, as discussed herein. Regarding interpretation, the team notes that the traveling screens perform a protective function in assuring operability of the ultimate heat sink for engineered safeguards of both units. Additionally, in the original design basis, the screens were to be automatically actuated; the team understands that the present manual mode of operation under administrative controls is a temporary one. The team believes that automatic operation of the traveling screens is a protective function for which the isolation and single failure requirements of IEEE-279 apply. The team also notes that TVA's corrective action complies with those aspects of IEEE-279 under their licensing basis as well as with TVA's design criteria.

In response to our concern, TVA developed a DCN to replace the fuses and resolve the coordination problem prior to restart. During our follow-up inspection in the week of February 1, 1988, the team confirmed that DCN X00078A replacing the fuses had been completed by TVA per the TROI closure form. A discrepancy in the fuse numbering in the initial version of the CAQR and the DCN was noted by the team, but this discrepancy had been previously noted and corrected by TVA in a revised CAQR which the team subsequently reviewed and accepted. The discrepancy in the initial CAQR resulted from using an earlier revision of the reference schematic diagram which showed fuse numbers that had since been revised in accordance with TVA's fuse renumbering program (in accordance with TVA procedure SQEP-34 and ECN L5880). By reviewing the current schematic, the team determined that DCNX00078A provided the correct numbering. On the preceding basis, the IDI team concluded that the traveling screen speed switches are now correctly isolated, and that fuse numbering and identification is not a concern.

Regarding the team's generic concerns about fuse coordination, TVA has performed prior studies of the ac and dc power systems for common mode failure of non-Class 1E circuits connected to the power system (10 CFR 50, Appendix R analysis and coordination studies); a cascade fuse analysis study of fuse combinations in the Class 1E 120V ac and 125V dc distribution (Ref. TVA Calculations SQN-CPS-013, SQN-E1-004); and a study done to assure isolation of the Crydom relays used for status monitoring system inputs from switchgear, motor control centers, and instrumentation panels. TVA had established the identity of the fuses in the studies through a walkdown program. Although these recent studies were comprehensive, they did not include all 1E/non-1E 120V ac series fuse combinations within individual motor control centers (i.e., situations as identified in this finding). TVA will investigate the latter situations to assure fuse coordination as a post-restart study scheduled for completion in March 1988. TVA believes that the only other cases where isolation is dependent on fuse coordination are the Crydom relay circuits previously analyzed, but this will be confirmed by the proposed additional analysis.

TVA has determined that the root cause of the deficiency was failure in the preparation of ECN L5637 to provide a complete fuse coordination study. Existing plant and DNE procedures SQEP-34, AI16, and DS-E8.1.2 require analysis of fuse substitutions listed in the approved design standard. These standards and procedures apparently were not in effect during preparation of the ECN. TVA has revised Design Standard DS-E8.1.2, Revision 3, to further emphasize the importance of coordination analysis and require that interim emergency substitution of unanalyzed replacement fuses be regarded as rendering the installed circuit inoperable for technical specification purposes; the interim period for such substitutions could not exceed the lesser of 72 hours or the allowable technical specification operability limit for the system of interest. Also, TVA has instituted a calculation checklist under TVA EEB procedure methods as part of the change control process; this will further identify the need for fuse coordination analysis when ECNs are being prepared.

TVA believes that this finding is an isolated case, since they state it has not been common practice to retrofit isolation of non-1E devices except for the Crydom relay circuits previously analyzed; based on information reviewed, the team tends to agree and expects the proposed TVA analysis to confirm this limited practice.

The team finds TVA's corrective actions acceptable for both our specific and generic concerns. TVA confirmed the fuses have been replaced prior to restart, and committed in the CCTS to completion by April 1, 1988 of their motor control center control circuit fuse study. Based on this CCTS commitment, this item is closed.

(Closed) Deficiency D5.2-5, Inadequate Separation of Redundant Main Control Board Wiring

During the July 28, 1987 walkdown of the ERCW control room panel, the team identified deficiencies in the installation of braided metallic sheathed cable, where the braided sheaths of redundant trains of control cable were touching or could migrate with time to touch; this was in violation of FSAR requirements. In response to this finding, TVA performed a QC inspection of all main control room panels to specifically identify all wiring requiring corrective action to achieve conformance with the FSAR separation criteria. TVA committed to correcting these deficiencies by installing approved spacers to separate and secure the cables. TVA stated that these modifications would be done under the design control program so that no new unanalyzed failure modes would be introduced through the use of different materials or techniques. The necessary modifications would be completed prior to restart. The team found this approach acceptable.

In accordance with the FSAR, TVA takes credit for metal braid in lieu of 6-inch or solid barrier separation only for circuits in main control room panels which contain redundant safety-related wiring, and which were supplied by Westinghouse. On this basis, the team found TVA's generic response acceptable.

During the February 2, 1988 site visit, the team inspected the modifications made in the ERCW panel and in portions of the operator console. These modifications consisted of installing fiber tubing spacers for supporting cable ties/clamps to achieve the required separation. This technique is specified in Detail "D" of TVA drawing 45W1640 R6, which was also reviewed by the team. TVA confirmed that retrofit of the spacers had been completed.

Based on our review of the engineering requirements for the corrective action cited above and physical inspection of a sample of the installation, this item is closed.

(Closed) Deficiency D5.2-10, Adequacy of ERCW Instrumentation Provided for Detection of a Break in Non-Seismic ERCW Piping

This item concerns the effectiveness of the alarms and indicating lights currently provided for detection of breaks in non-seismic ERCW piping during a seismic event. TVA had not demonstrated that manual isolation of a double-ended break could be done in sufficient time in response to the available alarms/indicating lights.

TVA committed to install automatic isolation to isolate the non-seismically designed piping from seismically designed ERCW piping in the event of a pipe break in the non-seismically designed piping. The team had asked TVA to also address in their response the acceptability of accuracy and repeatability errors in the required flow measurement.

TVA developed DCN X00113A which provides for automatic isolation of a break in the TVA Class H ERCW lines serving the turbine building. This isolation would be initiated in each line by a coincidence of high flow and low pressure in the line. TVA is providing a Class 1E flow and pressure channel in each of the two TVA Class C piping trains; the coincident signal in each train will close the corresponding isolation valve and mitigate the loss of ERCW through the break. The flow measurement will utilize existing elbow taps in the Class C piping which are currently used for the high flow alarm channels. A pressure switch will be added to each line. The purpose of the coincidence logic is to reduce vulnerability to spurious closure of the isolation valves, which could lead to a plant transient or trip in both units by isolating ERCW supply to critical non-safety-related cooling loads in the turbine building.

The team reviewed DCN X00113A and discussed its implementation during our February 2, 1988 site visit. We found the automatic isolation concept to be acceptable. Since implementation was incomplete at that time, we requested that the control room personnel demonstrate that adequate interim manual procedures were in place to assure adequate break mitigation capability during plant heatup; they produced Abnormal Operating Instruction AOI-9 R9 dated November 3, 1987 which added a specific step for detection and mitigation of the ERCW line break of interest following an earthquake. Detection would utilize the existing high flow alarms and the existing seismically qualified high flow status lights. The seismically qualified manual controls for the isolation valves were also referenced in the procedure, and are readily available to the operator. While the team requires that automatic isolation features be operational prior to restart (i.e., criticality), the team concluded that these interim manual measures are acceptable for plant heatup.

The Instrumentation and Control and Mechanical Systems IDI disciplines reviewed the flow and pressure setpoint calculations and demonstrated accuracy calculations provided by TVA Calculation FT-67-206 R2 (RIMS B25 880110 801). TVA also provided a response addressing the accuracy and repeatability of the elbow taps in response to our recent request. In that response, TVA clarified that elbow tap accuracy was included in the calibration setup error value developed in the referenced calculation. The elbow flow constants were determined from in-place testing, and the worst-case calibration errors (due to orifice inaccuracies and calibration equipment errors) were included in the determination of overall channel accuracy. Based on this clarification by TVA, the team concludes that the demonstrated accuracies are sufficiently conservative for this application.

Regarding our concern about repeatability of the elbow tap measurement, TVA demonstrated from various test values provided in the referenced calculation that the elbow constants derived from different test flow rates and different piping configurations were within an acceptable tolerance. TVA also confirmed that over 20 diameters of straight piping were available upstream of one elbow (which in itself should promote good repeatability). For the other elbow, there is an open butterfly isolation valve about two diameters upstream; however, TVA demonstrated that the comparatively low variance in values of the flow constant for this elbow that were derived from tests under various flow conditions indicates that the butterfly valve does not appear to have a significant effect on the elbow flow measurement for this application.

Another requirement for acceptably repeatable elbow tap measurements is that turbulent flow conditions should exist. TVA demonstrated by calculation that turbulent flow conditions exist at the tested flow values and at the setpoint values for both elbows.

Based on the clarification of the tests and calculations cited above, the team concludes that acceptable accuracy and repeatability of the flow and pressure measurements required for break detection has been demonstrated. We also reviewed the design and qualification requirements provided in DCN X00113A and found them acceptable. The IDI team confirmed TVA's CCTS commitment to having the automatic isolation features fully operational prior to startup. For plant heatup, the interim manual procedures cited herein were acceptable to the team.

In a letter to NRC dated April 21, 1988 (L44 880421 805), TVA confirmed that the automatic isolation provisions for the non-safety-related portion of the ERCW system are installed and are functional. This item is, therefore, closed.

(Closed) Deficiency D5.3-1, Inadequate Shutdown Capability Outside Control Room: Traveling Screen/Screenwash Circuits

This item concerned a situation the team identified where short circuits induced by a design basis control room fire could prevent operation of the ERCW traveling screens and screenwash pumps. If debris were present, this could disable the ERCW system for both units.

TVA will independently fuse the main control room circuits exposed to the design basis fire. These fuses will be coordinated with the control power fuses to prevent loss of control power at the pumping station. These changes will be implemented prior to restart.

TVA determined that the root cause of this deficiency was failure to include the traveling screen and its auxiliary equipment in the SQN 10 CFR 50, Appendix R functional requirements, and not a failure to recognize vulnerability of local control circuits to fire induced failures in portions of the circuits that provide status indication in the control room.

Since the SQN licensing basis allows credit for properly coordinated fuses for isolation purposes, the team finds TVA's corrective action acceptable. Based on the information reviewed, the team agrees with TVA's determination of root cause.

TVA issued DCN X00059A with the intent of providing the required isolation of control room portions of the traveling screen backwash pumps and traveling screen drives control circuits. However, when the revised schematics were retrieved by TVA during the February 1 - 5, 1988 inspection for use by the team, TVA discovered that the required isolating fuses for the traveling screen drives status lights had inadvertently been omitted in the design modification; thus the modification did not completely fulfill TVA's commitment to corrective action. TVA immediately issued CAQR SQN 880124 identifying this problem, and developed FCR 6740 to provide the necessary corrective action. The team reviewed the recent CAQR and the FCR and determined that all of the changes required to provide control room isolation and correct the subject deficiency had now been addressed. TVA later verified that the supplemental corrective actions had also been implemented.

Based on the corrective actions cited above, the team considers this item closed. We note that TVA's error in implementing this corrective action appears to be an isolated one and not characteristic of other instrumentation and control corrective actions the team reviewed. The original intent of TVA's corrective action appears to have been inadvertantly distorted in subsequent documentation. However, the team believes it is unlikely that this error would have been detected prior to heatup if we had not requested that the DCN documentation be retrieved. Accordingly, we strongly recommend that TVA's engineering assurance efforts be increased for modifications required to assure that the requirements of the corrective actions are fulfilled.

(Closed) Deficiency D5.4-1, Adequacy of Freeze Protection for Instrument Lines in the ERCW Pumping Station

This item concerns inadequate freeze protection for safety-related instrument lines in the ERCW pumping station. The team was concerned that since non-1E heaters are used, their failure could go undetected during a seismic event. In addition, the team found no procedures that would assure freezing would be detected in a timely fashion under normal or seismic conditions.

In response to the team's concerns, TVA revised AOI-9 to add specific procedures such that the ERCW pumping station will be manned within three hours of any seismic event; this would allow local control and supervision of the screenwash pumps and strainer backwash without relying on the vulnerable instrument lines. TVA also revised SI-606 to add lower limits (40°F) on environmental temperatures for the ERCW pumping station and the diesel generator areas. These temperatures are monitored every 8 hours during normal and abnormal conditions; the control room will be notified immediately if the 40°F limit is reached. TVA stated that Class 1E power is available if temporary space heaters are required due to failure of the installed heaters.

To further pursue any generic concerns, the team had sampled three additional areas where Class 1E instruments could be located and cold temperatures could be encountered; the refueling water storage tank, the condensate storage tank, and the atmospheric steam dump valve areas (East and West valve vaults). TVA stated that instrumentation for the tanks is heat traced and demonstrated that the valve vault rooms have low temperature surveillance limits.

The team finds TVA's response and corrective action acceptable on both a specific and generic basis. Based on our confirmation during the follow-up inspection of February 1 - 5, 1988 that the revised procedures had been issued, this item is closed.

(Closed) Deficiency D5.4-2, Seismic Qualification of Westinghouse Switches

This item documented seismic qualification of a Westinghouse supplied vertical control room panel and two Westinghouse switch models to margins of safety less conservative than the three-fourths criterion stipulated in FSAR 3.10.2.

TVA has confirmed that Westinghouse provided generically qualified systems through a program of topical reports which have received NRC approval, but which did not specifically reflect the three-fourths margin of safety specified in FSAR 3.10.2.

The team reviewed the separate qualification reports for the panel and switches and confirmed that the panel response levels at the switch mounting locations are adequately enveloped by the switch excitation levels.

TVA will amend the FSAR to remove the three-fourths criterion from FSAR 3.10.2. The proposed revision was provided in TVA's response to finding D3.4-7 ("Chiller Unit Seismic Qualification") and was reviewed and accepted by the team. Based on TVA's CCTS commitment to this FSAR revision, the team considers this IDI item closed.

(Closed) Unresolved Item U5.4-3, Adequacy of Seismic Qualification for Field Located Relays, Timers, and Terminal Blocks

This item concerned the potential for invalidating seismic qualification of field located devices on switchgear, motor control centers, and other panels. In response to the team's concern, TVA performed a 100 percent review of the Class 1E power systems equipment where the control devices of interest had been annotated for field location on the drawings. This review included all Class 1E switchgear, motor control centers, and shutdown logic relay panels.

The review identified the following types of components that had been field located: fuseblocks, terminal blocks, arc suppression networks (for the Crydom control relays), timer relays, solid state relays, elapsed time indicators (non-1E), and auxiliary relays. All of these devices are passive, except for the timer relays, the non-1E elapsed time indicators, and the auxiliary relays. The timer relays are spares requiring engineering approval prior to use.

TVA CEB judged that the passive devices would tolerate the anticipated acceleration levels based on experience or similarity to other devices (e.g., other qualified fuses or terminal blocks).

TVA stated that the auxiliary relays (Westinghouse MG-6 and two Allen-Bradley models) were identical or sufficiently similar to relays qualified by the shutdown board or motor control center vendor, and that the TVA analysis performed during the inspection demonstrated adequate margins of qualification for the locations of the devices. TVA also determined that no more than two relays were ever added to the same compartment; this represents approximately 10 lbs. of additional weight per compartment. This comparatively small amount of added weight, TVA determined, would not compromise the seismic qualification of the instrument panels. TVA also stated that more recent practice prohibits field location of Class 1E devices without specific engineering evaluation.

During the February 1 - 5, 1988 follow-up inspection, the team reviewed two formal calculations issued by TVA documenting the preceding supplemental analysis. Calculation SQN-E5-008 documented the 100 percent drawing review and the field verification performed for engineering input to the seismic analysis of the field located/procured components. Calculation SCG-4M-00281 provided the seismic analysis demonstrating qualification of the panels and their field located/procured components. The instrumentation and control and mechanical components IDI disciplines reviewed these calculations and found them acceptable. The team noted that the drawing review and field verification appeared very thorough and well documented. Based on our review, this item is closed.

(Closed) Deficiency D5.6-1, Inadequate Specification of Background Radiation for ERCW Effluent Liquid Radiation Monitors

This item concerns the inability of the ERCW effluent monitors to detect radiological leakage during a design basis accident due to high accident background radiation levels, FSAR 11.4.2.1.2 takes credit for these monitors in detection and mitigation of a leak during an accident.

TVA originally stated that this is an error in the FSAR, that the monitors are only required for effluent monitoring during normal operation, and that no credit is taken for these monitors during an accident.

In their response, TVA provided a proposed revision of FSAR 11.4.2.1.2 which clarified the role of the monitors as being limited to detection of leakage during non-accident conditions. No credit appears to be taken in Chapters 7 or 15 of the FSAR for operation of the monitors during accident conditions. On that basis, the team concluded the CCTS committment to revise the FSAR was acceptable and this item was closed. However, in a letter to NRC dated April 21, 1988 (L44 880421 802) TVA stated that the ERCW radiation monitors could detect radiological leakage during a design basis accident and therefore, it is not necessary to revise FSAR Section 11.4.2.1.2. This new response will be reviewed by NRC's Office of Special Projects. Therefore, this item is closed for the purpose of this inspection.

(Closed) Deficiency D5.6-2, Inadequate Specification of Pressure and Temperature Ratings for ERCW Effluent Liquid Radiation Monitors

This item concerns insufficient pressure and temperature ratings for the ERCW effluent liquid radiation monitors. While the specification values were deficient, TVA determined during the inspection that the pressure and temperature ratings of the installed monitors were adequate for the service conditions. Apart from this nonconformance to quality assurance requirements, the team was concerned that other instruments might have been inadequately specified.

Regarding the root cause of this finding, TVA notes that the monitors were purchased before the ERCW flow diagram was issued, and were specified to meet the actual system parameters then existing at the process interface, not the ERCW system design parameters.

In their response, TVA also addressed the team's generic concerns by referring to two previous studies performed for similar concerns. In an earlier review by Black & Veatch for Watts Bar, a concern was identified regarding safety related control valves procured by TVA EEB. A subsequent review by TVA for Sequoyah indicated that safety-related control valves met the system design pressure and temperature requirements (EEB 840124 934). Also, a generic concern about specification of instruments to meet system pressure boundary requirements had been raised during the Sequoyah DBVP. A review of instruments covered by the ECNs reviewed by the DBVP had been performed by TVA to assure adequate pressure rating for system boundary conditions, and no problems were identified (B24 870123 038). The team reviewed the scope and results of the latter ECN study and found it appeared sufficiently comprehensive for providing a basis for a generic conclusion.

Regardin the potential for future occurrences of incorrect specification of pressure ratings, the team notes that in TVA's response to finding D2.2-1 ("Design Pressure of ERCW System") they state that design interfaces are more tightly controlled than in the past; specifically, TVA Administrative Instruction MEB-AI 17 R1 emphasizes the need to specify design pressure and temperature in all system and component interfaces, based on the system design criteria. Additionally, NEP-4.1 prohibits changing system design pressures or temperatures without first verifying and documenting that all components and equipment in the system meet the new conditions. The team agrees these requirements should promote correct specification of temperature and pressure ratings for future procurement.

Based on the team's review of the TVA responses as cited above, our generic concerns have been resolved and this item is closed.

(Closed) Unresolved Item U5.8-1, Instrumentation and Control Design Documentation Deficiencies

This unresolved item concerned apparent deficiencies in demonstrating inter-discipline review, lack of revision levels or dates on certain documents, and questions regarding the completeness of an instrument tabulation that did not appear current.

TVA provided a detailed response. Regarding multidiscipline review, TVA explained that EN DES EP 4.04 was the procedure in force at the time; that procedure required documentation of the interface review comments during "squad checking" on a temporary form which could be disposed of after the drawing was initialed by the reviewers and their management, signifying acceptance of the revision. The initialed drawing rather than the temporary comment form was the only permanent record required of specific interface review. For the specific case identified by the team (Logic Diagram 47W611-67-4 R7), TVA explained that the drawing change was governed by exception C to TVA NEP-6.1, which waives the requirement for interface review if the changes are limited to clarifying notes that result in no subsequent change to other design documents or physical changes to the plant. Upon further review of the drawing in question in light of the applicable TVA procedures, the team agrees that engineering interface review would not have been required for this change, since in this case a note was added pertaining to operation but not to design.

Regarding Construction Specification N2M-865, TVA explained that since the mechanical design requirements and fabrication details of ducts and piping are solely within the purview of NEB (the preparer of the specification), no interface review was required. TVA referenced interdepartmental reviews that were performed on the specification in accordance with EN DES EP-3.04 which was in force during the revision. The team agrees that in this situation, additional interface review would not have been required.

Regarding the lack of revision number or issue date on radiation monitoring specification 1491, TVA demonstrated that this specification was part of purchase requisition 92759 for procurement of an engineered system of radiation monitors. This requisition was prepared, reviewed, and approved as one document, including the specification, under EN DES procedure 5.01. Accordingly, separate review and approval signatures and issue dates were not required on this specification as they would have been for a stand-alone specification. Based on the supplemental documentation retrieved and referenced by TVA, the team agrees with TVA's assessment.

Regarding the lack of revision numbers, issue dates, and approval signatures on data sheets accompanying requisition contracts 92784 and 83577, TVA explained that these requisitions were also treated as an integrated document with the data sheets being a part of the requisition. TVA demonstrated from the cover sheet that the document had been independently reviewed by an engineer. TVA practice since 1984 is governed by DS-E18.3.5, whereby individual data sheets are prepared and reviewed.

Regarding the Instrument Tabulation, TVA demonstrated that the latest revision provided to the team was as-constructed revision FF dated March 12, 1987 and was based on an as-designed revision 20 dated May 4, 1981. This revision reflects the ECNs incorporated to date in the plant and is current.

Based on the preceding clarifications by TVA regarding past and current documentation practice, this item is closed.

ELECTRICAL POWER

(Closed) Deficiency D6.2-1, Insufficient Demonstration of Worst-Case Loading in Diesel Generator Loading Analysis

This item concerns the worst-case loading condition used in TVA's calculation SQN-E3-002, Revision 5. The calculation did not consider the effect of Unit 1 auxiliary loads in the diesel generator loading analysis.

The IDI team verified that TVA has entered on the CCTS, their commitment to revise the diesel generator loading calculation to incorporate Unit 1 loads prior to Unit 1 restart. The team considers this a satisfactory resolution, and this issue is closed.

(Closed) Deficiency D6.2-2, Insufficient Demonstration of Adequate Class 1E Motor Starting and Running Voltages

This item involved two concerns regarding the worst-case conditions used in TVA's calculation OE2-EEBCAL001, Revision 8. First, the calculation did not consider the condition when the onsite diesel generators are the source of AC power and second, part of the calculation considered Unit 1 to be in cold shutdown rather than in hot shutdown following full load rejection.

In response, TVA provided the recently issued calculation SQN-E3-011 Revision 3, dated January 28, 1988, "Diesel Generator Voltage Analysis," which addresses the first concern. This study estimates the worst-case generator voltage-versus-time profile during a LOCA with loss of offsite power, based on recent load tests on the diesel generators. Corrections involving extensive manual calculations were applied to the tested voltage profile to account for the worst-case conditions which would prevail during a LOCA, but which could not be accurately simulated during off-load testing. These included the worst-case set of LOCA loads, full-flow conditions on pumps, coincident starting of random (non-sequenced) loads, and tolerances in load sequencing. While the IDI team found this approach technically acceptable, we consider the use of manual calculations in this case to be less than ideal, and we recommend that the existing calculation be replaced with a full system dynamic analysis using a validated dynamic stability computer program at the first convenient opportunity.

The diesel generator voltage analysis confirms the IDI team's hypothesis that the loss-of-offsite-power (LOOP) condition is the worst case rather than the offsite-power condition as assumed in calculation OE2-EEBCAL001, since ac system voltages fall below those calculated for the offsite-power condition for brief intervals during the load restoration sequence following a LOOP. Nevertheless, adequate voltage and frequency levels will be available for required safety-related equipment operation and compliance with NRC Regulatory Guide 1.9, Revision 0.

In response to the team's second concern, the team verified that TVA's commitment to revise calculation OE2-EEBCAL001 to include the Unit 1 auxiliary loads before Unit 1 restart has been entered on the CCTS. This is acceptable to the team. In view of TVA's corrective actions, this item is closed.

(Closed) Deficiency D6.2-4, Absence of Neutral Grounding and Ground Fault Detection on 480V AC Auxiliary Power Systems

This deficiency was based on the lack of effective system neutral grounding and the apparent absence of any facilities for ground fault detection in the SQN 480V ac auxiliary power systems. This condition violates FSAR commitments to the "no-single-failure" principle in IEEE Standard 279 and to the power cable insulation requirements in NEMA Standard WC5 (ICEA Standard S-61-402).

TVA's response to this issue first pointed out that all of the 480V distribution substations are in fact equipped with manually-actuated local ground fault detector circuits capable of sensing solid ground faults on the distribution circuits (although this was not apparent from drawings the team originally examined, and the TVA/EEB engineering contacts were not initially aware of it). Furthermore, under an existing routine inspection instruction, an auxiliary plant operator is assigned to test for ground faults at each distribution substation once per shift.

The "single-failure" issue involved a postulated scenario in which an undetectable intermittent ground fault could cause overvoltage-related electrical failures disabling safe-shutdown equipment in one train, coinciding with a detectable random failure disabling redundant equipment in the other train and an initiating event requiring safety-system actuation. (The existing ground detectors cannot reliably sense intermittent ground faults, which can cause surge voltages high enough to damage insulation.) TVA's position is that this scenario is not credible because it involves a coincidence of highly improbable events, so no action is needed to address it. The inspection team concurs with this view, and we consider this aspect of the problem to be satisfactorily resolved in view of the formalization of the testing procedure as discussed below.

The second FSAR issue involved a violation of the ICEA/NEMA cable standards requiring the use of conductors whose insulation rating is at least 173 percent of system phase-to-phase voltage in ungrounded power systems in which ground faults can persist for more than one hour. This requires an insulation rating of 1.73 x 480V = 830V. The cable actually installed is rated at the 133 percent insulation level on a 600V basis, or 1.33 x 600V = 790V. While the cable rating is technically deficient, the team agrees with TVA's position that it is acceptable based on the enforced practice of frequent ground testing and immediate repair to be established before restart (see the next paragraph), the small margin of deficiency (less than 4 percent) in the voltage rating, and the conservatism of the ICEA/NEMA standard. (The standard is based on typical practices for nonredundant industrial power distribution systems, where ground faults may be allowed to remain for days until a convenient shutdown can be arranged.)

TVA has agreed to take the following actions in response to item D6.2-4: (1) to upgrade the informal once-per-shift ground fault test procedure to a formal, documented surveillance instruction before Unit 2 restart, (2) to amend the Sequoyah FSAR to justify the technical discrepancy between the plant design and NEMA WC5 requirements, and indicate that the plant is only in substantial compliance with the intent of the standard, and (3) to evaluate the need for further hardware and procedure modifications after restart. We found these actions to be a satisfactory response to the deficiency. Since the surveillance instruction has been approved and issued, and the FSAR revision and further engineering evaluation have been appropriately docketed on CCTS, Deficiency D6.2-4 is closed.

(Closed) Deficiency D6.6-1, Unsubstantiated Motor-Operated Valve Performance at Degraded Voltage

This item concerns TVA's failure to specify a minimum operating voltage in the procurement documentation of a number of safety-related motor-operated valves (MOVs) in the ERCW system specifically, and perhaps in other safety-related systems as well. (The team reviewed only the documentation for the ERCW valve operators during the inspection.)

In response, TVA prepared a QIR (MEB-SQN-87194, Revision 0). In this analysis TVA first surveyed the procurement and environmental qualification documentation of all safety-related MOVs which are required to change state during a DBE, and determined that the degraded-voltage capabilities of all but eight of these "active" MOVs have been established either by contract specifications or EQ testing. The eight questionable active valves were assumed to be operable at a minimum of 90 percent of rated voltage. (The team accepts this assumption in view of its consistency with NEMA Standard MG-1, which is the motor design standard prevailing in the absence of specific requirements, and the conservative motor application practices used for nuclear-safety-related MOVs.) The QIR then compared the specified voltage requirements to the system voltage levels determined in calculation OE2-EEBCAL001, the LOCA-with-offsite-power ac system voltage analysis, and concluded that all active MOVs have adequate voltages when required to operate.

However, as noted under Deficiency D6.2-2, the worst-case system voltages occur during the loss-of-offsite-power (LOOP) rather than the offsite-power condition. The diesel generator voltage analysis (Calculation SQN-E3-011, Revision 3) reveals that a number of active safety-related MOVs experience one or more periods of insufficient voltage lasting from a fraction of a second to a few seconds during the post-LOOP load restoration sequence. (Revision 0 of QIR MEB-SQN-87194 was prepared concurrently with the diesel generator voltage study, and TVA had not had the opportunity to incorporate the LOOP condition in the QIR at the time of the IDI team's follow-up inspection.)

TVA documented this apparent deficiency in CAQR SQP871743 and performed an engineering evaluation of it in QIR SQP-87-529. In this analysis, TVA conservatively assumed that each active safety-related MOV stalls entirely during the intervals when its terminal voltage is insufficient, calculated the resulting increased valve stroke time (based on current MOVATS test results), and compared the calculated times with the times required by the current Sequoyah Technical Specifications and/or Design Criteria. TVA determined that ample margin exists between the Technical Specification and/or Design Criteria limits and the actual operational requirements of all of the MOVs affected by low voltages during the LOOP condition. In recognition of this margin and the conservatism of the assumption the valves do not move during the low-voltage intervals, the team considers this item closed.

APPENDIX B

PERSONNEL CONTACTED

MECHANICAL SYSTEMS

Name	Title	Organization
F. Carr	Engineering Specialist	TVA/MEB
R. Daniels	Lead Mechanical Engineer	TVA/MEB
S. Fried	Consultant - Chief Mechanical/ Nuclear Engineer	Bechtel
E. Gibson	Assistant Chief Engineer	TVA/MEB

PERSONNEL CONTACTED

MECHANICAL COMPONENTS

Name	Title	Organization
W. E. Roberts	Technical Supervisor, Civil Engineer	TVA/CEB
K. Mogg	Principal Mechanical Engineer	TVA/CEB
D. Lundy	Principal Civil Engineer	TVA/CEB
J. Rochelle	Senior Civil Engineer	TVA/CEB
K. S. Seidle	Assistant Chief Civil Engineer	TVA/CEB
G. Bushnell	Consultant-Supervisor, Engineering Mechanics	Stone & Webster
F. H. Coleman	Mechanical Engineer	TVA/CEB
J. F. Edwards	Electrical Group Leader	TVA/EEB
M. R. Belew	Senior Electrical Engineer	TVA/EEB
A. B. Poole	Senior Civil Engineer	TVA/CEB
A. Chan	Consultant	Stone & Webster
S. H. Fried	Consultant-Chief, Mechanical/Nuclear Engineering	Bechtel

PERSONNEL CONTACTED

CIVIL/STRUCTURAL

Name	Title	Organization
C. Johnson	Lead Civil Engineer	TVA/CEB
S. Taylor	Civil Engineer	TVA/CEB
J. Peyton	Senior Civil Engineer	TVA/CEB
E. Stone	Senior Civil Engineer	TVA/CEB
R. Hernandez	Assistant Chief Engineer	TVA/CEB
M. Cones	Senior Civil Engineer	TVA/CEB
J. Rochelle	Senior Civil Engineer	TVA/CEB
R. Day	Civil Engineer	TVA/CEB
K. Mogg	Principal Engineer	TVA/CEB
J. Vargese	Engineering Specialist	TVA/CEB
R. Zimmerman	Engineer	Gilbert
O. Gurbuz	Professional Engineer	Bechtel
A. Langmo	Manager of Engineering	Bechtel
T. Folger	Engineering Manager	Stone & Webster

PERSONNEL CONTACTED

INSTRUMENTATION AND CONTROL

Name	Title	Organization
M. R. Belew	Senior Electrical Engineer/ Supervisor, I&C Section	TVA/EEB
R. C. Williams	Lead Electrical Engineer/SQP	TVA/EEB
J. F. Edwards	Group Leader/SQP Knoxville	TVA/EEB
J. E. Staub	Engineering Specialist/I&C	TVA/SQN
S. Childers	Section Head/Operations Procedures	TVA/SQN
F. P. Carr	Engineering Specialist	TVA/MEB

PERSONNEL CONTACTED

ELECTRICAL POWER

Name	Title	Organization
K. W. Brown	Senior Electrical Engineer	TVA/EEB
J. D. Collins	Lead Electrical Engineer	TVA/EEB
M. R. Belew	Senior Electrical Engineer	TVA/EEB
J. D. Hines	Electrical Engineer	TVA/EEB
S. Mazumbar	Electrical Engineering Specialist	TVA/EEB
G. L. Nicely	Senior Electrical Engineer	TVA/EEB
R. C. Williams	Lead Electrical Engineer	TVA/EEB/SQN