Tennessee Valley Authority, Post Office Box 2000, Soddy-Daisy, Tennessee 37384-2000

February 28, 2003

TVA-SQN-TS-03-03

10 CFR 50.59(c)(2)(viii)
10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

In the Matter of)
Tennessee Valley Authority)

Docket No. 50-327

SEQUOYAH NUCLEAR PLANT (SQN) - UNIT 1 - LICENSE AMENDMENT (SQN-TS-03-03) TO UTILIZE METHODOLOGY DESCRIBED IN TOPICAL REPORT NO. 24370-TR-C-003, REVISION 1, FOR MODIFICATION OF STEAM GENERATOR ROOF COMPARTMENT (TAC NO. MB5387)

Reference: TVA letter to NRC dated February 14, 2003, Sequoyah Nuclear Plant - Steam Generator Replacement Project - Topical Report No. 24370-TR-C-003, "Steam Generator Compartment Roof Modification, Revision 1"

In accordance with the provisions of 10 CFR 50.90 and 10 CFR 50.59(c)(2)(viii), TVA is requesting an amendment to SQN Unit 1 Operating License (OL) DPR-77. The proposed request provides a revision to the SQN Updated Final Safety Analysis Report (UFSAR) that includes a change to the methodology for restoration of the Unit 1 steam generator roof compartment following steam generator replacement. The steam generator roof compartment modification utilizes a through-bolted connection frame methodology that is described in Revision 1 of Topical Report No. 24370-TR-C-003 (see TVA reference

A053

letter). The revision to the UFSAR was reviewed under the requirements of 10 CFR 50.59, "Changes, Tests and Experiments" and based on this review, it was concluded that a license amendment is required in accordance with 10 CFR 50.59(c)(2)(viii).

TVA has determined that there are no significant hazards considerations associated with the proposed change and that the license amendment qualifies for categorical exclusion from environmental review pursuant to the provisions of 10 CFR 51.22(c)(9).

The SQN Plant Operations Review Committee and the SQN Nuclear Safety Review Board have reviewed this proposed change and determined that operation of SQN Unit 1, in accordance with the proposed change, will not endanger the health and safety of the public. Additionally, in accordance with 10 CFR 50.91 (b)(1), TVA is sending a copy of this letter and enclosures to the Tennessee State Department of Public Health.

Enclosure 1 provides a complete description and justification of the proposed amendment. Enclosure 2 contains revised markup pages from the SQN UFSAR.

TVA requests that the implementation of the proposed UFSAR change be consistent with startup activities (prior to Mode 4) from the Unit 1 steam generator replacement outage scheduled to begin March 16, 2003.

There are no commitments contained in this submittal. This letter is being sent in accordance with NRC RIS 2001-05, "Guidance on Submitting Documents to the NRC by Electronic Information Exchange, CD-ROM, or Hard Copy."

If you have any questions about this change, please telephone me at (423) 843-7170 or J. D. Smith at (423) 843-6672.

Sincerely,

Pedro Salas
Licensing and Industry Affairs Manager

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 28 day of February, 2003

Enclosures:
1. TVA Evaluation of the Proposed Changes
2. Annotated pages from the SQN UFSAR

cc(Enclosures):

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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNIT 1

TVA EVALUATION OF THE PROPOSED CHANGE

1. DESCRIPTION

This letter is a request to amend Operating License DPR-77 for SQN Unit 1. The proposed license amendment revises the SQN Updated Final Safety Analysis Report (UFSAR) to include a change to the methodology for reconstruction of the Unit 1 steam generator (SG) roof compartment. The SG roof compartment is being modified as part of the SG replacement (SGR) project to allow removal and replacement of the SGs. The SG roof compartment modification utilizes a through-bolted connection frame methodology that is different from the original design. This methodology is described in Revision 1 of Topical Report No. 24370-TR-C-003 and was previously submitted to NRC for review and approval. The SQN UFSAR was reviewed under the requirements of 10 CFR 50.59, "Changes, Tests and Experiments" and based on this review, it was concluded that a license amendment is required in accordance with 10 CFR 50.59(c)(2)(viii).

2. PROPOSED CHANGE

During the Unit 1 SGR outage, (scheduled to begin March 16, 2003), four construction openings in the SG compartment roof will be created to facilitate removal of the old SGs and installation of the replacement SGs. The compartments will be restored by connecting the removed section of concrete to the remaining structure using a through-bolted connection frame. The through-bolted connection frame design is described in Topical Report 24370-TR-C-003, Revision 1.

During preparation for the SQN Unit 1 SGR project, evaluations were performed in accordance with 10 CFR 50.59 that identified the through-bolted connection design as a new methodology for restoration of the concrete SG roof compartment. Based on the 10 CFR 50.59 evaluation, it was determined that this modification activity would result in a departure from the method of evaluation described in the SQN UFSAR. Accordingly, TVA is proposing a revision to the SQN Unit 1 Operating License (i.e., UFSAR) to request NRC review and approval for the new methodology.

3. BACKGROUND

Four SGs from SQN Unit 1 will be replaced during the SGR outage scheduled to begin March 16, 2003. To support the replacement of the old SGs with the replacement SGs, access openings will be created in the roof of the SG compartments inside containment. An appropriately sized access opening will be made in each SG compartment roof by cutting out a section of concrete from the roof of the compartments using wire saws. Upon completion of installation of the replacement SGs, the original cut concrete section (plug) of the SG compartment roof will be reattached to the respective compartment roof by means of through-bolted connections, comprised of steel connection frames and threaded rods. The plug will be attached to the top and bottom connection frames using four 2-inch diameter threaded rods that are installed in core bore holes through the plug. The top and bottom connection frames will clamp the concrete plug to the complimentary portion of the SG compartment using six 2 1/2-inch and 18 2-inch diameter threaded rods. The threaded rods are installed in the core bore holes located around the perimeter of the concrete plug and will be pre-tensioned. A series of steel shims will be driven into the annular space (created at the cut line) and mechanically locked into place. The annular space will be grouted.

The original design of the SG compartment was based in part on the load combinations defined in Table 3.8.3-2 of the SQN UFSAR. The UFSAR table is based on Table CC-3200-1 of the Proposed American Society of Mechanical Engineers (ASME) Section III, Division 2, 1973, Proposed Standard Code for Concrete Reactor Vessels and Containments, Section CC-3000 which was issued in 1973 (the time of original design) by the ACI-ASME Committee on Concrete Pressure Components for Nuclear Service, for trial use and comment. TVA plans to use a modified design that is described in Topical Report No. 24370-TR-C-003, Revision 1. The topical report uses modified load combinations and allowable stresses as adopted in the 1975 edition of ASME Section III, Division 2, instead of those described in the UFSAR. Analyses performed using the adopted ASME load combinations have shown that the modified SG compartment roof design will not exceed allowable stresses in the concrete, rebar and structural steel when subjected to the design basis differential pressure of 24 pounds per square inch (psi) combined with the other design basis loads such as seismic, pipe thrust, dead load, and live load. This design differential pressure is approximately 23 percent higher than the maximum compartment accident pressure differential of 19.52 psi.

4. TECHNICAL ANALYSIS

As described in Topical Report No. 24370-TR-C-003, Revision 1, the normal service load combinations used to evaluate the modified SG compartment roof configuration were the same as those

used for the original configuration. Under normal service load conditions, the maximum concrete and rebar stresses in the modified roof are within the allowable normal service concrete and rebar stress limits as specified in Section CC-3430 of ASME Section III, Division 2, 1975. The critical areas where these stresses occur are near the middle surface of the cut section at the junction of the roof and the end of the whip restraint beam. The stress levels in other areas are generally much lower. Therefore, the modified SG compartment roof configuration is acceptable under normal service conditions.

The load combinations evaluated for the modified roof were based on Table CC-3230-1 of the adopted 1975 Edition of ASME Section III, Division 2, which replaced the proposed 1973 ASME Section III, Division 2. These load combinations are similar to those used for the original SG compartment roof design except for the Abnormal and Abnormal/Severe Environmental load categories for which the Yr load (reaction load due to fluid discharge on broken pipe, which in the present case is the pipe thrust load) is now not considered in the load combination. For factored load combinations on the modified roof configuration, the most critical load combinations are the Abnormal and Abnormal/Extreme Environmental load categories. The critical areas of high stresses for the Abnormal load combination are the approximately triangular corner areas of the existing roof bounded by the cut-line near each end of the center wall. For the Abnormal/Extreme Environmental load combination the critical area included the area near the middle of the cut section at the junction of the roof and the end of the whip restraint beam in addition to the corner areas identified for the Abnormal load combination. It is noted that the maximum stresses/forces occurred only in the localized areas mentioned above. The stresses in other areas are lower. The maximum stresses for the factored load combinations were found to be within the allowable concrete and rebar stresses based on limits specified in Section CC-3400 of ASME Section III, Division 2, 1975. The maximum vertical deflection occurred for the Abnormal/Extreme Environmental load combination at the middle of the roof near the end of the whip restraint beam.

It is noted that the design basis accident (DBA) differential pressure of 24 psi was used in the modified SG compartment roof stress evaluation. Even though the calculated stresses under accident conditions equaled the allowable stresses in some locations, this analysis is conservative since it used a differential pressure that is 23 percent higher than the maximum calculated differential pressure of 19.52 psi.

The influence of the modified roof configuration on stresses in the SG compartment wall sections adjacent to the roof has been determined to be insignificant and the wall and roof stresses remain within design allowables.

The bolts used in the steel through-bolted connection will be pre-loaded to a stress level of 0.7 F_y. By conservative analysis, the maximum calculated bending stress in the connection frame beams and the maximum calculated bearing stress on concrete and the tapered steel shims were determined to be below allowables. The connection frame beams will be used in conjunction with the through-bolts to provide the clamping action that will transfer the vertical design basis loads from the concrete section to the compartment. The connection frame beams span over all of the connection through-bolts. Since all the connection frame beams are connected together, beam rigid body rotation about the bolt axes are prevented at all concrete section/compartment connections.

The connection frame beams have been designed to transfer all vertical design loads, at the concrete section/compartment interface, via bending and shear stresses. The beams have been designed such that the maximum stresses in the beam plates and connecting welds are less than the allowable stresses.

The connection frame beams are sized such that the concrete bearing stresses under the beams are below allowables due to both the connection through-bolt pre-tension loads and due to all design basis loads.

The connection frame beams are connected by web angles or connection plates. The welded angles/plates are designed to transfer all vertical design loads between beam members of the frame, as pinned connections. Vertical loads are due to the vertical seismic inertia from the concrete and the maximum DBA pressure (seismic inertia loading from the steel frame is negligible). As the concrete section deflects, it lifts the individual frame members, hence, inducing vertical loads at the beam-to-beam connections and vertical prying loads at the through-bolt connections. The beam connection angles/plates are also designed to transfer all horizontal seismic loads due to the maximum accelerations of the frame.

The modified SG compartment roofs have been found to be structurally adequate for the loads associated with the design loading conditions/combinations which are in general consistent with the original design except as noted above.

The modifications to the SG compartment roofs do not affect the structural capability of the SG compartments to contain the internal pressure associated with the design bases main steam line breaks. The modifications do not affect temperature differentials through the compartment roof or the radiation shielding capacity of the structures.

As discussed in Section 6.5.6.3 of the UFSAR, there is a maximum calculated leakage of 250 cubic feet per minute (cfm) between the upper and lower containment through the divider barrier, of which

the SG compartments are part. The amount of leakage between the two sections of the containment will not be significantly affected by the restoration of the SG compartment roofs. The use of non-shrink grout to seal the joint created between the concrete sections and the remaining structure will maintain the boundaries between upper and lower containment. It is noted that any leakage due to possible cracks in the grout, particularly under design DBA loading, will be extremely small and therefore insignificant.

5. REGULATORY SAFETY ANALYSIS

The proposed license amendment provides a revision to the Sequoyah Nuclear Plant (SQN) Updated Final Safety Analysis Report (UFSAR) for NRC review and approval. The revised UFSAR pages are provided in enclosure 2 of this submittal and a full description of the regulatory safety analysis is provided in section 4.0 of Topical Report 24370-TR-C-003, Revision 1.

As described in the topical report, Standard Review Plan (SRP), Sections 3.8.3 and 6.2.1.2 were reviewed to assure conformance with the requirements of 10 CFR 50.55a and 10 CFR 50, Appendix A, General Design Criteria (GDC) 1, 2, 4, 5, and 50. Based on this review, the proposed license amendment to utilize a modified design for the SG roof compartment either meets or exceeds these requirements.

5.1 No Significant Hazards Consideration

TVA has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No.

   The probability of occurrence or the consequences of an accident are not increased as presently analyzed in the safety analyses since the objective of the event mitigation is not changed. No changes in event classification as discussed in UFSAR Chapter 15 will occur due to the modification of the Unit 1 steam generator (SG) compartment roof design.

   The grout used to fill the gap between the replaced concrete and the surrounding concrete, like the surrounding concrete, could "theoretically" experience the formation of micro-cracks when subjected to the design pressure load. Conservative estimates of the flow path

through these micro-cracks yield values that are numerically insignificant when compared to the allowable divider barrier bypass leakage. Micro-cracks resulting from the design pressure load will have a negligible effect on the function of the divider barrier and the analyses that depend on the divider barrier. Therefore, the containment design pressure is not challenged, thereby ensuring that the potential for increasing offsite dose limits above those presently analyzed at the containment design pressure of 12.0 pounds per square inch (psi) is not a concern.

Therefore, the proposed modification to the Unit 1 SG compartment roof design will not significantly increase the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No.

   The possibility of a new or different accident situation occurring as a result of this condition is not created. The SG compartment roof forms part of the divider barrier. This barrier is not an initiator of any accident and only serves to force steam that is released from a loss-of-coolant accident/design basis accident (LOCA/DBA) to pass through the ice condenser. The failure of any part of the divider barrier is considered critical since it would allow LOCA/DBA steam to bypass the ice condenser, thereby increasing the pressure within the primary containment.

   As discussed in the UFSAR, there is a maximum calculated leakage of 250 cubic feet per minute (cfm) between the upper and lower containment through the divider barrier. The amount of leakage between the two sections of the containment will not be significantly affected by the restoration of the SG compartment roofs. The use of non-shrink grout to seal the joint created between the concrete sections and the remaining structure will maintain the boundaries between upper and lower containment. It is noted that any leakage due to possible cracks in the grout, particularly under DBA loading, will be extremely small and therefore insignificant.

   Therefore, the potential for creating a new or unanalyzed condition is not created.

3. Does the proposed change involve a significant reduction in a margin of safety?

Response: No.

A design DBA differential pressure assumed in the original design of the SG compartment roof is 23 percent higher than the maximum calculated differential pressure of 19.52 psi. Since the same design differential pressure was also used in the modified SG compartment roof stress evaluation, the margin of safety was not reduced.

As discussed previously, the amount of leakage that bypasses the divider barrier will not be affected by the restoration of the SG compartment roofs. The use of non-shrink grout to seal the joint created between the concrete sections and the remaining structure will maintain the boundaries between upper and lower containment. Hence, the worse-case accident conditions for the containment will not be affected by the proposed modifications.

Therefore, a significant reduction in the margin to safety is not created by this modification.

Based on the above, TVA concludes that the proposed amendment present no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and accordingly, a finding of "no significant hazards consideration" is justified.

5.2 Applicable Regulatory Requirements/Criteria

As stated in 10 CFR 50.59(c)(2), a licensee shall obtain a license amendment pursuant to 10 CFR 50.90 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

(viii) Result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses.

As stated in 10 CFR 50.59(a)(2), departure from a method of evaluation described in the Final Safety Analysis Report (FSAR) (as updated) used in establishing the design bases or in the safety analyses means:

(i) Changing any of the elements of the method described in the FSAR (as updated) unless the results of the analysis are conservative or essentially the same; or

(ii) Changing from a method described in the FSAR to another method unless that method

has been approved by NRC for the intended application.

TVA's submittal meets the requirements of 10 CFR 50.59(c)(2) and 10 CFR 50.90.

6. ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 50.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

7. REFERENCES

1. Sequoyah Nuclear Plant, Final Safety Analysis Report (As Updated) Revision 17, Section 3.8 dated November 8, 2002
2. TVA letter to NRC dated February 14, 2003, Sequoyah Nuclear Plant - Steam Generator Replacement Project - Topical Report No. 24370-TR-C-003, Steam Generator Compartment Roof Modification, Revision 1"

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNIT 1

PROPOSED UPDATED FINAL SAFETY ANALYSIS REPORT (UFSAR) MARK-UP

AFFECTED FSAR Pages

3.8-45
3.8-49
3.8-50
3.8-58
3.8-58a
3.8-72

New Table 3.8.3-2A

the passageways in the crane wall against missiles, jets, and pressure that may originate within the crane wall enclosure, thus preventing consequent damage to the containment vessel and to piping and machinery between the crane wall and containment vessel.

The doors will maintain their integrity and seal for not less than the first 12 hours following an accident Limited leakage during this period is permissible

3 8.3.1.7 Steam Generator Compartments (Divider Barrier)

Two double-compartment structures house the four steam generators in pairs on opposite sides of the building. Each structure consists of curved and straight sections of walls that vary in thickness from 2 to 4 feet. Divider barrier walls around two steam generators extend 42 feet up from the divider floor and are capped with a 3-foot-thick slab spanning over the steam generators from the crane wall. A wall between the two steam generators extends from the divider barrier walls to the crane wall, completing the double compartment. The center wall extends only 32-1/2 feet above the floor. The area above the top of this wall, except for that occupied by a main steam pipe restraint beam, will reduce the compartment pressure buildup in a single compartment by venting the steam to the other compartment See Figures 1.2.3-11, -12, and -13.

During the Unit 1 steam generator replacement, four construction openings in the steam generator compartment concrete roofs were created to facilitate removal of the old steam generators and installation of the replacement steam generators The compartments were restored by connecting the removed section of concrete to the remaining structure using through-bolted steel connection frames. Steel shims were placed in the gap between the removed concrete sections and the remaining structure and the gap was filled with non-shrink grout.

3.8.3.1.8 Pressurizer Compartment (Divider Barrier)

This compartment separates the pressurizer from the upper compartment. Its walls project about 38 feet above the Elevation 733.63 floor where they are capped with a 3-foot-thick slab. It is similar to the steam generator compartments except its wall thickness varies from 2 to 3 feet and the volume is much smaller, see Figure 1.2.3-12. A hatch is provided in the top of the compartment

3 8.3.1.9 Operating Deck at Elevation 733 63 (Divider Barrier)

This 2-1/2-foot-thick irregular shaped floor is the major divider barrier between upper and lower compartments It is supported at its outer edges by the crane wall and the compartment walls for the steam generators and pressurizer. Support near the center of the building consists of the refueling canal walls and the five columns of the upper reactor compartment. This floor contains five hatches for equipment removal. The concrete covers on these hatches are designed for the same loadings as the floor. The floor outline is shown in Figure 1.2.3-11.

3 8.3.1.10 Ice Condenser Support Floor - Elevation 721 (Divider Barrier)

This floor extends 12 feet-8 inches from the outside of the crane wall to the 4-inch expansion joint separating it from the steel containment vessel. A circumferential beam under its outer edge is cast with the floor. This edge beam is supported by concrete columns which extend down through the Elevation 693 floor to the fill slab at elevation 679.78. The floor extends 300° around the outside of the crane wall between the ice condenser end walls at azimuths 245° and 305°, as shown in Figures 1.2.3-11, -12, -13.

Hypothetical Pressure

This loading was do to a hypothetical compartment pressure used as part of the original design resulting from a double-ended break of a reactor coolant pipe if such pipe were located in either the pressurizer compartment, the steam generator compartment, or the compartment above the reactor. This loading was used as part of the original design and is not required to be considered in the evaluation and/or modification of the existing structures. This loading was the result of an agreement between Westinghouse Corporation and the Nuclear Regulatory Commission in order to provide a high degree of conservatism in the design of these compartments

This hypothetical pressure was not used in the evaluation of the modifications to the Unit 1 steam generator compartments resulting from the replacement of the steam generators.

½ Safe Shutdown Earthquake (1/2 SSE)

Reference Section 3.7 2.

Safe Shutdown Earthquake (SSE)

This is the maximum postulated earthquake the plant is designed to withstand and still permit a safe shutdown Reference Section 3.7.2.

Pipe Forces

These forces are the pressure jet effects that can occur due to breaks in systems piping They may be the jet force impinging upon the structure, or the equipment and pipe anchorage forces as the result of such a jet. The static equivalent of the major equipment anchorage loadings were furnished by Westinghouse Corporation, the support designer.

Jet forces from postulated pipe ruptures, both longitudinal and transverse, were assumed to load the interior concrete structure.

Two loading conditions were assumed:

1. Effect of initial jet force alone on structure before the compartment transient pressure has time to build up

2. Effect of jet force using the saturation pressure at the rupture point in combination with the uniform compartment differential pressure.

A minimum load factor k = 1.3 was used with both conditions based on localized yielding of the structural member and a ductility factor of 3. See Section 3.6.

The only jet force in the compartment above the reactor cavity is from the control rod opening. This is due to a pressure of 2250 lb/in^2. The reactor coolant pipe will not produce a jet force in this area.

Missiles

The systems located inside the reactor containment have been examined to identify and classify potential missiles The basic approach is to assure design adequacy against generation of

missiles, rather than allow missile formation and try to contain their effects Reference Section 3.5.

Ice Condenser Loads and Loading Combinations

The ice bed structure was designed to meet the loads described below within the behavior criteria limits presented in Table 3.8.3-5 of these criteria. The following load combinations are defined for design purposes:

1. Dead Load + ½ SSE loads (D + ½ SSE)
2. Dead Load + Accident induced loads (D + DBA).
3. Dead Load + SSE (D + SSE).
4. Dead Load + SSE + Accident induced loads (D + SSE + DBA)

The loads are defined as follows:

Dead load (D) - Weight of structural steel and full ice bed at the maximum ice load specified.

Live Load (L) - Live load includes any erection and maintenance loads, and loads during the filling and weighting operation

Thermal Induced Load - Includes those loads resulting from differential thermal expansion during operation plus any loads induced by the cooling of ice containment from an assumed ambient temperature at the time of installation.

Accident Fluid Dynamic and Pressure Loads (DBA) - Accident pressure load includes those loads induced by any pressure differential drag loads across the ice beds, and loads due to change in momentum.

½ SSE - As previously defined.

SSE - As previously defined

3.8 3.4 Design and Analysis Procedures

3.8.3.4.1 General

The following discussion is a description of the original design and analyses performed to ensure that the design of the interior concrete structures complied with the applicable codes, standards and specifications as stated in section 3 8.3.2.

Each component of the interior concrete structure was considered individually. Its boundary conditions and degrees of fixity were established by comparative stiffness; loads were applied, and moments, shears, and direct loads determined by either moment distribution or finite element methods of analysis. Reinforcing steel was proportioned for the component sections in accordance with Table 3.8.3-1 or Table 3.8.3-2. The ultimate strength provisions of ACI 318-71 Building Code were used to check the combined effects of torsion, shear, and direct tensile loads.

During the construction stage, a factor of 1.4 was applied to the design pressures resulting from LOCA. The structure was then examined using the 40 percent margin and the recommendations

Thermal effects accompanying a pipe break (See Figure 3.8 3-2) are also accounted for. A single compartment was also designed to resist 43 lb/in^2 hypothetical pressure combined with dead load only. This hypothetical loading was used as part of the original design and is not required to be considered in the evaluation and/or modification of the existing structures.

The center wall and the beam below the top slab are used as anchor points for main steam pipe restraints. These restraints prevent pipe whip in case of a pipe break and transmit forces in any direction to the wall.

These compartments span mainly in the horizontal direction resulting in tensile stress and horizontal moments in the walls near the center of their height. Close to the ends of the compartments discontinuity stresses, similar to those of a flat head cylinder, result in the vertical direction.

The STRUDL frame program was used to find the maximum horizontal forces in the walls by modeling a vertical 1-foot height of wall including a 112° sector of crane wall. Short chord lengths were used to represent curved sections of walls. The shallow shell and flat plate finite element STRUDL programs were used to analyze individual sections of the walls for moments and shears in both directions. The top slab was analyzed using a combined member-grid and flat plate finite element STRUDL program. Manual calculations were done at various locations to ensure computer accuracy. The inverted "tee" shaped beam which stiffens the top slab was analyzed for the dynamic effects of a main steam pipe breaking and striking the flange of the beam.

Independent Design

1. Roof Slab

   The roof slab was analyzed as a plate using the finite element plate bending program, GENDEK 3 The roof slab was analyzed both as a beam-stiffened slab and a uniform slab, neglecting the effects of the beam. The edges were considered fixed.

2. Enclosure Walls and Separation Wall

   The steam generator compartment walls were designed as a mixed model using the finite element features of STRUDL II. This mixed model was composed of flat plate and curved shell elements and was considered fixed at all points of intersections with the other components of the divider barrier. A further check was made by using the frame analysis features of STRUDL II and modeling a 1-foot-wide vertical section of both compartment walls and the separator wall as a series of beam elements fixed at the crane wall.

   The separator wall was also analyzed as a plate using GENDEK 3 with the edges fixed at the crane wall and enclosure wall and free at the top and bottom.

Reanalysis Due to Unit 1 Steam Generator Replacement

The modified configuration of the Unit 1 steam generator compartment was analyzed for design loads using a 3D finite element ANSYS (Version 5 6) model. Although the roof slab remains the focus of the evaluation, the model included five components – the 3 feet thick roof slab, entire steam generator compartment wall, center wall, 180° sector of the crane wall, and the whip restraint beam; to obtain an accurate representation of the system. The material properties used in the model for the concrete were consistent with those used in the original analysis. The concrete strength used in the roof evaluation is the in-place compressive strength of the steam generator compartment roof concrete at 90 days which is 5700 psi.

The modified steam generator compartment roof was analyzed for the following design loads: dead load, live load, design pressure differential of 24 psi from a DBA (main steam pipe break), operating and accident temperature effects, seismic effects (OBE and SSE), and pipe thrust load on the whip-

restraint beam from a broken main steam pipe. The modified steam generator compartment roof was evaluated to the load combinations and allowable stresses tabulated in Table 3.8.3-2A

An exception from Table 3.8.3-2, which was used in the original evaluation of the interior concrete including the SG compartments, was taken for the load factors associated with the Yr load (reaction load due to fluid discharge on broken pipe, which in the present case is the pipe thrust load) for the Abnormal and Abnormal/Severe Environmental Load Categories as described below. The load combinations in Table 3.8.3-2 are based on Table CC-3200-1 of Reference 3.8 3.9.1. The Yr load is combined with load factors of 1.5 and 1.25 that are associated with the DBA design pressures for the Abnormal and Abnormal/Severe Environmental Load Categories, respectively. Since the Yr load lasts at its peak value only for a very short duration and the time taken to build up the abnormal DBA pressures is much longer, the Yr load is important only for evaluating local effects and hence it is overly conservative to combine the Yr load with such extreme factored DBA pressures. Therefore, the load combinations used in this evaluation for the Abnormal and Abnormal/Severe Environmental Load Categories were based on Table CC-3230-1 of Reference 3.8.3 9.2, which superseded Reference 3 8.3.9.1, and are presented in Table 3.8.3-2A.

3 8.3 4 9 Pressurizer Compartment (Divider Barrier)

Personnel Access Doors in Crane Wall

Periodic visual inspections of the doors are to be made. Parts inspected during the visual inspection are to include all bolted connections, structural members for paint deterioration, latches, hinges, and elastomer seals. The seals are to be carefully inspected for cracks, blemishes, or any other indications of deterioration of the elastomer and for proper seating at the sealing surfaces.

3.8 3.8 Environmental Effects

The atmosphere in the ice bed environment is at 10°F and the absolute humidity is very low. Therefore, corrosion of uncoated carbon steel is negligible.

To ensure that corrosion was minimized while the components of the ice condenser were in storage at the site or in operation in the containment, components were galvanized, painted, or placed in a protective container. Galvanizing was in accordance with ASTM A 123 or A 386.

Materials such as stainless steels with low corrosion rates were used without protective coatings.

Corrosion has been considered in the detailed design of the ice condenser components, and it has been determined that the performance characteristics of the ice condenser materials of construction are not impaired by long-term exposure to the ice condenser environment.

Since metal corrosion rates are directly proportional to temperature and humidity, corrosion of ice condenser components at operating temperatures has been assumed to be almost non-existent Data available in the open literature does not reflect the exact temperature range and chemistry conditions that are expected to exist in the ice condenser, but does indicate that corrosion rates decreased with decreasing temperatures for the materials and conditions being considered. Although the data in the literature indicated that corrosion of components is not expected, Westinghouse has chosen to employ several preventive measures in the construction of the Ice Condenser System To inhibit corrosion, galvanizing is being used on the ice baskets. Westinghouse has performed tests which show that galvanized material would not be expected to fail due to corrosion during a 40-year exposure to a 5-15°F ice condenser refrigerated air environment Other structural members were either galvanized, protected by corrosion resistant paints that meet the requirements of ANSI 101.2-1972 (Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities) as a minimum, or have been constructed of corrosion resistant steel.

With due consideration of the non-corrosive environment, and judicious selection of component materials based upon sound engineering judgment, the structural integrity of the ice condenser components will not be jeopardized, and the design criteria for the plant will be met.

3.8 3.9 References

1. Proposed ASME Section III, Division 2, 1973.
2. ASME Section III, Division 2, 1975

Table 3.8.3-2A

LOADING COMBINATIONS, LOAD FACTORS AND ALLOWABLE STRESSES FOR SG COMPARTMENT ROOF MODIFICATION (5)(6)

Category	T_a	D	$L_{(1)}$	P_a	T_o	F_{eqo}	F_{eqs}	R_o	R_a	Y_r	Allowable Stresses
Service:											(Flexure) $f_c = 0.45 f'c$ $f_s = 0.50 f_y$ (3)
Const	---	1.0	1.0	---	1.0	---	---	---	---	---	
Normal	---	1.0	1.0	---	1.0	1.0	---	1.0	---	---	(Shear) 50% of Factored (3)
Factored: Extreme Environmental	---	1.0	1.0	---	1.0	---	1.0	1.0	---	---	(Flexure) $f_c = 0.75 f'_c$ $f_s = 0.90 f_y$ (4)
Abnormal	1.0	1.0	1.0	1.5	---	---	---	---	1.0	---	(Shear) (2) $v_c = 2\sqrt{f'_c}$
Abnormal/ Severe Environmental	1.0	1.0	1.0	1.25	---	1.25	---	---	1.0	---	$\phi = 0.85$
Abnormal/ Extreme Environmental	1.0	1.0	1.0	1.0	---	---	1.0	---	1.0	1.0	

1. Includes all temporary construction loading during and after construction of containment
2. v_c is lower for tension members and is given by $v_c = 2\sqrt{f'_c}\,(1 + 0.002N_u/A_g)$, with Nu negative for tension.
3. The allowable stress is increased by 33-1/3% when temperature effects are combined with other loads.
4. The tensile strain may exceed yield when the effects of thermal gradients are included in the load combination. i.e, f_s can be <= f_y, and ε_s can be > ε_y when thermal effects are included
5. The load combinations, load factors and allowable stresses in this table are based on the adopted ASME Section III Division 2, 1975 which are, in general, consistent with the proposed ACI 359 - ASME Section III Division 2, 1973 with the exception of load factors associated with the Y_r load
6. Structural steel components of the splice-plate connections were designed in accordance with TVA Design Criteria SQN-DC-V-1.3.2, Miscellaneous Steel Components for Class I Structures.

LOADS NOMENCLATURE:

D Dead loads, or their related internal moments and forces
F_{eqo} Operating basis earthquake
F_{eqs} Design basis earthquake
L Live load, or their related internal moments and forces
P_a Accident/incident maximum pressure
R_o Piping loads during operating conditions
R_a Piping loads due to increased temperature resulting from the design accident
T_a Thermal loads under the thermal conditions generated by the postulated break and including T_o.
T_o Operational temperature
Y_r Reaction load on broken pipe due to fluid discharge (corresponds to R_r in ASME Section III Div. 2, 1975)

* The term "design basis earthquake" has the same meaning as the term "safe shutdown earthquake."