UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

ENCLOSURE 1

SAFETY EVALUATION BY THE OFFICE OF SPECIAL PROJECTS

RELATING TO THE NON-NUCLEAR HEATUP PRIOR TO RESTART

TENNESSEE VALLEY AUTHORITY

SEQUOYAH UNIT 2

DOCKET NOS. 50-328

1.0 INTRODUCTION

In letters dated September 28 and December 4, 1987, Tennessee Valley Authority, (TVA) has proposed a heatup (operation in Modes 4 and 3) of Sequoyah Unit 2 prior to the completion of all restart activities and the restart (criticality, Mode 2) of Unit 2. It would be a non-nuclear heatup of both the primary and secondary plant systems using reactor coolant pump heat. The reactor coolant system would be taken to rated temperature and pressure (i.e., 547°F and 2,235 psig). The plant systems would meet the operability requirements for Modes 4 and 3 in the Unit 2 Technical Specifications (TS). TVA states that this heatup will extend for 5 to 6 weeks to allow a "shakedown" of plant equipment and systems to ensure system operability before the restart of Unit 2.

2.0 DISCUSSION

TVA holds operating licenses for Sequoyah Nuclear Plant Units 1 and 2. Several events during the last few years reflected adversely on the quality of performance of TVA's nuclear activities. TVA voluntarily shut down the Sequoyah plants in August 1985. Since then, TVA has been working to restart the two units. TVA's program to restart the units is addressed in its Corporate and Sequoyah Nuclear Performance Plan (NPP). This proposed heatup is one step toward the restart of Unit 2.

The staff has discussed this proposed heatup with TVA prior to the TVA letter of December 4, 1987. Based on the status of its review of the NPP, the staff concluded that major issues that TVA must address and satisfactorily resolve prior to heatup were the following: 1) regeneration of pipe support calculations, 2) use of potentially degraded silicone rubber insulated cable and 3) NRC's integrated Design Inspection (IDI) deficiencies. TVA subsequently provided the status of the resolution of these issues with its justification for heatup in its letter of December 4, 1987.

As part of its plan to restart Unit 2, TVA developed restart criteria to determine what conditions must be corrected before the restart. TVA's criteria are contained in Table 7 of the Sequoyah NPP. The staff reviewed the restart criteria and concluded in its letter dated June 9, 1987 that the criteria were acceptable.

3.0 EVALUATION

3.1 Pipe Support Calculation Regeneration Program

As a part of the design review process for the Sequoyah Nuclear Plant, Unit 2, TVA identified that a significant number of the original pipe support design calculations were not retrievable. TVA proposed to regenerate the missing calculations to the current pipe support design criteria (SQN-DC-V-24.1) and to evaluate the existing calculations to the criteria applicable at the time they were generated. Further staff review identified that a number of revisions to TVA's design criteria had occurred which incorporated portions of later NRC Standard Review Plan (SRP) criteria. These SRP criteria contained relaxations from the criteria specified in Sequoyah's FSAR and, therefore, may not be consistent with the original plant design basis. To address this issue, the staff requested TVA to develop new design criteria (SQN-DC-V-24.2) to ensure pipe supports were evaluated in accordance with FSAR commitments. TVA subsequently instituted the Sequoyah Unit 2 Regeneration of Pipe Support Calculations on Rigorous Analysis Piping program (TVA letter to NRC dated August 21, 1987). The program included functional walkdowns to provide additional assurance that the regenerated calculations represented the installed configurations. The scope of the program included approximately 5,790 pipe supports (TVA letter to NRC dated December 4, 1987).

The results of the pipe support calculation program identified 630 supports that do not meet the design criteria (SQN-DC-V-24.2). To prioritize the modifications, these supports were evaluated by TVA against TVA's pipe support calculation restart criteria. These restart criteria were used as a screening tool to ascertain which supports needed to be modified prior to restart and which ones could be modified after restart but prior to the completion of Unit 2 applied to other operating plants for evaluation of pipe supports to determine interim operability for IE Bulletins 79-02/79-14. TVA's originally proposed restart criteria are contained in Civil Engineering Branch Instruction CEB-CI-21.89, Revision 0 (TVA letter to NRC dated August 31, 1987). TVA presented the criteria to NRC in a meeting on September 1, 1987 (Meeting Summary dated September 4, 1987). The NRC concluded that the criteria were generally acceptable subject to case-by-case review of two of the provisions in the criteria. These results are provided in the NRC Meeting Summary dated September 4, 1987. Based on an evaluation using the pipe support calculation restart criteria, TVA determined that approximately 340 of the 630 support modifications must be completed before restart and 290, could be deferred until after restart.

TVA submitted a clarification/revision to CEB-CI-21.89 in its letter dated November 17, 1987. The proposed changes and clarifications to CEB-CI-21.89 are summarized below:

1. An anchor bolt factor of safety of 2.0 can be utilized on an interim basis.

2. Snubber swing angle tolerances are not a design constraint if visual monitoring during initial plant heatup shows no thermal binding.

3.2 Silicone Rubber Insulated Cable Evaluation Program

A number of employee concerns indicated that cable pulling practices at Sequoyah violated procedures and/or procedures were not adequate to assure cable integrity following installation. Cable insulation damage may have occurred from overtensioning of cables pulled through conduits with existing cables (pullbys), cable jamming, cable in long vertical drops, and cable pulled through a short bend radius.

To ensure that cables were properly installed at Sequoyah, TVA developed a cable test program to verify cable integrity and submitted this program on April 8, 1987 for staff review. The program proposed in-situ nondestructive (D.C. high potential) tests on a representative worst-case conduit configuration. There are no standards specifically applicable for in-situ testing of installed cable. Therefore, the cable qualification standard IEEE-383 (1974) was used as a basis for acceptability of the cable installation at Sequoyah.

On April 22, 1987, during the initial tests of cables in long vertical cable runs, four of 16 silicone rubber insulated cables failed the test and TVA, in consultation with the staff, revised its test program. TVA provided its revised test program to the staff on July 31, 1987. The revised test program proposed a reduction in test voltages to be applied to cables under test. The reduced overall test voltage was based on the same voltage per unit insulation thickness (240 v/mil) as the original test, multiplied by the nominal thickness of insulation assumed in the previously qualified cable which is less than the TVA cable thickness. TVA conducted additional tests in August and all cables not having silicone rubber insulation passed the test. However, six more failures occurred out of 75 silicone rubber insulated cables tested at the reduced test voltage.

On September 10, 1987, in a meeting on the cable testing issue, TVA and NRC discussed failures of silicone rubber insulated cables at the reduced test voltages. The failures were identified during in-situ testing and from laboratory testing of uninstalled cables. These failures demonstrated to TVA that silicone rubber insulated cables manufactured by American Insulated Wire (AIW), Anaconda, and Rockbestos have the potential to be seriously damaged by normal stresses expected during shipping, handling and installation. TVA provided a report on these failures pursuant to 10 CFR Part 21 because it believed the findings could affect other plants. There are about 960 silicone rubber insulated single conductor cables inside containment, totaling about 60,000 feet.

In a letter dated November 13, 1987, the staff informed TVA that based on the information developed up to that time by TVA, all the silicone rubber insulated cables at Sequoyah were considered suspect. Although the generic concerns associated with the use of this material in other plants are under review by NRR, it was the staff's position that this issue must be resolved for Sequoyah prior to restart. TVA was told that if TVA elected not to replace these cables, then TVA will have to demonstrate to the staff's satisfaction prior to restart that these cables will perform their intended safety functions in a harsh environment.

On November 24, 1987, in a meeting between NRC and TVA, TVA presented the status of its ongoing efforts to resolve the silicone rubber insulated cable issue. TVA presented results from Wyle Laboratory tests that demonstrated a significantly lower insulation thickness than the installed cable thickness may be adequate for the installed cables to perform their intended function during and after a LOCA. TVA also identified industry standards that could qualitatively explain the discrepancies between the results of in situ tests performed at Sequoyah and those results from the Wyle Laboratory tests. The in-situ and Wyle Laboratory tests demonstrated that the cable breakdown voltage per mil thickness decreases as the thickness of the cable increases. On this basis, TVA asserted that failures at relatively low hi-pot voltages do not mean that the installed silicone rubber insulated cables have insufficient insulation thickness to perform their intended function during and after a LOCA.

In a letter dated December 28, 1987, TVA documented its basis for concluding the silicone rubber insulated cable was adequate to perform its intended function. TVA also documented that all the AIW cable in safety-related harsh environment applications and the associated Anaconda and Rockbestos cables mixed in the AIW cable conduits in Unit 2 containment have been replaced. This was a result of a decision made before the Wyle Laboratory test results were known. These cables were replaced with cables acceptable to the staff.

TVA has completed its testing of cables to assess the three principal concerns raised by TVA's Employee Concerns Special Program. The results of this effort are documented in a letter to the staff dated November 20, 1987. Based on a review of the results (which involves the testing of 925 single conductor cables), the staff concludes that TVA has adequately demonstrated the integrity of cables in the Sequoyah plant that do not utilize silicone rubber insulation.

In addition, the staff has reviewed the TVA test data and concluded that the remaining installed silicone rubber cables - Anaconda and Rockbestos - are acceptable for service. The Wyle Laboratory tests represent a partial qualification of the silicon rubber cables for a period of ten years which provides sufficient margin for restart.

Therefore, based on the above, the staff concludes that the silicone rubber insulated cable in the containment is acceptable for heatup.

3.3 Integrated Design Inspection (IDI) Deficiencies

All of TVA's programmatic efforts have been focused on individual engineering disciplines and at the component level. Thus, the engineering interfaces and systems aspects of design were not adequately evaluated. The staff conducted an IDI of the Essential Raw Cooling Water (ERCW) system in order to obtain additional assurance that engineering interfaces and system aspects of design were not overlooked and that all major changes and construction problems were identified and resolved by TVA. The NRC review of the ERCW system consisted

3. Latest code of record rules can be utilized for support evaluations.

4. Code Case N-411 (variable damping) can be utilized if:

   a. The 84th percentile earthquake is utilized.
   b. Three dimensional earthquake motion is considered.
   c. Independent support motion cannot be assumed.

5. Regulatory Guide 1.61 damping values may be used if:

   a. 84th percentile earthquake is utilized.
   b. Three-dimensional earthquake motion is considered.
   c. Independent support motion can be utilized.

6. Support flexibility may be used to reduce piping thermal load effects on pipe supports.

TVA stated that review of the 340 restart support modifications against the revised criteria determined that an additional 220 support modifications could be deferred to after restart (TVA letter to NRC dated December 4, 1987). This reduction leaves approximately 120 restart support modifications to be completed before restart. TVA stated that the approximately 120 restart pipe support modifications will be completed before heatup of Unit 2. In addition, TVA stated that approximately 80 of the 220 post restart support modifications had already been completed. All of these modifications will bring the associated supports into compliance with SQN-DC-V-24.2.

TVA stated that compliance to SQN-DC-V-24.2 for the approximately 430 support modifications (i.e., 290 first cut post-restart plus 220 second cut post restart minus 80 post restart which have already been completed) deferred to after restart is to be achieved by completion of Unit 2 fuel cycle 4. Although further discussions concerning the margin for ASME Class III, Section NF versus non-NF snubbers and structural components are required for the staff to agree that SQN-DC-V-24.2 fully complies with the TVA's FSAR commitments, this issue does not have to be resolved prior to heatup or restart since this issue is related to the criteria for the final pipe support evaluations that are to be completed after restart and prior to the completion of Unit 2 fuel cycle 4.

TVA's pipe support calculation restart criteria CEB-CI-21.89, Revision 0, as modified above, are consistent with the staff approved restart criteria and with criteria applied to other operating facilities for the resolution of piping and pipe support issues. The staff concludes that the evaluation of piping supports using these criteria will provide assurance that adequate margins exist in the design of piping supports to mitigate FSAR design basis events and to safely shut down the plant and is, therefore, acceptable as short term criteria for heatup and restart.

of: (1) an IDI to verify the adequacy of the design, and (2) an as-built system walkdown to compare the as-built configuration to the design. The IDI was conducted over a seven week period, and one additional followup inspection has been completed. The IDI inspection reports to date are Nos. 50-327, 328/87-52 dated September 25, 1987 and 50-327, 328/87-48 dated November 6, 1987. TVA responded in letters dated October 29, November 10, and December 29, 1987.

A public meeting was held with TVA on July 8, 1987 and onsite activity began on July 27, 1987. The as-built verification inspection exit meeting was held on August 19, 1987, and the IDI inspection exit meeting was held on September 11, 1987.

TVA was notified by NRC letter dated October 9, 1987 of those items that needed resolution prior to restart. The final IDI inspection report was issued on November 6, 1987, listing 3 additional restart items. TVA responded to the October 9, 1987 letter in its letter of October 29, 1987. The information TVA provided at that time was examined during a followup inspection by the IDI team which was completed on November 19, 1987. The associated inspection report should be issued in January 1988. TVA addressed all the inspection findings in its letter dated December 29, 1987.

The IDI inspection indicated the work quality in most functional areas was typical of what would be found at reactors of similar vintage. However, the nature and number of problems found in the civil/structural area were greater than expected. As a result, TVA was requested in the NRC November 6, 1987 letter to conduct a broader review of this area at Sequoyah. The followup inspection revealed, however, that the civil/structural problems did not have the generic implications originally identified and the staff concluded, therefore, that the previously requested broader review of civil/structural work by TVA was not necessary.

As a result of the as-built verification inspection of the ERCW system, the staff concluded that, in general, the ERCW system is installed and constructed in accordance with design specifications except for identified deficiencies. The staff has reviewed TVA's proposed corrective actions with regard to these deficiencies and is in general agreement with those actions. An inspection to verify implementation of those actions is scheduled prior to heatup.

In its letters dated December 4 and 29, 1987 and January 26, 1988, TVA provided the status of the resolution of the IDI deficiency heatup items. These items need to be completed before heatup. TVA stated in its letter dated January 26, 1988 that all the heatup items were completed. A final IDI followup inspection was held on February 1-5, 1988 to confirm corrective actions for all restart activities identified in the IDI and to confirm the heatup items were completed prior to heatup. This inspection assured that all heatup items were properly implemented by TVA before the heatup of Unit 2.

3.4 Radiological Analysis

Sequoyah Unit 2 has fuel in the core. The unit has been down since August 1985 and the irradiated fuel is at least 28 months old.

An analysis was done by TVA to determine the heatup of the fuel assuming a large-break Loss-of-Coolant Accident (LOCA) occurred in Mode 3 during heatup. TVA conservatively assumed that the fuel would have no cooling from the time of the LOCA until emergency core cooling system water would completely recover the fuel. TVA determined that the fuel would not be damaged.

Although no damage is expected during the LOCA, TVA also performed a conservative dose analysis taking credit only for systems required to maintain core water inventory. This analysis assumed a core history of 1000 effective full-power days with only 24 months decay. The large break LOCA is the most limiting dose consequence event for Unit 2 operation in Mode 3 and 4. The doses calculated by TVA were 2 rem whole body and a negligible inhalation exposure at the site boundary (2 hour exposure), and less than 1 rem whole body and a negligible inhalation exposure at the low population zone (30 days exposure). These exposures are conservative because the containment is assumed not to isolate, although containment isolation operability is required by the TS, and the fuel has decayed more than 24 months.

The staff has reviewed the assumptions made by TVA and the calculated exposures, and is in agreement with the conclusions of TVA as to the magnitude of the exposure. The dose consequences calculated by TVA for the heatup for a large break LOCA are a small fraction of those reported in the staff's SE, Supplement No. 1 to NUREG-0011, dated February 1980, on the licensing of Sequoyah Unit 2. These accident dose consequences would be substantially lower if containment isolation operability, required by the TS, is included in the calculations.

Therefore, the staff concludes from its review of accident exposures that Unit 2 is acceptable for heatup.

4.0 CONCLUSION

Based on the above, the staff concludes that it is acceptable for TVA to heatup Sequoyah Unit 2 after all the remaining heatup required activities are complete. This would be a heatup before all the restart activities are complete. The plant systems would meet the operability requirements for Modes 4 and 3 in the Unit 2 TS.

5.0 REFERENCES

1. Letter from R. Gridley (TVA) to NRC, Sequoyah Unit 2 Regeneration of Pipe Support Calculations on Rigorous Analysis Piping, August 21, 1987.

2. Letters from R. Gridley (TVA) to NRC, Sequoyah Unit 2 Support Modification Restart Criteria for Rigorous Analysis Piping, August 31 and November 17, 1987.

3. Letter from S. A. White (TVA) to J. G. Keppler (NRC), Sequoyah Nuclear Plant System Heatup, September 28, 1987.

4. Letter from J. G. Keppler (NRC) to S. A. White (TVA), Items Identified By the Integrated Design Inspection Requiring Resolution Prior to Restart of Sequoyah Unit 2, October 9, 1987.

5. Letter from S. A. White (TVA) to J. G. Keppler (NRC), October 29, 1987.

6. Letter from R. Gridley (TVA) to NRC, Cable Test Program Procedures, Data, and Results, November 20, 1987.

7. Letter from R. Gridley (TVA) to NRC, Non-Nuclear Heatup of SQN Unit 2, December 4, 1987.

8. Letter from S. A. White (TVA) to NRC, Silicone Rubber Insulated Cable, December 28, 1987.

9. Letter from S. A. White (TVA) to NRC, Response to NRC Inspection Report 50-327/328/87-48, December 29, 1987.

10. Letter from S. A. White (TVA) to NRC, Independent Design Inspection, January 26, 1988.

11. NRC/TVA Meeting Summaries for meetings held September 1, September 10, and November 24, 1987. The summaries are, respectively, dated September 4, September 15, and December 2, 1987.

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