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

September 5, 2002

TVA-SQN-TS-00-06 10 CFR 50.90

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

Gentlemen:

In the Matter of) Docket Nos. 50-327
Tennessee Valley Authority) 50-328

SEQUOYAH NUCLEAR PLANT (SQN) - UNITS 1 AND 2 - TECHNICAL SPECIFICATION (TS) CHANGE NO. 00-06, RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION (RAI) (TAC NOS. MB2972 AND MB2973)

References: 1. TVA letter to NRC dated September 21, 2001, "Sequoyah Nuclear Plant (SQN) - Units 1 and 2 - Revision of Instrumentation Measurement Range, Boron Concentration Limits, Reactor Core Limitations, and Spent Fuel Pool Storage Requirements for Tritium Production Cores (TPCs) - Technical Specification (TS) Change No. 00-06"

2. TVA letter to NRC dated July 19, 2002, "Sequoyah Nuclear Plant (SQN) - Units 1 and 2- Technical Specification (TS) Change No. 00-06, Revised Response to Request for Additional Information (RAI) (TAC Nos. MB2972 and MB2973)"

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3. NRC letter to TVA dated September 4, 2002, "Sequoyah Nuclear Plant (SQN), Units 1 and 2 - Request for Additional Information on Technical Specification Change No. 00-06, Regarding Tritium Production Cores Amendments (TAC Nos. MB2972 and MB2973)"

TVA submitted TS Change 00-06 to NRC by the Referenced 1 letter to propose changes to the SQN TSs that will accommodate the production of tritium. TVA submitted the Referenced 2 letter in response to a request for additional information associated with the tritium SQN TS change request. In the Referenced 3 letter, NRC provided the following comments associated with TVA's Referenced 2 response:

1. *The licensee's response to Question 17 regarding the loss-of-coolant accident (LOCA) peak cladding temperature (PCT)-sensitive parameters should be consistent with the wording of the question.*

2. *The licensee's response to Question 16 regarding the impacts of downcomer boiling is not complete. To adequately address this question, the licensee will need to provide an estimate of the impact of inadequate downcomer modeling in their Appendix K LOCA model on PCT results, and address the impact this would have on the tritium-producing burnable absorber rod temperatures. The licensee must also provide a schedule for reanalyzing their LOCA analyses once the downcomer modeling issues have been resolved.*

This letter provides TVA's responses to these comments. In doing so the enclosure to this letter provides revised responses to Questions 16 and 17 of the Referenced 2 letter. There are no new commitments contained in this letter. The proposed TS change in the Referenced 1 letter is not altered by the enclosed responses.

This letter is being sent in accordance with NRC RIS 2001-05. If you have any questions about this response, please telephone me at (423) 843-6672 or K. C. Weller at (423) 843-7527.

Sincerely,

James D. Smith
Acting Licensing and Industry Affairs Manager

Subscribed and sworn to before me
on this 5th day of September

Notary Public

My Commission Expires August 12, 2006

JDS:KCW:PMB
Enclosure
cc (Enclosure):
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ENCLOSURE

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2
DOCKET NOS. 327 AND 328

REVISED RESPONSES TO REQUEST FOR ADDITIONAL INFORMATION
QUESTIONS 16 AND 17
TECHNICAL SPECIFICATION (TS) CHANGE 00-06

RAI Question 16:

In Section 2.15.5.1 of the SQN Topical Report the licensee states that the boundary conditions (fuel rod temperatures and fluid conditions) for the TPBAR temperature calculations are taken from the Appendix K LOCA analyses of record. Modeling of the downcomer region and downcomer boiling have recently been shown to substantially impact peak clad temperature (PCT) and oxidation following a loss-of-coolant accident (LOCA), especially for ice condenser containments. Please discuss how the downcomer region and downcomer boiling are modeled in the SQN LOCA Appendix K evaluation model, and dicuss any potential adverse impacts this modeling may have on PCT, oxidation, and TPBAR temperatures and oxidation.

Response:

Framatome-Advance Nuclear Power, Inc. (FRA-ANP) used an NRC-approved Appendix K evaluation model, which is comprised of the RELAP5/MOD2-B&W, REFLOD3B, and BEACH computer models, to establish the licensing basis for fuel operational limits at SQN. The "worst" case LOCA transient, in terms of peak cladding temperature, was used to establish boundary conditions for predicting the post-LOCA thermal response of Tritium-Producing Burnable Absorber Rods (TPBAR). The TPBARs were shown to respond acceptably in the LOCA environment.

Unlike the RELAP5/MOD2-B&W blowdown model, the REFLOD3B reflooding model is not finely discretized; for example, the downcomer and lower reactor vessel head are simulated by a single node. The REFLOD3B model, however, includes the heat content of all of the vessel structures and the wall heat transfer coefficients in the prediction of vessel fluid conditions. The reflooding calculation showed no indication of reflood fluid saturation or the presence of downcomer boiling. All of the Sequoyah Appendix K LOCA calculations were carried out until the core was completely quenched, which occurred at about 800 seconds.

Although the limited noding in the REFLOD3B model is a simplification that does not model all local fluid conditions, the Appendix K model contains conservatisms that more than compensate for any local phenomena that are not explicitly simulated, such as the behavior of the downcomer fluid. Appendix K requires that highly conservative assumptions and unrealistic modeling be used in the analysis of LOCA events. These requirements were included to compensate for LOCA phenomena that were either incompletely understood or unrecognized at the time. The following Appendix K requirements provide a substantial degree of conservatism:

Section I.A.

> "Fission Product Decay. The heat generation rates from radioactive decay of fission products shall be assumed to be equal to 1.2 times the values for infinite operating time in the American Nuclear Society (ANS) Standard (Proposed American Nuclear Society Standards -- "Decay Energy Release Rates Following Shutdown of Uranium-Fueled Thermal Reactors." Approved by Subcommittee ANS - 5, ANS Standards Committee, October 1971)."
>
> This decay heat requirement, originally intended to adjust LOCA calculations for variations in core design and operational parameters, has been demonstrated to be extremely conservative by experiments and decay heat models.

Section I.C.

> "...For postulated cold leg breaks, all emergency cooling water injected into the inlet lines or the reactor vessel during the bypass period shall in the calculations be subtracted from the reactor vessel calculated inventory."
>
> This requirement causes the analyst to discard fluid entering the reactor vessel and neglects the actual fluid penetration into the downcomer, an occurrence verified by experiment.

Section I.C.

> "After critical heat flux is first predicted at an axial fuel rod location during blowdown, the calculation shall not use nucleate boiling heat transfer correlations at that location subsequently during the blowdown even if the calculated local fluid and surface conditions would apparently justify the reestablishment of nucleate boiling ... Transition boiling heat transfer shall not be reapplied for the remainder of the LOCA blowdown, even if the clad superheat returns below 300 F..."

Film boiling lock-in during blowdown, particularly applied near the core entrance, artificially retards core quench by keeping the fuel and cladding surface temperature elevated.

Each of these conservatisms artificially reduces the rate of core reflood and elevates the calculated PCT, thus overshadowing the occurrence of any local phenomena that are not specifically modeled, such as downcomer boiling.

FRA-ANP has requested, and expects to receive within the next few months, NRC approval of its realistic LOCA methodology. This realistic model explicitly models downcomer fluid conditions and the effects of structural wall heat transfer in sufficient detail to predict the occurrence of downcomer boiling. Although the method has not been specifically applied to Sequoyah, it has been used to analyze large break LOCAs for a Westinghouse-designed plant that has similar but more bounding containment pressure response. (Since low containment pressures during reflood enhance the possibility of downcomer boiling, this condition is an important factor governing downcomer behavior.) PCT predictions in this application are on the order of 1700 degrees Fahrenheit (°F).

The significantly lower PCTs predicted by realistic methods demonstrate that local phenomena, such as downcomer boiling, are dominated by Appendix K conservatisms, as intended by the rule. Specifically, the PCT predicted by FRA-ANP's deterministic model is more than 400°F higher than that obtained using the realistic model.

The inclusion of TPBARs in a reactor is similar to the effect of using burnable poison rods. Despite this reality, the thermal response of the TPBARs is calculated using boundary conditions and assumptions based on the highly-conservative results from an Appendix K model, which are intended for fuel rod thermal analysis. Because of the added conservatism of applying the results of an Appendix K model to a burnable poison, it is concluded that downcomer boiling is not pertinent to the calculation of the thermal response of TPBARs.

It is concluded that the conservatism included in the prediction of PCT using the FRA-ANP Appendix K method more than accounts for any effects that might result from downcomer boiling. The application of boundary conditions from the highly conservative Appendix K model to the calculation of the thermal response of the TPBARs confirms their safe operation in a post-LOCA environment. FRA-ANP is aware of the potential importance of the downcomer boiling in certain plant designs and has independently initiated discussions with the NRC on downcomer boiling in the context of another application not related to Sequoyah. These discussions will define a process and schedule for resolving how this matter should be incorporated into future LOCA analyses.

Upon reaching this resolution, an evaluation of whether downcomer boiling should be included in the calculation of the post-LOCA thermal response of TPBARs will be made. Any changes to the present SQN evaluation required to address downcomer boiling will be addressed by FRA-ANP and TVA in accordance with the requirements of 10CFR50.46(a)(3)(i). A schedule for reanalysis (if required) will be provided in accordance with 10CFR50.46(a)(3)(ii) when the model changes (if any) have been identified.

RAI Question 17:

Please provide references to the approved LOCA analysis methodologies applied for SQN. Also provide a statement that SQN and its vendor have ongoing processes which assure that LOCA analysis input values for peak cladding temperature-sensitive parameters bound the as-operated plant values for those parameters.

Response:

Current NRC-approved computer codes and evaluation methodologies that serve as the SQN LOCA licensing basis are described in depth in the SQN reload fuel topical (Reference 1). Relevant LOCA methodology is described in Reference 2.

Applicability of the TVA-supplied inputs to the SQN LOCA analyses is confirmed by TVA each fuel cycle. The impact of changes to plant component or operational configurations on LOCA analyses of record are addressed as necessary as part of the plant change process. Changes to fuel assembly design or materials and their impact on existing LOCA calculations are addressed each fuel cycle to assure that current analysis results remain applicable and bounding and relevant acceptance criteria are met for current fuel configurations.

Based on the practices described above SQN and FRA-ANP have ongoing processes which assure that LOCA analysis input values for peak cladding temperature-sensitive parameters bound the as-operated plant values for those parameters.

References:

1. BAW-10220P-A, "Mark-BW Fuel Assembly Application for Sequoyah Nuclear Units 1 and 2," Framatome ANP, Inc., November 2001.

2. BAW-10168P-A, Revision 3, "RSG LOCA - BWNT Loss-of-Coolant Accident Evaluation Model for Recirculating Steam Generator Plants," Framatome ANP, Inc., B&W Nuclear Technologies, Lynchburg, Virginia, December 1996.