May 29, 1997

Mr. Oliver D. Kingsley, Jr.
President, TVA Nuclear and
Chief Nuclear Officer
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING THE WATTS BAR NUCLEAR PLANT, TRITUIM PRODUCING BURNABLE POISON ROD LEAD TEST ASSEMBLIES (TAC NO. M98615)

Dear Mr. Kingsley:

By letter dated April 30, 1997, the Tennessee Valley Authority (TVA) submitted a request for amendment of the Watts Bar Nuclear Plant Unit 1 (WBN) Technical Specifications (TS) that would permit the insertion of lead test assemblies (LTAs) containing tritium producing burnable poison rods in WBN during Cycle 2. The amendment application included the Department of Energy's Technical Report, PNNL-11419, "Report On The Evaluation of the Tritium Producing Burnable Absorber Rod Lead Test Assembly," prepared by the Pacific Northwest National Laboratory, as much of the technical basis for its requested action. The Nuclear Regulatory Commission staff has been reviewing the PNNL report and has identified a number of areas, as stated in the enclosure, where additional information specific to the WBN is needed. Accordingly, we request that TVA provide the identified information by June 13, 1997, so that the NRC staff may continue its review of your application.

Sincerely,

Original signed by Ronald W. Hernan for

Robert E. Martin, Senior Project Manager
Project Directorate II-3
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosure: Request for Additional Information

cc w/Enclosure: See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

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TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT

DOCKET NUMBER 50-390

REQUEST FOR ADDITIONAL INFORMATION REGARDING

TRITIUM PRODUCING BURNABLE ABSORBER ROD LEAD TEST ASSEMBLIES

By letter dated April 30, 1997, the Tennessee Valley Authority (TVA) submitted a request for amendment of the Watts Bar Nuclear Plant Unit 1 (WBN) Technical Specifications (TS) that would permit the insertion of lead test assemblies (LTAs) containing tritium producing burnable absorber rods (TPBARs) in WBN during Cycle 2. The amendment application included the Department of Energy's (DOE) Technical Report, PNNL-11419, "Report On The Evaluation of the Tritium Producing Burnable Absorber Rod Lead Test Assembly," prepared by the Pacific Northwest National Laboratory. This report is hereafter referred to as the "DOE report".

1. Cladding and Top and Bottom End Plugs

Section 2.2.1.1 of the DOE report states that the TPBAR cladding stresses and the end plug weld stresses will not result in cladding collapse, excess ovality, or cracking over the irradiation life of the TPBAR. The structural members (cladding and top and bottom end plugs) of the LTA were designed using stress and fatigue criteria and methodology consistent with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (ASME Code, Section III, Division I, Subsection NG, Article 3220, 1995).

The Nuclear Regulatory Commission staff (NRC) concludes that the method used to analyze the stresses on structural members is conservative as long as the margins specified in Subsection NG of Section III of the ASME Code are satisfied. DOE used the 1995 edition of the code, however, the staff has only endorsed the 1989 edition. A comparison of Article NG-3220 in the 1995 edition with Article NG-3220 in the 1989 edition indicates that they are identical. TVA must submit a request for relief for the use of the 1995 code since the NRC staff has only endorsed up to the 1989 Edition of the ASME Code.

2. Use of ASTM Standard A 771 for Purchase of Cladding

The DOE report does not address the conformance of the design with 10 CFR Part 50, Appendix B and NQA-1 because the cladding was ordered to conform to ASTM A 771. Reliance on ASTM A 771 for the purchase of the cladding does not satisfy the requirements of 10 CFR Part 50, Appendix B. The quality assurance program described in ASTM A 771 needs to be supplemented to include conformance with NQA-1 and 10 CFR Part 50, Appendix B.

3. Effects of Thermal Cycling on TPBAR Components and Quality Standards to Address Them

DOE's report does not address the effects of thermal cycling during postulated design-basis accidents (DBAs) on the materials, particularly on the cladding and the aluminide barrier.

4. Metal-Metal Interactions Occurring During a LOCA

DOE has not discussed whether any metal-metal or intermetallic interactions that could result in the development of brittle microstructures will occur during postulated DBAs. Discussion is also needed on temperature limits for metal-metal and intermetallic interactions. TVA is requested to investigate these issues and provide the resulting findings to the ACRS and the NRC staff.

5. Demonstration that the MATHCAD Model is Conservative

Section 2.2.5 of the DOE report summarizes the analytical models used to calculate TPBAR operating parameters. The software used to calculate the TPBAR performance parameters is MATHCAD. DOE states that the models may contain large uncertainties for some situations. TVA is requested to submit additional documentation to show that the MATHCAD model is conservative when it is used to calculate TPBAR temperatures and pressures. This documentation could consist of results obtained for other applications using MATHCAD and compared with actual operating service.

6. Comparison of Reactivity Characteristics of the TPBAR to BPRAs

Section 3 of the DOE report does not contain a comparison of the reactivity characteristics of the TPBARs with the burnable poison rod assemblies (BPRAs). Instead, a comparison of the infinite medium multiplication factor (k_∞) for TPBARs and wet annular burnable absorbers (WABAs) as a function of burnup is shown in Figure 3-1 of the DOE report. In this case, the close comparison between these two designs is a general indication that other core design parameters are also similar. This analysis illustrates that differences are small enough to be accommodated within the range of core-to-core variations that are customarily handled in fuel cycle design. However, the scoping analysis does not present a basis for ensuring that all core design limits are satisfied. The staff concludes that the Watts Bar license amendment request must contain a comparison of the reactivity characteristics of the TPBAR to the BPRAs in order to demonstrate that the TPBARs are functionally similar to the BPRAs.

7. Cycle 2 Reload Analysis

Section 3 of the DOE report discusses the effects of the TPBAR LTAs in terms of nuclear design, power distribution, reactivity control, and reload safety analysis. DOE concludes that the TPBARs mimic the neutronic behavior of BPRAs and WABAs and that the plant-specific reload safety analysis will demonstrate that all established fuel design limits will be met. DOE states that the nuclear design criteria will be assessed in the core reload evaluation using NRC-approved methodologies. The analyses are presented as scoping studies and as supporting evidence for the reload safety evaluation, rather than as a direct assessment of the general design criteria. The staff concludes that the scoping analysis offers evidence that the TPBARs and the WABAs are functionally similar, but does not present a basis for assuring that all core design limits are satisfied. In order to establish the acceptability of operation of WBN with TPBAR LTAs, TVA is requested to provide the Cycle 2 reload analysis demonstrating that Watts Bar will remain in compliance with 10 CFR Part 50.

8. Analysis of 400-mil Pellet Gap

Section 3.2 of the DOE report evaluates the sensitivity of flux peaking on pellet gaps and fabrication tolerances. The peak pellet gap is calculated with DORT, a discrete ordinate transport code. The staff notes that the maximum gap was calculated to be less than 400 mils. A 400-mil gap in the absorber pellet stack results in a relatively small local power peak of 4.5 percent in the surrounding fuel pins. TVA is requested to provide an analysis of the effect of a 400-mil gap in the absorber pellet stack to demonstrate that a local power peak of 4.5 percent in the surrounding fuel pins will be the maximum achieved.

9. Maximum Negative Worth of TPBAR

Section 3.3 of the DOE report discusses the overall reactivity contribution of ^{6}Li in the LTA and its similarity to that of regular BPRAs. The staff notes that the most significant difference in the behavior of the TPBAR is the decay of tritium to a strong absorber, ^{3}He. As discussed in the January 22, 1997, public meeting, the effect of tritium decay during a long shutdown near the end of a cycle might result in more negative reactivity in the TPBARs than in a comparable WABA or BPRA. The DOE report indicates that the tritium decay is being included in the PHOENIX-L upgrade. The staff believes that the WBN reload analysis should consider a case that assesses the maximum negative worth of the TPBAR LTA. This case could be near the end of cycle following a long shutdown rather than the usual beginning-of-life case. TVA is requested to provide this information.

10. Benchmarking of PHOENIX-L Code

Section 3.4 of the DOE report discusses the change in the standard suite of NRC-approved Westinghouse core analysis codes (PHOENIX/ANC) to account for the presence of the TPBAR in the core. In a letter dated May 17, 1988, the NRC staff approved the Westinghouse Topical Report WCAP-11596, "Qualification of the PHOENIX-P/ANC Nuclear Design System for Pressurized Water Reactor Cores," for use. Only the PHOENIX-P code, which is one of the NRC-approved Westinghouse core analysis codes, will be altered slightly to accommodate the presence of the TPBARs in the core. The proposed changes to the PHOENIX-P code model the depletion of ^{6}Li in the TPBARs, the decay of ^{3}H, and the production/depletion of ^{3}He. Westinghouse will document the new version, PHOENIX-L, in a report to PNNL and TVA, subject to the reporting criteria imposed by 10 CFR 50.46(a)(3). Westinghouse will maintain computer software verification and validation files on PHOENIX-L. The staff has requested Westinghouse to describe (in a letter to the staff) the specific changes to the PHOENIX-P code and the results of the benchmarking. The staff will review the letter from Westinghouse, discussing the changes to the PHOENIX-P code, as part of its review of TVA's application, dated April 30, 1997, for an amendment to the facility operating license for WBN.

11. Thermal-Hydraulic Analysis for Cycle 2

Section 4.1 of the DOE report states that the thermal-hydraulic analysis of the TPBAR design was performed by hand calculations and MATHCAD software. These calculations were not presented in the report; however, Tables 4-2 and 4-3 of the report summarize some of the WBN parameters that were used in the thermal-hydraulic analysis. The NRC staff notes that these parameters appear to be Cycle 1 parameters. As noted in Table 4-2 of the report, Cycle 2 parameters increase slightly but have not yet been entirely established. On the basis of this preliminary analysis, the DOE report states that the thermal-hydraulic criteria are met with the TPBAR located in an assembly with a total power peaking of up to 1.42 and with the TPBAR adjacent to a fuel rod with an F_{dh} (enthalpy-rise hot channel factor) of 1.65 or less. Since the analysis, i.e., the hand calculations, was not presented in the DOE report, the NRC staff cannot conclude, on the basis of the information provided in the DOE report, that the TPBAR LTAs will not affect the WBN thermal-hydraulic design, with the TPBAR located in an assembly with a total power peaking of up to 1.42 and with the TPBAR adjacent to a fuel rod with an F_{dh} of 1.65 or less. Since the DOE thermal-hydraulic analysis is preliminary, TVA is requested to provide information showing, for Cycle 2 of WBN that the thermal-hydraulic behavior of the TPBAR LTAs located in non-limiting positions in the core will meet all acceptance criteria.

12. Weld Qualification Procedure

On the basis of the information in Section 5.3 of the DOE report, the staff concludes that the weld qualification procedure for TPBARs is deficient. Since the TPBAR is considered safety-related, the welder qualification and weld process specification must conform to the requirements of Section IX of the ASME Code, as well as to additional requirements of the construction code, owners specifications, and the additional requirements for special processes of NQA-1 and the Westinghouse quality assurance (QA) program. The DOE report does not address which construction code will be used for welder qualification and weld process specifications. ASTM E2 is no longer an approved standard; it was replaced in 1982 by ASTM E883. ASTM E883 describes how to conduct metallographic examinations, and its use for examining these welds needs to be described in more detail. Therefore, TVA must supplement the welding procedure described in Section 5.3.1.5 of the DOE report to address these concerns before the staff can conclude that TPBAR LTA irradiation in the WBN reactor is acceptable.

13. Non Destructive Examination (NDE)

DOE states that the cladding and end plugs are tested in conformance with applicable codes and standards. Table 5-5 of the DOE report notes the NDE techniques and applicable standards used during TPBAR fabrication. The staff concludes that, since the TPBAR is being classified as safety-related and is being produced to the criteria of Section III of the ASME Code, the NDE techniques and applicable standards should conform to the requirements of Section III, or an alternative to the requirements must be submitted to the NRC for approval under Title 10 of the Code of Federal Regulations, Section 50.55a (10 CFR 50.55a). Since DOE states that the TPBARs are being designed to the 1995 edition of the code, the staff concludes that the NDE techniques performed by PNNL and by subvendors should be qualified to the requirements of Section XI, Appendix VIII or to an acceptable alternative proposed under 10 CFR 50.55a.

14. Inadvertent Loading and Operation of an LTA in an Improper Position

Section 6.3.4 of the DOE report states that LTA loading errors are precluded by the Watts Bar administrative procedures that are in place to prevent fuel assembly and burnable poison misloading. The DOE report states that in the unlikely event that an LTA is loaded in the wrong location, the resulting power distribution will be detectable by the in-core movable detector system or the core power distribution perturbation will be within the specified fuel design limits. However, it is not clear to the NRC staff whether this misloading was assumed to be a limiting location. The purpose of this analysis is to verify that misloading the TPBAR LTA to a limiting location is within the limits of the safety analysis report. Also Chapter 3 of the DOE report discusses how the TPBARs are designed to mimic the reactivity characteristics of the BPRAs. Therefore, it is not clear how the in-core detectors would be able to distinguish the TPBARs from the BPRAs.

In addition, the DOE report states that the thermal-hydraulic analysis in Chapter 4 demonstrates that the LTA would not exceed the TPBAR design limits even if it were loaded in the limiting fuel assembly in the core. The staff is unable to concur with these conclusions on the basis of the information presented in the DOE report. DOE's analysis in Chapter 4 is preliminary and states that the thermal-hydraulic criteria are met with the TPBAR located in an assembly with a total power peaking of up to 1.42 and with the TPBAR adjacent to a fuel rod with an F_{dh} (enthalpy hot-channel factor) of 1.65 or less. As noted in Table 4-4 of the DOE report, TPBARs have a slightly higher power than the BPRAs. Therefore, placement of the TPBAR LTAs in a location other than described, and thus more limiting, must be analyzed. TVA is requested to submit information evaluating the consequences of loading the LTA in the limiting assembly in the core.

15. Quality Assurance Program

The staff is continuing its review to determine whether the quality assurance (QA) program controls are adequate to establish conformance with the requirements of 10 CFR Part 50, Appendix B. Fundamental issues concerning the safety classification of specific components in the TPBAR LTAs, commercial-grade dedication, design information controls, and the adequacy of Pacific Northwest National Laboratory's (PNNL's) QA program related to the design and manufacture of TPBARs have been identified in a request for information letter to DOE dated April 21, 1997. Since PNNL is identified as maintaining primary responsibility for the design and fabrication of the TPBARs establishes that an evaluation of PNNL's QA Program will constitute an integral part of the staff's review of the TPBAR LTA Program as applied to commercial light-water reactors. Therefore, the staff will conduct onsite inspections at PNNL in order to verify the adequate implementation of 10 CFR Part 50, Appendix B requirements related to the design and fabrication of the TPBARs.

Because the TVA's Watts Bar plant has been selected as the location for the confirmatory TPBAR LTA irradiation, TVA will need to provide TPBAR suppliers (PNNL and the Westinghouse fuels fabrication facility in Columbia, South Carolina) with the programmatic controls and processes that will demonstrate compliance with the requirements of 10 CFR Part 50, Appendix B, before installing these assemblies into the Watts Bar reactor core. Please provide a response indicating the status of TVA and PNNL's activities on these matters.

16. Refueling Operations

Section 6.2 of the DOE report states that 150 hours after reactor shutdown, the heat load of each LTA is less than 0.024 kW (3 Watts per pin). The total heat load to the spent fuel pool from all four LTAs after irradiation is not expected to increase significantly from normal assemblies with BPRAs and is expected to be within the capability of the Watts Bar spent fuel pool cooling system. Please provide quantitative information with respect to this matter for the WBN.

17. Anticipated Transient Without Scram (ATWS)

Section 6.3.5 of the DOE report discusses the TPBAR LTA impact on ATWS events. The DOE report states that the TPBARs could affect the reactivity assumptions of the ATWS analysis, although this effect would be minimal due to the ^{6}Li cross-section. As stated in Chapter 3, the TPBARs are designed to mimic the neutronic behavior of conventional BPRAs and, therefore, the TPBARs are not expected to affect the existing ATWS neutronics analysis. The staff is unable to conclude that the TPBARs will have minimal impact on the ATWS neutronics analysis, based on the information presented by DOE. Provide information with respect to this matter for the WBN ATWS analysis for Cycle 2.

18. Thermal-Hydraulics and Reload Analysis

(a) Page E5-1 of TVA's application dated April 30, 1997 states that "the TPBAR final thermal-hydraulic analysis assumed an assembly average relative power of 1.40, a peak rod adjacent to the TPBAR with an F delta h of 1.65, and the peak TPBAR heat generation rate. The TPBAR meets thermal-hydraulic design criteria using these assumptions. By design, the TPBAR LTAs will be loaded in core locations that have non-limiting assembly average relative powers in order to conform with WBN Technical Specification 4.2.1 which requires that lead test assemblies be placed in non-limiting core locations. The TPBAR host assembly power will be monitored to ensure that assembly power is maintained at levels consistent with the assumed assembly average relative power of 1.40." This statement only addresses the assumed thermal-hydraulics of the TPBAR not the thermal-hydraulic effect of the TPBAR in different locations throughout the core. Provide the thermal-hydraulic analyses of the reactor core with the TPBAR LTAs in the proper and mislocated positions.

(b) Page E6-1 states that "the TPBAR host assembly power will be monitored to ensure that assembly power is maintained at levels consistent with the assumed assembly average relative power of 1.40." Please describe the monitoring frequency, action levels, and reactor operator compensatory actions.

(c) When will the plant-specific reload safety analysis in support of the Cycle 2 core reload be complete and available for staff review if necessary?