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John A. Scalice
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JUN 18 1997

U.S. Nuclear Regulatory Commission
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Gentlemen:

In the Matter of	)	Docket No. 50-390
Tennessee Valley Authority	)	

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING WATTS BAR NUCLEAR PLANT TRITIUM PRODUCING BURNABLE POISON ROD LEAD TEST ASSEMBLIES (TAC NO. M98615)

The purpose of this letter is to provide a response to NRC's request for additional information on the above subject dated May 29, 1997, as discussed in the public meeting with the NRC staff on June 4, 1997. [Enclosure 1]

It should be noted that the responses to Questions 3, 4, and 5 require disclosure of U. S. Department of Energy (DOE) classified information. The classified portions of these responses are therefore being provided separately by DOE correspondence.

Also attached [Enclosure 2] is an updated copy of the Tritium Producing Burnable Assembly Rod (TPBAR) Lead Test Assembly (LTA) Failure Modes and Effects Analysis (FMEA) developed by DOE. This document supersedes the FMEA provided by DOE letter dated March 12, 1997.

The new commitments identified in this letter are summarized in Enclosure 3. Should there be any questions regarding this letter, please contact P. L. Pace at (423) 365-1824.

Sincerely,

J. A. Scalice

JUN 1 8 1997

Enclosures
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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT UNIT 1
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
TRITIUM PRODUCING BURNABLE POISON ROD LEAD TEST ASSEMBLIES

QUESTION 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.

RESPONSE TO QUESTION 1

The TPBAR pressure boundary (cladding and top and bottom end plugs) is not classified as an ASME Class I, II, or III component. This approach is consistent with the requirements and guidance of 10 CFR 50.55a, Regulatory Guide 1.26, and NUREG 0800, Sections 3.2.2 and 5.2.1.1 regarding the classification of pressure retaining components of nuclear power plants. Accordingly, the specific provisions and regulatory processes of 10 CFR 50.55a with regard to the design, fabrication, and inservice inspection of ASME Class I, II, or III components are not applicable to TPBARs. Therefore, a relief request is not required.

As is standard industry practice for the design of burnable absorber rods, TPBAR pressure boundary (cladding and top and bottom end plugs) mechanical design criteria and analysis methodology use Section III of the ASME code as a general guide. Pacific Northwest National Laboratory (PNNL) has applied the 1995 Edition of the ASME Boiler and Pressure Vessel (B&PV) Code, Section III, Division 1, Subsection NG, Article 3220, in the performance of these design activities. PNNL has compared the 1995 Edition of Article 3220 with the 1989 Edition and found no differences relevant to TPBAR design or analysis. Accordingly, mechanical design criteria and analysis methodology are also consistent with the 1989 Edition of the ASME B&PV Code incorporated by reference in 10 CFR 50.55a.

QUESTION 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.

RESPONSE TO QUESTION 2

The Technical Report refers to American Society of Testing and Materials (ASTM) A 771 in order to provide a precise engineering description of TPBAR cladding and end plug materials. As described in Chapter 7 of the Technical Report, activities associated with the fabrication of the TPBAR are performed under the PNNL Project Quality Assurance Program which complies with 10 CFR 50, Appendix B, and ANSI/ASME NQA-1. Purchase orders for TPBAR cladding implement the applicable requirements of the PNNL Project Quality Assurance Program and require conformance to the PNNL cladding specification. The TPBAR cladding specification references ASTM A-771 with regard to cladding material properties and contains additional technical requirements applicable to TPBAR cladding that are not addressed by ASTM A-771.

The 316SS bar stock material used in the fabrication of TPBAR cladding tubes and end plugs was reverified from material originally procured for Fast Flux Test Facility (FFTF) fuel rod cladding. Reverification was performed under a special PNNL dedication procedure (reference Question 15, Issue 15-3 response) and the PNNL Project Quality Assurance Program.

QUESTION 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.

RESPONSE TO QUESTION 3

Section 2.2.1.3 of the Technical Report addresses thermal cycling and resulting clad fatigue during normal and transient operating conditions. The cladding has been shown to satisfy the conditions of NG-3222.4(d) of the ASME B&PV Code. The evaluation of cladding thermal cycling is based on Watts Bar design cycle data and is shown in Table 2-4 of the Technical Report. Additional information regarding thermal cycling effects on the cladding barrier coating are provided in a classified response. Information regarding the quality assurance program is addressed in Question 15 response.

QUESTION 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 inter-metallic interactions. TVA is requested to investigate these issues and provide the resulting findings to the ACRS and the NRC staff.

RESPONSE TO QUESTION 4

As indicated in the Technical Report, the TPBAR is calculated to reach the design stress at 1500 degrees F due to a combination of a loss of cladding material strength and high internal pressure due to high internal gas temperature. The classified Technical Report identifies the lowest eutectic temperature that can form in the TPBAR. This temperature is substantially above 1500 degrees F. Since the TPBAR is calculated to reach the design stress at a temperature below the lowest eutectic temperature, liquid metal embrittlement is not considered in the mechanism for TPBAR cladding failure during a design basis LOCA. Watts Bar design basis events other than the design basis LOCA result in TPBAR temperatures below 1500 degrees F and far below the lowest eutectic temperature.

Additional discussion of expected TPBAR behavior during a design basis LOCA including metal-metal interactions is being submitted to NRC under separate (classified) cover.

QUESTION 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.

RESPONSE TO QUESTION 5

The approach taken in the analytical modeling of the TPBARs is to use conventional equations for heat transfer and established material properties. Principal uncertainties associated with thermal properties and heating rates have been addressed by using conservative assumptions. The use of conservative assumptions (e.g., inputs) has provided expected TPBAR performance parameters that are still within satisfactory considerations. In turn, these analytical model results are used in establishing TPBAR design assumptions. Where available, corroborating test data has been used to support the assumptions. Further details on the specific analytical assumptions that demonstrate the model calculates conservative temperatures and pressure involve unique TPBAR design characteristics, and these are being submitted to the NRC under separate (classified) cover. If necessary, the analytical model is available for NRC review.

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QUESTION 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.

RESPONSE TO QUESTION 6

The Watts Bar Cycle 2 core will employ WABAs as a discrete burnable absorber. The reference core design will use clusters of 4 WABAs in LTA locations. In the core design containing TPBARs, clusters of 8 TPBARs are slated for the LTAs. Eight TPBARs have more negative worth than four WABAs. To provide a more consistent comparison of TPBAR and WABA worths, a Watts Bar Cycle 2 core model was developed which employed clusters of 8 WABAs in the LTA locations. For the worth comparison, these core models were taken to hot zero power at various points in the cycle depletion to eliminate Doppler feedback. For each of the models (i.e., the model with 8 TPBARs and the model with 8 WABAs), restarts were performed in which the absorber number density, ^{10}B in the case of WABAs and ^{6}Li the case of TPBARs, was set to zero. The <u>change</u> in the k_∞ of the LTA assembly that results when the absorber is removed represents the worth of the absorber in the LTA location. Figure 1 provides these results.

Note in Figure 1 that in the early part of the cycle, the TPBAR and WABA worths are reasonably comparable. This occurs despite the lower absorption cross section of ^{6}Li relative to ^{10}B, since the loading of ^{6}Li in the TPBAR is much larger than the loading of ^{10}B in a WABA. The low absorption cross section and high loading of ^{6}Li, however, combine to cause the TPBAR to retain a substantial fraction of its initial worth even at the end of the cycle. WABAs, on the other hand, lose almost all of their worth since, by end-of-life, nearly all the ^{10}B is depleted.

The TPBARs will be explicitly modeled in the core models that will be used to perform the Cycle 2 Reload Safety Evaluation. Thus, the effects of any differences in worth will be evaluated as part of the Reload Safety Evaluation.

QUESTION 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.

RESPONSE TO QUESTION 7

A reload core analysis will be performed to ensure compliance with core design limits. Preliminary evaluations have been performed assuming maximum, nominal, and minimum burnup windows for the Cycle 1 fuel that will be utilized in Cycle 2. The preliminary analysis shows that key parameters such as $F_{\Delta H}$ and MTC are within design limits. The Reload Safety Evaluation (RSE) is expected to show that the reference safety analysis remains valid and no additional changes to the technical specifications are anticipated. The final RSE for Cycle 2 is scheduled for completion on August 28, 1997.

QUESTION 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.

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RESPONSE TO QUESTION 8

In Revision 1 to the Technical Report, the TPBAR fabrication gaps increased from 300 mils to 400 mils relative to the initial version of the Technical Report, but the reported localized power peaking remained bounded by 4.5%. The size of the evaluated fabrication gaps was increased in Revision 1 of the Technical Report to account for an increase in the thermal and irradiation growth of target rod internals, and to account for the potential for improper orientation of the pencils during fabrication of the TPBARs.

The initial version of the Technical Report assumed bounding fuel enrichments and ^{6}Li loadings for the TPBARs in the calculation of the power peaking due to fabrication gaps. In Revision 1 to the Technical Report, WBN Cycle 2 specific fuel enrichments and target loadings were used to calculate the localized power peaking. Despite the larger fabrication gap size, the power peaking remains bounded by 4.5% since the WBN Cycle 2 fuel enrichments and target loadings are less than the bounding values used in the initial analysis.

QUESTION 9 - MAXIMUM NEGATIVE WORTH OF TPBAR

Section 3.3 of DOE report discusses the overall reactivity contribution ^{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.

RESPONSE TO QUESTION 9

As discussed in the response to Question 6, near beginning-of-life (BOL) WABAs and TPBARs have reasonably comparable worth. Because of the larger absorption cross section of ^{10}B relative to ^{6}Li, and the smaller number density of ^{10}B in a WABA relative to the number density of ^{6}Li in a TPBAR, WABAs lose their worth much more quickly than TPBARs. Near end-of-life (EOL), the negative reactivity of TPBARs is much larger than for WABAs.

As indicated in the staff's RAI, the negative worth of TPBARs will increase slightly after a long shutdown due to the decay of tritium into ^{3}He. This effect, however, is quite small even for long shutdowns near EOL. To demonstrate this, an ANC core model of the Watts Bar Cycle 2 core was used to simulate the build-up of ^{3}He for a 90-day shutdown at 80% of the Cycle 2 core burnup. A 90-day shutdown was chosen as a reasonable shutdown length since shutdowns of much longer than this would likely result in refueling. The 80% point in the cycle was chosen since long shutdowns any later in the cycle would also likely lead to refueling.

At 80% of the cycle, a cycle burnup of about 14,000 MWD/MTU, only about 42% of the initial ^{6}Li inventory in the LTAs will have been converted into tritium. Tritium has a 12.33 year half-life. After 90 days, less than 1.4% of the tritium will have decayed into ^{3}*He*. In the ANC core model, the absorption cross section of the LTA assembly was adjusted to account for the extra neutron absorption that would result if this amount of ^{3}He build-up were to occur. The models with and without the simulated ^{3}He build-up were then compared at full power. The result was that the relative power in the LTA fuel assembly decreased by 0.007, from 1.198 to 1.191, due to the additional negative worth of the ^{3}He build-up. The core $F_{\Delta H}$, the hot rod relative power, increased by only 0.001, from 1.390 to 1.391. Finally, the k_{∞} of the LTA assembly decreased only slightly, by only 139 pcm of reactivity. This, then, is the added negative worth of the TPBAR due to the additional ^{3}He.

These results indicate that the ^{3}He build-up after a long shutdown will have an insignificant effect on the Watts Bar Cycle 2 core power distribution.

QUESTION 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-11595, "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 the ^{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.

RESPONSE TO QUESTION 10

On March 12, 1997, DOE sent to NRC a letter describing the modifications to the PHOENIX-P computer software so that it could be used for modeling TPBARs. In that letter, a statement was made that PHOENIX-P had not yet been modified to account for tritium decay. However, other changes needed to analyze the TPBARs had been made and a description of those changes was provided.

The PHOENIX-P has subsequently been modified to model tritium decay. In order to explicitly model the tritium-helium-3 decay chain in the Cycle 2 core model, the ANC code will also be modified to track the tritium and helium-3 isotopes. DOE will submit a separate letter to NRC documenting these changes.

QUESTION 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.

RESPONSE TO QUESTION 11

The thermal-hydraulic analysis described in Chapter 4 of the Technical Report has been completed, documented, and is available for audit.

The entire analysis, i.e., Calculation, was not presented in the previously submitted report; however, the basic methodology utilized for the TPBAR thermal hydraulic analysis is a one dimensional subchannel analysis. The analysis is used to solve the film temperature drop between the TPBAR cladding surface and the coolant and the bulk coolant condition within the subchannels. The MATHCAD software package is used to solve the set of simultaneous equations. The purpose of the calculation is to verify that two functional requirements are met: 1) to preclude subcooled nucleate boiling on the surface of the TPBAR cladding, and 2) to preclude bulk boiling in the guide thimble coolant channel during Condition I and II events. The functional requirements established for the thermal performance of the TPBARs were augmented as part of Revision 1 to the Technical Report. The original thermal performance Functional requirements stated that the cladding temperature could not exceed 650 F during Conditions I and II. This value was initially chosen because it is the design temperature for the RCS pressure boundary and is also generally associated with the saturation temperature at the WBN nominal operating pressure (2250 psia). It was subsequently determined that this temperature is not appropriate for core internal components since the saturation temperature may be different than 650 degrees F depending on the WBN operating conditions. The change to the new Functional requirements reflected in Revision 1 is consistent with previous Westinghouse analyses for burnable poison rod thermal performance, and inherently incorporates the effects of variations in the saturation temperature.

The TPBAR and fuel rod powers are input as surface heat fluxes, based upon the various axial, radial, and total power conditions. These are defined to bound the operating conditions for WBN and also specific to the Condition I or II analysis. For the fuel rods, one rod is assumed to be at the $F_{\Delta H}$ limit, with the remaining rods at the assembly normalized average power. The assembly power is adjusted to bound the operating conditions of the plant, while maintaining TPBAR cladding and bulk coolant temperatures within the limits of the Functional requirements.

Fluid pressure drop and flow distribution are provided as boundary conditions based on existing Westinghouse analyses for borosilicate BP rod designs. The TPBAR external dimensions are identical to the existing BP rod design. The guide thimble dimensions are also identical to existing designs.

The plant specific input parameters used in the final analysis are Watts Bar Cycle 2 values. The TPBAR thermal-hydraulic analysis assumed an assembly total power peaking of 1.40, a peak rod adjacent to the TPBAR with an $F_{\Delta H}$ of 1.65, and a peak TPBAR heat generation rate. These assumptions are conservative for the following reasons:

- By virtue of their negative reactivity effect, the TPBARs will suppress the power in any assembly in which they reside. For the same reason, they will also suppress the power in fuel rods adjacent to them. In an actual core, fuel rods adjacent to the TPBARs would be expected to operate at relative powers which are at or below the assembly average relative power. Thus, assuming a peak rod adjacent to the TPBAR with an $F_{\Delta H}$ of 1.65 is highly conservative.

- The assemblies in the host plant Cycle 2 reload core have been predicted to have an assembly total power peaking of less than 1.40 as assumed in the TPBAR thermal-hydraulic analysis.

- For fuel assemblies with WABA or TPBARs, assembly powers increase from beginning-of-life to end-of-life due to absorber depletion. However, TPBAR power is highest at beginning of life since the reaction rate in the TPBAR pellets is highest at the beginning of life. Thus the coincident assumption of peak TPBAR heat generation rate with an assembly total power peaking of 1.40 is conservative.

The final thermal-hydraulic analysis (including input parameters) has been reviewed and accepted by Westinghouse and has been determined to be sufficient for the purpose of demonstrating adequate TPBAR thermal-hydraulic performance in the Watts Bars Cycle 2 reload core.

QUESTION 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.

RESPONSE TO QUESTION

The safety functions of the TPBAR are discussed in the response to Question 15, Issue 15-1. As described in the response to Question 1, the TPBAR is not an ASME Class I, II, or III component and, therefore, ASME Code requirements are not applicable to the cladding/end plug welds of the TPBAR. PNNL has performed a comparison of the technical criteria of ASME Section IX and the TPBAR welding specification. The PNNL fabrication procedures meet or exceed the requirements of ASME Section IX to the extent that they are technically relevant to the TPBAR.

PNNL has developed a welding specification that addresses weld and weld NDE qualification (procedures, personnel, and equipment) and the fabrication welding process. The welding specification is used as a basis for developing TPBAR fabrication procedures. TPBAR fabrication welds are subjected to visual examination, helium leak testing, and radiographic examination. Weld process qualification test welds and TPBAR fabrication lot test welds are subjected to metallographic examination, in addition to the examinations performed for fabrication welds. The following industry standards are referenced in the welding specification and the welding specification meets or exceeds the relevant criteria of these standards.

[1]ASTM E3
ASTM E883
ASTM C-859
ASTM E1025
ASTM E499
ASME B&PV Code, Section V, Article 10, Appendix V
American Welding Society (AWS) A2.4
AWS A3.0

[1]Note that the Technical Report refers to ASTM E2. This was a typographical error in the report. Metallographic examinations performed during weld qualification processes conform to ASTM E3 (specimen preparation) and ASTM E883 (process criteria).

The welding specification augments these industry standards with additional technical requirements based on the design analysis of TPBARs, the experience gained from previous tritium target test programs, and previous fabrication process experience with the material used for TPBAR cladding. The welding specification and fabrication procedures comply with administrative and documentation requirements of the PNNL Project Quality Assurance Program which complies with 10 CFR 50, Appendix B, and ANSI/ASME NQA-1.

TPBAR fabrication welding processes are controlled in accordance with PNNL's procedure for preparing a Manufacturing and Quality Plan (MAQP). This procedure requires the weld process to be qualified and the qualification report as well as any "key" parameters from the qualification to be listed on the TPBAR MAQP. The PNNL design organization and Westinghouse have reviewed and approved the MAQP. Westinghouse has also qualified PNNL as a supplier of components in accordance with the Westinghouse Quality Management System (QMS). Westinghouse has conducted audits of PNNL design and manufacturing activities, and Westinghouse will verify the TPBARs and their associated documentation comply with the requirements of the MAQP before they are released for further assembly by Westinghouse's Columbia facility.

QUESTION 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.

RESPONSE TO QUESTION 13

The safety functions of the TPBAR are discussed in the response to Question 15, Issue 15-1. As described in the response to Question 1, the TPBAR is not an ASME Class I, II, or III component and, therefore, ASME Code requirements and 10 CFR 50.55a are not applicable to the TPBAR. PNNL has developed component specifications that address NDE of TPBAR materials. These specifications are used to specify requirements for TPBAR cladding purchased material, including material NDE.

Specifically with regard to ASME Section XI, Appendix VIII that addresses ultrasonic examination, the TPBAR cladding tubes and end plug materials are subjected to ultrasonic examination. The PNNL specifications for these components reference industry standards ASTM E 213 and ASTM E 1065 and the specifications meet or exceed the relevant criteria of these standards. TPBAR purchase requirements and component specifications augment these industry standards with additional technical requirements, testing and examination requirements, and the administrative and documentation requirements of the PNNL Project Quality Assurance Program which complies with 10 CFR 50, Appendix B, and ANSI/ASME NQA-1. Vendor ultrasonic NDE procedures, personnel, and process qualification are reviewed and approved by PNNL prior to the performance of examinations and are verified to comply with ASNT-TC-1A, PNNL component specifications, and the PNNL Project Quality Assurance Program.

QUESTION 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 that 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.

RESPONSE TO QUESTION 14

As described in the response to Question 11 above, the TPBAR thermal-hydraulic analysis has been finalized. All assemblies in the host plant Cycle 2 reload core have been predicted to have an assembly total power peaking of less than 1.40 as assumed in the TPBAR thermal-hydraulic analysis. Accordingly, there are no locations in the Cycle 2 reload core that are predicted to be more limiting. The TPBAR LTAs will be loaded in a non-limiting core location in order to conform with WBN Technical Specifications which require that lead test assemblies be placed in non-limiting core locations. There are no thermal-hydraulic characteristics inherent in the LTA design and no limitations based on analytical assumptions that require any specific placement in the core. In the unlikely event a TPBAR was to be loaded in a core location not intended to host a burnable poison assembly, the power in that assembly would be reduced substantially below what was intended by the core design. Therefore, the assembly containing the out-of-position TPBAR would not be predicted to be the most limiting assembly in the misloaded core. Since the TPBAR performs the same role in the core as a conventional burnable poison assembly, the effects of misloaded TPBAR are the same as for conventional burnable poison assembly, the core power distribution is adversely affected. The (Final Safety Analysis Report (FSAR) demonstrates that such core loading errors and the resulting power distribution effects are either within the analytical uncertainties of core design or will be detected by the incore flux mapping system.

QUESTION 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 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 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.

RESPONSE TO QUESTION 15

Based on the above, a review of the NRC RAI letter to DOE dated April 21, 1997, and NRC staff statements during an onsite inspection at PNNL during the week of April 28, 1997, the following issues are being addressed in this response:

1. Items 1 and 2 of the RAI to DOE requested delineation of those portions of the TPBAR considered to be safety related and a description of how the safety significance was determined. The staff indicated that although PNNL had acknowledged that the TPBARs are part of a basic component, the initial question related to identifying the specific components in the TPBAR LTAs that are considered safety related remained. Additional information for these items is provided in response to Issue 15-1 below.

2. Item 3 of the DOE RAI requested a consolidated description of the quality assurance program controls that would govern the design, fabrication, testing, and installation of the LTAs. With respect to RAI Items 5 and 13, the staff requested a current copy of PNNL's quality assurance program that implemented ASME NQA-1, 1989, as well as a description of how TVA's quality requirements which conform to NRC Regulatory Guides which endorsed ANSI N45.2 series standards were transmitted to Westinghouse and PNNL and the method whereby the PNNL quality program was found acceptable by the host licensee. The staff determined that inadequate information had been provided to resolve RAI Item 3 and further staff evaluation of PNNL's quality assurance program related to design and fabrication of TPBAR LTAs would be performed during a

future inspection of PNNL for RAI Items 3, 5, and 13. The staff also determined that licensees who anticipate irradiating TPBAR LTAs will need to explicitly identify the programmatic controls and processes that will demonstrate compliance with the requirements of 10 CFR 50, Appendix B, prior to installing these assemblies into the core. Additional information for these items is provided in response to Issue 15-2 below.

3. Item 8 of the DOE RAI requested clarification regarding the treatment of commercial grade items that were not manufactured in accordance with Appendix B quality assurance requirements or the PNNL quality assurance program for use in TPBARs. The staff determined that inadequate information had been provided to resolve this issue. Specifically, the previous responses failed to address the essential programmatic elements that are necessary for the dedication of commercial grade items including the processes associated with the identification and verification of "critical characteristics." Additional information for this item is provided in response to Issue 15-3 below.

4. Item 11 of the DOE RAI requested a description of the process where by design information will be controlled and transmitted across the interfaces between PNNL, Westinghouse, host utility organizations, and design service suppliers. The staff determined that inadequate information had been provided to resolve this issue. Specifically, the previous response lacks sufficient detail to adequately evaluate the process used to control the transmittal of design information between cognizant organizations. Additional information for this item is provided in response to Issue 15-4 below.

5. Item 21 of the DOE RAI requested clarification as to whether Westinghouse special processes (e.g. welding) have been re-qualified as necessary to account for differences in TPBAR material from that typically used in LTA assemblies. The staff determined that inadequate information had been provided to resolve this issue and the item would remain open pending future evaluation of PNNL's Manufacturing and Quality Plan related to the production of TPBARs. Reference was also made to the staff's evaluation related to Section 5.3.1.5, Weld Qualification. Additional information for this item is provided in response to Issue 15-5 below.

Issue 15-1 - Safety Related Classification of TPBARs

Burnable absorbers are an essential element of a reactor core design. The presence and the location of the absorber rods, in conjunction with soluble boron and control rods, determine the appropriate level of reactivity to keep the reactor in a safe state. Since burnable absorber rods are static temporary reactivity control elements and an integral part of the reactivity control system, these rods are safety related. With the exception of tritium production, the TPBARs function the same as burnable absorber rods and are, therefore, also safety related.

Since the TPBAR LTAs are safety related, 10 CFR 50, Appendix B and 10 CFR Part 21 are applied to the design, procurement, fabrication, assembly, handling, and insertion of the TPBAR LTAs. This is consistent with Westinghouse and TVA treatment of burnable poison rod assemblies (BPRAs) and wet annular burnable absorbers (WABAs). The TPBARs were designed to a set of functional requirements developed by PNNL. These functional requirements incorporate the TPBAR LTA technical and functional requirements transmitted to PNNL by TVA and were reviewed and approved by a design review board that included Westinghouse and TVA participation. The initial Failure Modes and Effects Analysis (FMEA) identified the possible failure modes of TPBARs and the potential effects of these failures on core performance. These were fully considered in the development of the functional requirements and the subsequent design and analysis of the TPBAR LTAs. The functional requirements are consistent with, or more conservative than, standard industry design practices for conventional burnable absorber assemblies and are sufficient to provide a high degree of confidence that the TPBAR LTA reactivity control function will be adequately performed. TVA has confirmed that the functional requirements developed for the design of the TPBAR LTAs and previously transmitted to PNNL are consistent with this determination of the TPBAR LTA safety function.

The FMEA has been updated for the TPBAR LTAs to more clearly distinguish the associated safety function. The FMEA summarizes the functions of the TPBAR and its components and describes credible failure modes that were considered during the design of the TPBARs that have the potential for affecting the TPBAR LTA reactivity control function. In addition, the FMEA also addresses those failure modes that can affect TPBAR tritium retention. The FMEA shows that individual TPBAR component failures will not result in the inability of the TPBAR LTAs to perform their safety function. However, there are postulated failures identified in the FMEA regarding fabrication and installation errors associated with TPBARs that could potentially affect the ability of the TPBAR LTAs to perform their safety function. Since the LTA irradiation will only involve 32 absorbers in four fuel assemblies, these effects could not result in the inability to keep the reactor in a safe state.

TTQP-1-046, *TPBAR Component Characteristics and Related Importance Factors*, is being revised to describe the safety function of the TPBAR LTAs. Certain TPBAR LTA component characteristics can affect the safety function of the TPBAR LTAs. The specific components of the TPBAR LTA that could affect its safety function are the absorber pellets, the pellet stack within the TPBAR, and the assembled TPBAR. TTQP-1-046 identifies those TPBAR fabrication inspections relied upon to verify that characteristics are within design specifications. The remaining activity that can affect the ability of the TPBAR to perform its safety function is TPBAR LTA placement in the correct core location. Insertion of the TPBAR LTA in the reactor core includes verification of assembly location in accordance with TVA's fuel handling procedures.

The above information does not impact any of the technical or quality requirements or any of the design, procurement, or fabrication processes applied to the TPBARs. This is based on the fact that 1) TVA initially required PNNL to establish, maintain, and implement a QA program that complies with 10 CFR 50, Appendix B, as well as comply with 10 CFR 21; and 2) the TVA functional and technical requirements originally encompassed the reactivity control functions of the TPBARs.

While tritium retention is not a safety function, the original TVA requirements (PNNL-TTQP-1-580) specifically addressed the technical requirements associated with tritium retention and TVA imposed quality assurance requirements as indicated above.

Issue 15-2 - Transmittal of Utility Requirements and Methods of Accepting PNNL QA Program

The overall quality assurance requirements for the design, construction, and operation of nuclear power plants is 10 CFR 50, Appendix B. Regulatory guides define acceptable means of compliance with those quality assurance requirements for the design and construction phase as well as the operations phase of a nuclear facility. The TVA NRC-accepted Nuclear Quality Assurance Plan (NQAP) delineates TVA's methods of compliance with 10 CFR 50, Appendix B through commitment to various Regulatory Guides with stated exceptions and clarifications.

The TVA NQAP provides measures to ensure that appropriate quality assurance requirements are established for material, equipment, and services to be used in a TVA nuclear facility. These measures do not require all TVA commitments and methods to be imposed on suppliers/vendors. TVA's commitment to Reg. Guide 1.28, Rev. 3 for example is clarified in the NQAP by stating that TVA follows the requirements of ANSI N45.2-1971.

ANSI N45.2-1971, Section 5, Paragraph 1 states in part:

> "Measures shall be established and documented to assure that applicable regulatory requirements, design bases, and other requirements which are necessary to assure adequate quality are included or referenced in the documents for procurement of items and services."

Paragraph 2 states in part:

> "Procurement documents shall include provisions for the following, as applicable:

(1) *Supplier Quality Assurance Program.* Identification of quality assurance requirements and the elements of the program applicable to the items or services procured. This may be accomplished in various ways, such as the following:

(a) invoking this standard by reference, or
(b) invoking applicable sections or elements of this standard, or
(c) invoking other specific requirements which meet the intent of this standard."

TVA identified the applicable regulatory requirements for the TPBAR LTAs as 10 CFR 50, Appendix B and 10 CFR 21. The overall quality assurance requirements for PNNL were determined to be 10 CFR 50, Appendix B. Therefore, TVA contractually requires PNNL to provide a quality assurance program that complies with 10 CFR 50, Appendix B. The quality assurance program PNNL provided was based on the methodology/format of ASME NQA-1, 1989 Edition. In order to confirm that PNNL's program complies with the applicable requirements, TVA procured the services of Westinghouse. Westinghouse was requested to confirm compliance with 10 CFR 50, Appendix B and ASME NQA-1. The reason for specifying ASME NQA-1 is because NQA-1 is the methodology basis of the Westinghouse QMS and ASME NQA-1 is also the current industry standard that replaced and provides a means of meeting the same requirements and intent of the standards that were in existence in 1971. In addition, since the TPBARs are being supplied to TVA through Westinghouse with Westinghouse certifying product quality (i.e. product meets design), TVA determined that Westinghouse should qualify PNNL as a supplier.

TVA's procurement of quality assurance services from Westinghouse was added to an existing contract that requires activities be performed in accordance with the Westinghouse NRC-accepted Quality Management System and requires compliance with 10 CFR 21. The Westinghouse QMS with stated positions and clarifications complies with 10 CFR 50, Appendix B, as prescribed in Regulatory Guide 1.28, Rev. 3, and ASME NQA-1, 1994.

The Westinghouse QMS was submitted to the NRC and accepted. Prior to NRC submittal, Westinghouse confirmed there were no reductions in commitments. As such, use of the 1994 Edition of ASME NQA-1 as a method of compliance with 10 CFR 50, Appendix B has been accepted by the NRC for Westinghouse activities. Westinghouse's performance of a qualification audit of PNNL using audit checklists that compare the PNNL QA program to the elements of NQA-1 Basic and Supplementary Requirements, 1994 Edition, confirms that the PNNL QA program complies with 10 CFR 50, Appendix B. Therefore, it is appropriate for the PNNL program to reference ASME NQA-1, 1989 Edition, and for the Westinghouse audit report to conclude that the PNNL QA program complies with 10 CFR 50, Appendix B and ASME NQA-1, 1994 Edition. TVA's evaluation of PNNL's and Westinghouse's compliance with the requirements is an integral part of TVA oversight activities (which include audits, surveillances, and reviews). The TVA oversight activities will confirm compliance with requirements prior to authorizing insertion of the TPBAR LTAs into the Watts Bar reactor core.

Satisfactory implementation of the Westinghouse QA oversight activities of PNNL ensures compliance with 10 CFR 50, Appendix B using methods consistent with industry practice and that have been accepted by the NRC for Westinghouse activities.

The programmatic controls and processes that demonstrate compliance with the requirements of 10 CFR 50, Appendix B include PNNL performing design, fabrication, assembly, and delivery of TPBARs for use in lead test assemblies in accordance with the PNNL TTQP QA program and procedures; Westinghouse performing QA oversight, engineering and technical support services, and final assembly of the TPBAR LTAs in accordance with the Westinghouse QMS; and TVA performing receipt, installation, use, and removal of TPBAR LTAs as well as oversight of project activities to ensure compliance with TVA requirements in accordance with the TVA NQAP.

Issue 15-3 - PNNL's Commercial Grade Dedication Process

During the NRC inspection of PNNL the week of April 28, 1997, the staff indicated that if only the 316SS bar stock must be dedicated, the process has been reviewed during that inspection and no further written response was necessary. PNNL has determined that no other items require dedication; therefore, no additional response is warranted.

Issue 15-4 - Control of Design Information and Interfaces

During the NRC inspection of PNNL the week of April 28, 1997, the staff indicated they would evaluate the controls for transmittal of design information across interfaces between the design organization, TVA, and Westinghouse during a future inspection. Therefore, PNNL procedures TTQP-1-021 and TTQP-1-058, the TVA LTA Project Plan, and any other documents controlling such transmittals and interfaces will be provided to the NRC Staff for review during a future NRC Inspection.

Issue 15-5 - Special Process (e.g. welding) Qualification

Westinghouse review of the PNNL MAQP has recently been completed. Additional information regarding weld qualification procedure and nondestructive examination is addressed in the responses to Question 12 and 13, respectively.

WATTS BAR NUCLEAR PLANT UNIT 1
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
TRITIUM PRODUCING BURNABLE POISON ROD LEAD TEST ASSEMBLIES

QUESTION 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 that 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.

RESPONSE TO QUESTION 16

WBN has a pending Technical Specification change to support the reracking of the spent fuel pool which is expected to be approved prior to LTA irradiation. In this change the WBN FSAR maximum designed spent fuel pool heat load with one of two trains of cooling available is 32.6×10^6 BTU/hr. The 4 LTAs (32 TPBARs) will generate 328 BTU/hr which is a small fraction of the maximum designed spent fuel pool heat load. The decay heat of the off-load is maintained less than the design limit and the additional heat input from the TPBARs is negligible compared to the maximum designed heat load.

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.

RESPONSE TO QUESTION 17

Response of the reactor to an ATWS event is affected by the Moderator Temperature Coefficient (MTC). A more negative MTC will cause the consequences of an ATWS to be less severe. The core physics analysis for Watts Bar Cycle 2 shows that the reactor will have a slightly more negative MTC due to the slightly lower concentrations (approximately 6 ppm) of boron in the reactor coolant. Therefore, inclusion of TPBARs in Watts Bar Cycle 2 will result in an ATWS event less severe than the reference core with no TPBARs.

QUESTION 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?

RESPONSE TO QUESTION 18

18(a) See response to Question 14

18(b) Assembly average power for the TPBAR host assemblies will be monitored at the same frequency that $F^N_{\Delta H}$ is monitored as required by the WBN Unit 1 Technical Specifications 3.2.2.

This technical specification requires that $F^N_{\Delta H}$ is monitored at a frequency of "once after initial fuel loading and each refueling prior to THERMAL POWER exceeding 75% RTP AND 31 EFPD thereafter."

If the measured assembly average relative power value is exceeded, the reactor power will be reduced 1.5% RTP from 100% RTP for each 1% that the host assembly power exceeds 1.40. This value is a full power limit. Assembly average power reduces as power is reduced. If the measured assembly average power exceeds the limit at a power less than 100% RTP, power would only be reduced if the average power exceed the 100% RTP value. For WBN the 100% value is 1.40X3411/193=24.75MW per assembly.

18c. The reload safety evaluation is scheduled for completion on August 28, 1997.

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1
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TPBAR LTA Failure Modes and Effects Analysis (FMEA)

FMEA Scope Description:

1. Only Failure Modes and Failure Effects that are safety significant or have the potential for affecting occupational or off-site radiation doses are addressed in the FMEA (e.g., failure to produce design quantities of tritium are not addressed).

2. Failures were included in the analysis only for those events that are within the scope of NRC licensed activities (e.g., failure effects with respect to the extraction facility are not addressed).

3. Impact levels in the table describe the assessment of each Failure Mode and resulting Failure Impact. Impact levels are assigned to be consistent with the definitions of TTQP-1-046 Importance Factor categories. Since the FMEA is only concerned with those Failure Impacts described in Note 1 above, Impact Levels are only assigned for the following two categories:

   Category A

   A failure mode that has the potential to result in the inability of the TPBAR LTAs to perform their safety function. A failure of the TPBAR LTA safety function is considered to occur if the Failure Impact results in the core not performing as predicted by core design to the extent that there is a potential for not maintaining the core in a safe state.

   Category B

   A failure mode that does not result in the inability of the TPBAR LTAs to perform their safety function, but could result in:

   increases in occupational or off-site radiological doses; or

   could result in small and localized power peaking in fuel rods in the vicinity of the TPBAR.

   Impact levels are not assigned for those Failure Modes that are considered unlikely or incredible.

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TPBAR LTA Failure Modes and Effects Analysis (FMEA)

Component	Function	Plant Condition	Failure Mode	Failure Mechanism	Failure Impact	Impact Mitigation	Impact Level	Detection
TPBAR Assembly	Absorb neutrons as predicted by core design	Operation at power and TPBAR in core	Misplacement in core	Administrative process failures	Potential for power maldistribution and higher fuel assembly peaking factors than predicted by core design		A	Errors large enough to exceed fuel design limits detectable by flux map surveillance testing
			Missing multiple Pencils	Fabrication process failure and subsequent inspection failure				
			^{6}Li loading error affecting multiple TPBARs	Incorrect ^{6}Li loading due to pellet lot manufacturing error and inspection failure				
			Pencil relocation See Table Note 1	Clad tube/end plug weld failure due to fabrication and inspection errors	Potential for localized power peaking - Fuel design limits not exceeded - See Table Note 1		B	Possibly by flux map surveillance testing
				Cladding collapse due to material strength substantially below design assumptions		Unlikely failure mode - Large design margin to collapse. No such experience with conventional poison rods.	NA	

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TPBAR LTA Failure Modes and Effects Analysis (FMEA)

Component	Function	Plant Condition	Failure Mode	Failure Mechanism	Failure Impact	Impact Mitigation	Impact Level	Detection
TPBAR Assembly (Continued)			Absorber relocation in TPBAR	Pellets crumble or change dimension sufficiently to produce excessive gaps in absorber due to pellet lot manufacturing error and inspection failure	Potential for localized power peaking - Fuel design limits not exceeded	Unlikely failure mode - No significant swelling, shrinkage, or significant deterioration during testing	NA	
	Be compatible with fuel assemblies and RCS	Operation at power and TPBAR in core	TPBAR pressure boundary failure resulting in RCS coolant contact with TPBAR internals	Cladding tube failure	Small amounts of dissolved TPBAR materials enter RCS - RCS chemistry remains within TS limits	TPBAR vibration shown by analysis to be insignificant No excessive vibration known to have occurred for similar BPRAs or WABA	NA	Not detectable during operation
				Clad tube/End plug weld failure				
				Clad failure due to excessive vibration wear				
			Excessive thimble wear	Excessive TPBAR vibration	Not significant		NA	Not detectable during operation
		TPBAR in fuel pool	Stuck TPBAR LTA assembly	TPBAR Bowing	Program schedule and economic impact	TPBAR mechanical analysis shows insufficient bowing to cause sticking	NA	Not detectable during operation

TPBAR LTA Failure Modes and Effects Analysis (FMEA)

Component	Function	Plant Condition	Failure Mode	Failure Mechanism	Failure Impact	Impact Mitigation	Impact Level	Detection
TPBAR Assembly (Continued)	Retain ^3H	TPBAR in core	Pressure boundary (cladding, end caps, weld) failure	Clad tube/end plug weld failure	Increased RCS ^3H concentration	Since most ^3H is gettered, increase would be very small	B	Routine coolant samples
				Cladding tube failure				
		TPBAR in spent fuel pool	Pressure boundary (cladding, end caps, weld) failure	Clad tube/end plug weld failure	Increased fuel pool ^3H concentration	Since most ^3H is gettered and no ^3H is being produced, increase would be negligible	B	Not detectable
				Cladding tube failure				
Cladding	Minimize ^3H leakage to RCS coolant	TPBAR in core	Barrier ^3H permeation substantially above predictions	- Improper coating application and subsequent failure to detect during inspection - Coating deterioration occurs during operation	Increased RCS ^3H concentration	Since most ^3H is gettered, increase would be very small	B	Routine coolant samples
		TPBAR in spent fuel pool			Increased fuel pool ^3H concentration	Since most ^3H is gettered and no ^3H is being produced, increase would be negligible		Not detectable
	Minimize H permeation from RCS into the TPBAR	TPBAR in core	Barrier H permeation substantially above predictions	Improper coating application and subsequent failure to detect during inspection	Getter overloading (see Getter)		See Getter	
				Coating deterioration occurs during operation				

TPBAR LTA Failure Modes and Effects Analysis (FMEA)

Component	Function	Plant Condition	Failure Mode	Failure Mechanism	Failure Impact	Impact Mitigation	Impact Level	Detection
Plated Getter	Reduce ^3H permeation by maintaining low ^3H partial pressure in the TPBAR	TPBAR in core	Getter ^3H absorption below predictions resulting in increased ^3H permeation	Getter overloaded by H ingress from RCS due to barrier coating defect Getter fabrication error and failure to detect during inspection	Increased RCS ^3H concentration		B	Routine coolant samples
		TPBAR in spent fuel pool			Increased fuel pool ^3H concentration			Not detectable
Liner	Align pellets Retain pellet particles Provide plenum space for gases	NA	No credible failure modes	NA	NA	No stresses on liner, therefore no credible mechanical failures	NA	NA
	Reduce T_2O to T_2	TPBAR in core	Failure to react T_2O	Improper material used in fabrication	Increased TPBAR internal pressure	Unlikely failure mode - T_2O reaction not sensitive to material properties	NA	Not observable during operation
Pellet	Retain some gas (^3H and He)	TPBAR in core	Release all gas	Improper pellet morphology (density and pore size)	Small increase in TPBAR internal pressure		NA	Not observable during operation
	Absorb neutrons	Operation at power and TPBAR in core	Incorrect ^6Li loading in a pellet	Pellet manufacturing error and subsequent inspection failure	Potential for localized power peaking - Fuel design limits not exceeded		B	Possibly by flux map surveillance testing

TPBAR LTA Failure Modes and Effects Analysis (FMEA)

Component	Function	Plant Condition	Failure Mode	Failure Mechanism	Failure Impact	Impact Mitigation	Impact Level	Detection
Pencils (Pellet Column)	Retain pellets in sections	NA	No credible failure modes	NA	NA	No operational stresses on pencils, therefore no credible mechanical failures	NA	NA
Spring	Restrain pencil stack during shipping and handling	Operation at power and TPBAR in core	Gap opens between pencils during shipping or handling	Spring manufacturing error and subsequent failure of inspections to detect - low spring rate results in pencil movement	Potential for localized power peaking - Fuel design limits not exceeded	Unlikely failure mode: Springs of this type in fuel have not experienced failure. Permanent separation of pencils in event of spring failure is unlikely due to installed orientation of the TPBAR.	NA	Possibly by flux map surveillance testing

Table Notes:

1. Pellets in pencil are assumed to either remain captured in the pencil assembly or restrained from movement outside the guide thimble by the dashpot (bottom of the guide thimble) or support plate (top of the guide thimble). There is no credible mechanism for pellet migration outside the guide thimble.

ENCLOSURE 3

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1
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1. Westinghouse will verify the TPBARs and their associated documentation comply with the requirements of the MAQP before they are released for further assembly by Westinghouse's Columbia facility. [Response to Question 12]

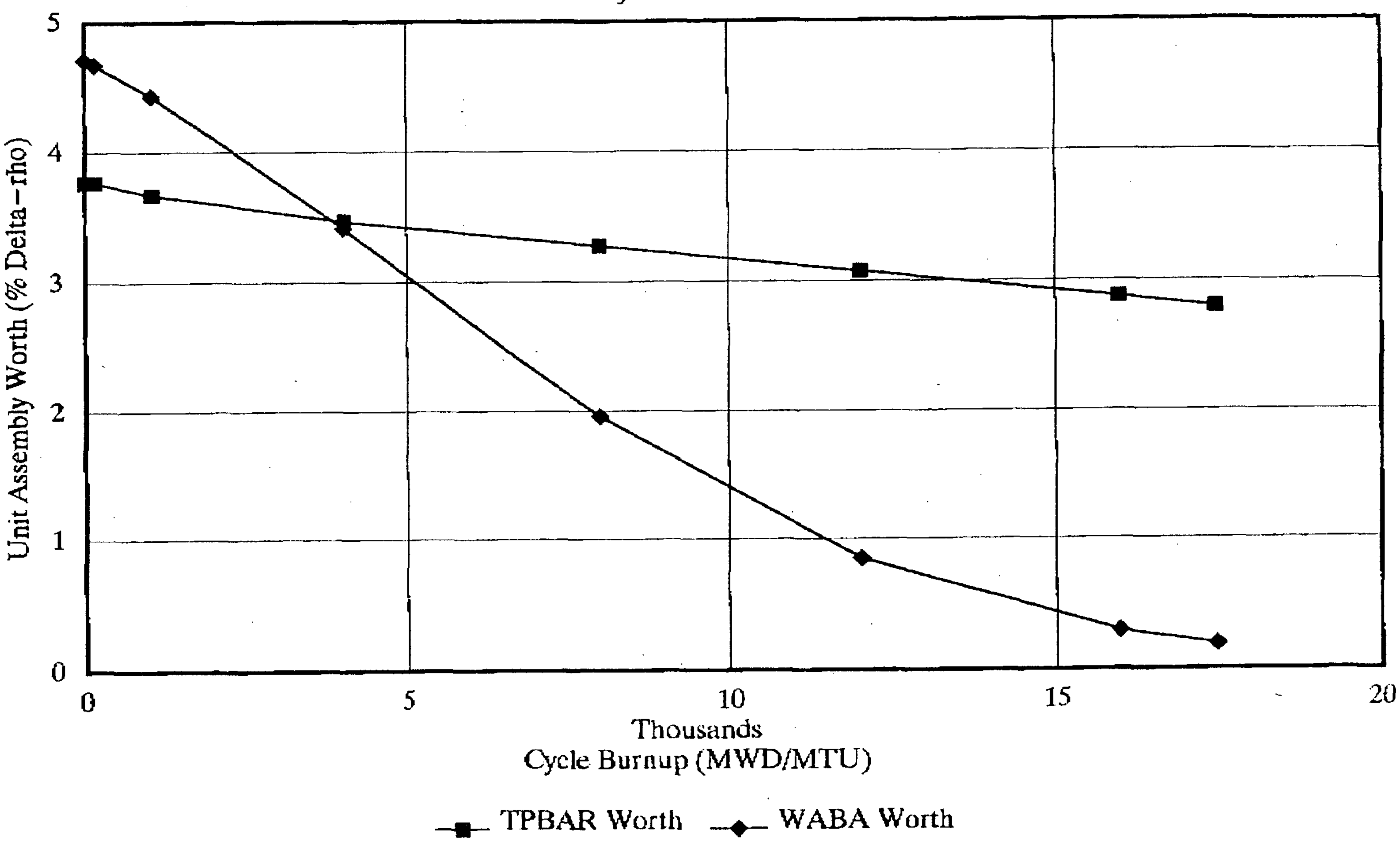
2. TTQP-1-046, *TPBAR Component Characteristics and Related Importance Factors,* is being revised to describe the safety function of the TPBAR LTAs. [Response to Question 15, Issue 15-1]

3. The TVA oversight activities will confirm compliance with requirements prior to authorizing insertion of the TPBAR LTAs into the Watts Bar reactor core. [Response to Question 15, Issue 15-2]

4. PNNL procedures TTQP-1-021 and TTQP-1-058, the TVA LTA Project Plan, and any other documents controlling such transmittals and interfaces will be provided to the NRC Staff for review during a future NRC inspection. [Response to Question 15, Issue 15-4]

Figure 1: Comparison of TPBAR and WABA Worths

for Watts Bar Cycle 2 Lead Test Assemblies



Note 1: Comparison is for clusters of 8 WABAs and 8 TPBARs in LTA locations.
Note 2: Worth comparison does not include the BA structure (cladding).