From: Mohan Thadani
To: Burkhardt, Janet; Lappert, Glenna
Date: 10/11/2007 11:23:17 AM
Subject: Fwd: FW: REVISION TO SPENT FUEL POOL CONFIGURATION

Glenna/Jan:

I had sent the forwarded email to be placed in ADAMS. Could you please check if it is in ADAMS.

Thanks.

Mohan
<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
From: Mohan Thadani [mailto:MCT@nrc.gov]
Sent: Thursday, July 19, 2007 10:03
To: Harrison, Albon; Morris, James; Head, Scott
Cc: Thomas Hiltz
Subject: REVISION TO SPENT FUEL POOL CONFIGURATION

Scott/Wayne/Jim:

The NRC staff has reviewed your application dated June 7, 2006. Based on that review, the NRC staff has identified a need for additional information. Our preliminary request for additional information (RAI) is presented in the attachment below. After you review our preliminary RAI, I will set up a phone call to discuss the RAI. I will send a formal NRC RAI reflecting the resolutions reached during the phone call.

If you have any questions, please contact me @ (301) 415-1476

Thanks.

Mohan

CC: Hiltz, Thomas

Mail Envelope Properties (470E3FDF.ECB : 23 : 35106)

Subject:	Fwd: FW: REVISION TO SPENT FUEL POOL CONFIGURATION
Creation Date	10/11/2007 11:23:11 AM
From:	Mohan Thadani
Created By:	MCT@nrc.gov

Recipients

nrc.gov
OWGWPO01.HQGWDO01
JCB2 (Janet Burkhardt)

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TGH CC (Thomas Hiltz)

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TWGWPO01.HQGWDO01
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OWGWPO01.HQGWDO01	nrc.gov
OWGWPO04.HQGWDO01	nrc.gov
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Files	**Size**	**Date & Time**
MESSAGE	2101	10/11/2007 11:23:11 AM
MD2343 RAI_1.wpd	152633	10/11/2007 11:18:10 AM

Options

Expiration Date:	None
Priority:	Standard
ReplyRequested:	No
Return Notification:	None
Concealed Subject:	No
Security:	Standard

Junk Mail Handling Evaluation Results

Message is not eligible for Junk Mail handling
Message is from an internal sender

Junk Mail settings when this message was delivered

Junk Mail handling disabled by User
Junk Mail handling disabled by Administrator
Junk List is not enabled
Junk Mail using personal address books is not enabled
Block List is not enabled

REQUEST FOR ADDITIONAL INFORMATION REGARDING
SOUTH TEXAS PROJECT, UNITS 1 AND 2
LICENSE AMENDMENT REQUEST
TO REVISE SPENT FUEL STORAGE CONFIGURATIONS
(TAC NOS. MD2343 AND MD2344)

On June 7, 2006, the STP Nuclear Operating Company submitted letter NOC-AE-06002013, "South Texas Project, Units 1 and 2, Docket No. STN 50-498 and STN 50-499, License Amendment Request - Proposed Amendment to Technical Specifications: Revision of the Spent Fuel Pool and In-Containment Storage Area Criticality Analysis," (Ref. 1). The letter requested approval to alter the approved South Texas Project (STP) Unit 1 and Unit 2 spent fuel pool (SFP) and in-containment storage area (ICSA) fuel assembly storage requirements.

10 CFR 50 Appendix A Criterion 62 requires, "Criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations."

10 CFR 50.68 (b) (4) requires, "If no credit for soluble boron is taken, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with unborated water. If credit is taken for soluble boron, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water, and the k-effective must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water."

10 CFR 50.36 © (4) requires, "Design features. Design features to be included are those features of the facility such as materials of construction and geometric arrangements, which, if altered or modified, would have a significant effect on safety and are not covered in categories described in paragraphs © (1), (2), and (3) of this section."

The new STP Unit 1 and Unit 2 SFP criticality analysis takes credit for soluble boron. Therefore the acceptance criteria are the SFP k-effective (k_{eff}) must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water, and k_{eff} of the SFP storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water.

The staff has provided guidance on meeting the regulatory requirements in Reference 2.

The staff requests responses to the following questions in order to continue the review of the license amendment request (LAR):

1. The licensee's LAR lists four (4) SFP criticality analyses as precedents for its SFP criticality, specifically: R. E. Ginna (Ref. 3), Diablo Canyon Power Plant (Ref. 4), Millstone Power Station Unit 2 (Ref. 5), and Joseph M. Farley Nuclear Plant (Ref. 6). However, the technical justification provided for the licensee's LAR in WCAP-16518 only references the R. E. Ginna licensing activity as precedent. Please explain how the other precedents are applicable to the licensee's LAR.

2. The licensee's LAR and technical justification state 'unity' is the acceptance criterion of maintaining sub-criticality when flooded with unborated water. This appears to be in conflict with the 10 CFR 50.46 (b)(4) requirement to maintain $k_{eff} < 1.0$ when flooded with unborated water. Please explain the use of 'unity' as the acceptance criterion, provide appropriate references.

3. The licensee's LAR states, "Most of the existing discharged fuel assemblies do not have

axial blankets. However, recent fuel cycles and future planned cycles utilize assemblies with top and bottom axial blankets with reduced enrichment (2.6 w/o U^{235}) and/or annular pellets. The criticality analysis makes use of this axial feature to lower the reactivity of the top and bottom regions of the assemblies." This appears to be in conflict with the third assumption in Section 1.5 of the technical justification provided in WCAP-16513-P which states, "All fuel assemblies, fresh and depleted, were conservatively modeled as containing solid right cylindrical pellets and uniformly enriched over the entire length of the fuel stack height. This conservative assumption bounds fuel assembly designs that incorporate lower enrichment blanket or annular pellets." Please clarify this apparent conflict.

4. The licensee's LAR states, "A surface fit polynomial may also be developed to directly determine the required minimum burnup as a function of initial enrichment and decay time for a particular category. Since the analysis was performed using four enrichment values and seven time points, a polynomial of third degree in x (enrichment) and sixth degree in y (time), will fit the analytical data. Such a surface fit will match the analytical results "exactly" at the data point. However, before implementation, interior points at intermediate enrichment and time values will be analyzed to ensure the polynomials chosen for the surface fit yield results within 1% of the results obtained by interpolation between the 2D polynomial fits generated in the criticality analysis."

   a. Please explain what the phrase "before implementation" means.

   b. The criticality analysis demonstrated in WCAP-16513-P uses a k_{eff} of 0.995 as the acceptance criteria. Indicating 0.5% margin to the regulatory limit of $k_{eff} <$ 1.0. How is the 1% factored into the criticality analysis?

   c. Since the proposed STP TS Section 5.6.1.2 only states, "A surface fit polynomial may be used to directly determine the required minimum burnup as a function of initial enrichment and decay time for a particular category," explain how this is controlled in the STP TS.

5. In the LAR the licensee's No Significant Hazards Determination (NSHD) discusses the SFP, but does not address the increased fuel enrichment for the in-containment storage area (ICSA) racks. Provide a NSHD for the ICSA.

6. In the LAR the licensee's NSHD does not include a discussion of the Metamic poison inserts. Provide a NSHD discussion for the Metamic poison inserts.

7. In the LAR the licensee's NSHD discusses the misloading of a rod cluster control assembly (RCCA), but does not address the misloading of Pyrex Burnable Poison Absorber Rods (BPRAs). Provide a NSHD discussion for the misloading of BPRAs.

8. The LAR proposes a four month implementation period where both the current and proposed requirements are to be considered applicable. With respect to the proposed implementation period provide the following information.

   a. The proposed implementation period would allow both current and new storage configurations to coexist in the SFP together. However, no analysis was presented to support this condition. Submit the results of the analysis which determined that both current and new storage configurations can coexist in the SFP together and continue to meet the regulatory requirements.

   b. The proposed implementation period removes the current requirements from the TS and places them in the Technical Requirements Manual (TRM). This appears to be in conflict with 10 CFR 50.36 paragraph © (4). Explain why the licensee believes moving the current requirements out of the TS is acceptable.

c. The proposed implementation plan includes a licensee commitment to place the current requirements into the TRM, but no commitment to remove them when the implementation period has been completed. Explain why there is not a proposed licensing commitment to remove the current requirements from the TRM following the implementation period.

d. The proposed implementation plan proposes to use a licensee commitment to place the current requirements into the TRM. Licensee commitments and the TRM maybe changed without NRC approval, explain why it is appropriate to control this activity with a licensee commitment rather than a licensing condition.

9. The proposed STP TS 5.6.1.1 a. and b. contain a reference to WCAP-14416-P-A. The staff's approval of WCAP-14416-P-A was withdrawn in Reference 15. Explain why it is acceptable to continue to reference WCAP-14416-P-A subsequent to the new analysis in WCAP-16513-P.

10. The proposed STP TS 5.6.1.1 c. states, "Additionally, credit may be taken for the presence of soluble boron in the spent fuel pool water, per Specification 3.9.13, to mitigate the misloading of one or more fuel assemblies, as described in Specification 5.6.1.6." Explain why the analysis in WCAP-16513-P only addresses the misloading of one assembly.

11. The proposed STP TS 5.6.1.2 states, in the first paragraph on page 5-12, "Interpolations between analyzed decay times to determine the required burnup as a function of initial nominal enrichment may be performed using at least a second-degree polynomial."

    a. As the analyzed decay times are based on second degree polynomial, explain why this does not introduce an uncertainty not accounted for in the analysis.

    b. Explain why these second degree polynomials do not need to be specified in the TS.

12. The proposed STP TS 5.6.1.3 states, "Empty water cells may be used to store non-fissile items provided that the cells are not face adjacent to a cell storing a fuel assembly or an evaluation has been performed that supports storage of the non-fissile item." The proposed STP TS 5.6.1.4 states, "Non-fissile items may be stored in empty water cells per the provisions of Specification 5.6.1.3." The proposed STP TS 5.6.1.8 states, "Empty water cells may be used to store non-fissile items provided that the cells are not face adjacent to a cell storing a fuel assembly or an evaluation has been performed that supports storage of the non-fissile item."

    a. Explain what type of evaluation has to be performed and why it is not included in the criticality analysis.

13. Section 1.3 of the technical justification provided in WCAP-16513 states that "The most reactive spent fuel pool temperature (with full moderator density of 1 g/cc) is used for each fuel assembly storage configuration such that the analysis results are valid over the nominal spent fuel temperature range (50° to 185°F) (Reference 6)." Please provide Reference 6.

14. Section 1.4.3 of the technical justification provided in WCAP-16513 states that: "For fresh fuel conditions, the fuel nuclide number densities were derived within the CSAS25 module using input consistent with the data in Table 1-3." Explain the term "...using input consistent with..."

15. Section 1.5 of the technical justification provided in WCAP-16513 states that: "The Westinghouse 17x17XL Standard fuel was modeled as the design basis fuel assembly to conservatively represent all fuel assemblies residing in all the storage configurations. The model bounds Westinghouse fuel products with a 0.3740-inch fuel pin, such as the Westinghouse Standard design, the V5H product, as well as the Robust Fuel Assembly (RFA) and RFA-2 products."

    a. The staff disagrees with the implication that fuel rod diameter alone is sufficient to determine whether or not one fuel assembly bounds another with respect to SFP criticality. Fuel rod diameter is just one of several physical parameters of the fuel that can be altered and thus alter the reactivity of the fuel rod and assembly. Provide a more detailed rationale for why the current model is bounding.

    b. Section 3.2 describes the fuel assembly designed used through out the analysis. This fuel assembly is the Westinghouse standard 17x17XL with the standard assembly parameters given in Table 3-1. Provide the following information:

        i. Provide a justification for the use of the Westinghouse standard 17x17XL, with standard assembly parameters, to model all fuel assembly designs approved for use at STP. Include a table showing the appropriate dimensions and tolerances for all of the fuel designs currently in the STP SFPs and those approved for use at STP.

        ii. What are the tolerances on the standard assembly parameters and how are those tolerances used in the subsequent uncertainty analyses?

    c. Section 3.2 of the technical justification provided in WCAP-16513 states that: "No credit is taken for any spacer grids or sleeves." Were any sensitivity studies performed to verify this to be a conservative assumption? How does crediting soluble boron affect the assumption?

16. Section 1.5 of the technical justification provided in WCAP-16513 states that: "Fresh fuel assemblies were conservatively modeled with a $U0_2$ density of 10.686 g/cm3 (97.5% of theoretical density). This translates into a pellet density equal 98.6% of theoretical density with a 1.1% dishing (void) fraction." Provide the justification for this assumption. Is the 1.1% dishing (void) fraction a minimum, nominal, or maximum value?

    a. Section 3.2 of the technical justification provided in WCAP-16513 states that: "The design basis fuel assemblies are modeled with the fresh fuel pellets as a solid right cylinder with a UO_2 density of 10.686 g/cm^3 (97.5% of theoretical density). No credit is taken for the nominal 1.1 void fraction percentage that is associated with dishing or chamfering. In addition, no credit is taken for any natural or reduced enrichment pellets, even for the blanketed assemblies. This assumption results in conservative calculations of reactivity for all fuel assemblies stored in the racks."

        i. Is this the same 1.1% dishing (void) fraction cited in Section 1.5? If so, reconcile the use of the 1.1% dishing (void) fraction to reduce the maximum theoretical density used in the analysis and the claim that "No credit is taken for the nominal 1.1 void fraction percentage that is associated with dishing or chamfering."

        ii. Justify using a nominal value rather than a bounding value or establishing an uncertainty for the dishing & chamfer on the fuel pellets.

17. Section 1.5 of the technical justification provided in WCAP-16513 states that: “All fuel assemblies, fresh and depleted, were conservatively modeled as containing solid right cylindrical pellets and uniformly enriched over the entire length of the fuel stack height. This conservative assumption bounds fuel assembly designs that incorporate lower enrichment blanket or annular pellets.” What is the tolerance on enrichment? How is this tolerance used in the criticality analysis?

18. According to the licensee’s LAR and Section 1.5 of the technical justification provided in WCAP-16513 states that: “All of the Boraflex poison material residing in the storage racks was conservatively omitted for this analysis.” Section 2.3 of the technical justification provided in WCAP-16513 states that: “Boraflex material is replace with water in this analysis.” Please provide the following information concerning this assumption.

    a. Is the water used in place of the Boraflex the same as the rest of the SFP water? Is it in free communication with the rest of the SFP?

    b. Boraflex is typically held in place by a wrapper or sheathing material. How is this material modeled.

19. Section 1.5 of the technical justification provided in WCAP-16513 states that: “In addition, the IFBA pins were modeled as annular cylinders 140 inches in length and centered about the midplane of the active fuel. Therefore, the IFBA coating is modeled with a 14-inch "cut-back" on the total length of the fuel (blanket and non-IFBA section). Also, 1.57 mg B^{10} /inch is assumed as 1.0X IFBA loading.”

    a. How is this an assumption and not the result of design and manufacturing information?

    b. What are the tolerances associated with IFBA pins?

    c. How does the manufacturing phenomenon of Axial Offset Deviation affect the assumption?

    d. Table 3-1 indicates the active fuel length is 168 inches. The above description only accounts for 154 inches of the active fuel length. Provide information that accounts for the remaining 14 inches.

20. Section 1.5 of the technical justification provided in WCAP-16513 states that: “The design-basis limit for k_{eff} at the zero soluble boron condition was conservatively reduced from 1.0 to 0.995 for this analysis.” Given that the regulatory requirement is that k_{eff} be < 1.0 at the zero soluble boron condition and that for the same number of significant digits 0.995 is equal to 1.0, please explain how this assumption is conservative?

21. Section 3.3 of the technical justification provided in WCAP-16513 discusses the modeling of axial burnup distributions. The discussion says a seven (7) zone model was used for models involving RCCAs and a four zone model was used for the other models. The size and individual power fraction of the zones are provided in Table 3-4. With respect to the modeling of axial burnup distributions provide the following information.

    a. The methodology employed in WCAP-16513-P uses fewer axial zones than either the R. E. Ginna analysis (Ref. 3) or DOE/RW-0472, "Topical Report on Actinide-Only Burnup Credit for PWR Spent Fuel Packages," (Ref. 7) as cited precedents, or that NUREG/CR-6665, “Review and Prioritization of Technical Issues Related to Burnup Credit for LWR Fuel,” (Ref. 8) recommends. Provide the justification for using fewer axial zones than either of these references.

b. Provide the justification for the size of the zones used in the analysis. The zone sizes are different for the four zone and seven zone models, explain why different zone sizes were used. The bottom zones in the seven zone RCCA model do not coincide with the tip of the RCCA or the transition from crediting 50% of absorber cross-section to crediting 100%, explain how this affects the analysis. The individual power fraction for each of the top three zones for both the four zone and seven zone are identical to the normalized burnup profile in DOE/RW-0472, since the zones are different sizes, explain why it is modeled in this manner.

   i. Why isn't there a different model for the fuel assemblies that contain BPRAs?

c. Has STP experienced any occurrence of Axial Offset Anomaly/Crud Induced Power Shift or Axial Offset Deviation? If so, were these factored into the axial burnup distribution?

d. In Section 3.3 it states, "The blanketed fuel assemblies are conservatively simulated by assuming a uniform burnup/power distribution in fuel pins with an axially uniform enrichment." Four storage configurations explicitly model blankets without an axially uniform enrichment. Provide clarification on how the axial burnup distribution is applied to blanketed assemblies.

e. Table 4.4-1 of the STP UFSAR indicates the core outlet range is between 615.5°F and 624.8°F. The actual core outlet temperature used, as given in Table 3-4, is below that range. NUREG/CR-6665 recommends using the maximum core outlet temperature. Justify using less than the maximum core outlet temperature. Justify using values less than those specified in the STP UFSAR. Are there other instances where parameter values used in the analysis deviate from those in the STP UFSAR?

22. In Section 3.4 of the technical justification provided in WCAP-16513 it states, "For item c., the fuel rod manufacturing tolerance for the reference design fuel assembly is assumed to consist of an increase in fuel enrichment of 0.05 w/o ^{235}U." Provide the justification for this assumption. Explain why this assumption is not listed in Section 1.5, Assumptions. Are there other assumptions in WCAP-16513-P that are not listed in Section 1.5?

23. In Section 3.4 of the technical justification provided in WCAP-16513 it states, "An increase in UO_2 density is not assumed since all calculations are performed using 97.5% of theoretical density, which is the highest credible density for PWR fuel." Reconcile that statement with the assumption from Section 1.5 which states, "Fresh fuel assemblies were conservatively modeled with a $U0_2$ density of 10.686 g/cm^3 (97.5% of theoretical density). This translates into a pellet density equal 98.6% of theoretical density with a 1.1% dishing (void) fraction."

24. In Section 3.4 of the technical justification provided in WCAP-16513 it states, "For item d., the following uncertainty components were evaluated. The inner stainless steel canister ID was decreased from 8.90 inches to 8.87 inches and the thickness of the canister was decreased from 0.085 inches to 0.081 inches. The storage cell pitch for the Region 1 fuel assembly storage configurations was decreased from 10.95 inches to 10.908 inches. The storage cell pitch for the Region 2 fuel assembly storage configurations was decreased from 9.15 inches to 9.125 inches." With respect to the SFP storage rack fabrication tolerances, provide the following information.

a. Were any sensitivity studies performed to verify that reducing all of the dimensions produced the limiting k_{eff}?

b. How were the tolerances associated with the Boraflex material and wrapping/sheathing addressed?

25. In Section 3.4 of the technical justification provided in WCAP-16513 it states, “In the case of the tolerance due to positioning of the fuel assembly in the storage cells (item e.), all nominal calculations were carried out with fuel assemblies conservatively centered in the storage cells. Cases were run to investigate the effect of off-center position of the fuel assemblies for each of the fuel assembly storage configurations. These cases positioned the assemblies as close as possible in four adjacent storage cells. Eccentric positioning has a positive reactivity effect for the Region 1 fuel assembly storage configurations; and a negative effect for the Region 2 fuel assembly storage configuration, except for the checkerboard configurations involving empty water cells (i.e., 1-out-of-4 or 2-out-of-4 fresh fuel storage configurations).” With respect to the eccentric positioning of fuel assemblies, provide the following information.

    a. How were the storage cell tolerances applied in this analysis?

    b. Explain why moving the fuel closer together had a negative reactivity effect for the Region 2 storage configurations. What was the result of moving the fuel further apart?

26. In Section 3.4 of the technical justification provided in WCAP-16513 it states, “For item f., a 5% burnup measurement uncertainty, a 5% manufacturing tolerance and a 10% calculational uncertainty on the ^{10}B loading of the IFBA rods were considered. The 5% bumup measurement uncertainty was applied to all the fuel assembly storage configurations that contain depleted fuel assemblies. The IFBA manufacturing uncertainty was applied to the Region 1 "Checkerboard #1" and Region 2 "2-out-of-4 5.0 w/o with 16 IFBA" storage configurations by calculating the additional soluble boron needed to account for these uncertainties in IFBA credit requirements.” With respect to the IFBA manufacturing tolerance and calculational uncertainty, provide the following information.

    a. What is the basis for the 5% manufacturing tolerance and a 10% calculational uncertainty on the B^{10} loading of the IFBA?

    b. Why isn’t the 10% calculational uncertainty on the B^{10} loading of the IFBA applied to the Region 1 "Checkerboard #1" and Region 2 "2-out-of-4 5.0 w/o with 16 IFBA" storage configurations?

    c. How does the manufacturing phenomenon of Axial Offset Deviation affect these tolerances?

27. With respect to calculation of the uncertainties and biases for each storage configuration/reactivity category provide the following information.

    a. Provide the dimensions and tolerances used in each case that was run to obtain the data, tabular form is acceptable. If this information is identical for each storage configuration, only one table need be provided.

    b. Explain how the Off-Center Assembly Positioning uncertainty was maximized.

    c. With respect to Tables 3-7, 3-8, and 3-9, explain why the ‘Decrease in Rack ID’ resulted in a k_{eff} decrease from the nominal case. Was a sensitivity study performed to determine if an increase in Rack ID would result in a k_{eff} increase from the nominal case?

d. Explain why the Enrichment, Cell Pitch, Rack Thickness, Rack ID, and Off-Center Assembly Positioning uncertainties are unchanged from the Region 2 "All-Cell," "1-out-of-4 Blanketed," "2-out-of-4 Blanketed," and "4-out-of-4 Blanketed" Storage Configurations.

e. Explain why the Enrichment, Cell Pitch, Rack Thickness, Rack ID, and Off-Center Assembly Positioning uncertainties are unchanged from the Region 2 "1-out-of-4 RCCA" and "4-out-of-4 Blanketed with 1 RCCA" Storage Configurations.

f. How are the manufacturing tolerances for the fuel assemblies incorporated into the uncertainties?

g. How are the manufacturing tolerances for the BPRA incorporated into the uncertainties?

   i. The configuration of the 20 rodlets in the BPRA used in the analysis is shown in Figure 3-23. Describe the sensitivity studies performed to determine the BPRA configuration used in the analysis. Describe the analysis' sensitivity to changing the number and configuration of the rodlets.

h. How are the manufacturing tolerances for the blankets incorporated into the uncertainties?

i. How are the manufacturing tolerances for the RCCA incorporated into the uncertainties?

j. How are the manufacturing tolerances for the poison inserts incorporated into the uncertainties?

k. How is the uncertainty associated with the location of the poison inserts in the cell incorporated into the uncertainties?

l. Explain how the nominal enrichments were chosen and how it affects the analysis.

m. With respect to the U^{235} enrichment uncertainty, the footnotes to the tables do not provide sufficient information to make an assessment of adequacy of the value in the table. Provide a detailed explanation of how the U^{235} enrichment uncertainty was determined. Provide the results of computer cases used in the analysis.

n. With respect to the burnup uncertainty, the footnotes to the tables do not provide sufficient information to make an assessment of adequacy of the value in the table. Provide a detailed explanation of how the burnup uncertainty was determined. Provide the results of computer cases used in the analysis.

o. With respect to the methodology uncertainty, the footnotes to the tables do not provide sufficient information to make an assessment of adequacy of the value in the table. Provide a detailed explanation of how the maximum KENO uncertainty was determined. Provide the results of computer cases used in the analysis.

p. With respect to the pool temperature bias, the footnotes to the tables do not provide sufficient information to make an assessment of adequacy of the value in the table. Provide a detailed explanation of how the pool temperature bias was determined. Include the justification for the use of the specified initial enrichment and burnup for determining the temperature bias. Provide the results of computer cases used in the analysis.

i. With respect to Table 3-13, explain why the pool temperature bias for the "1-out-of-4 Blanketed" Storage Configuration is less that a third of the values determined for the Region 2 "All-Cell," "2-out-of-4 Blanketed," and "2-out-of-4 Blanketed" Storage Configurations, when the only difference is the number of blanketed assemblies modeled in the analysis.

q. Since even fresh fuel has manufacturing tolerances and enrichment tolerances, explain why there no Tolerance/Uncertainty table for the Category 11 fuel assemblies.

r. With respect to Table 3-15 provide the following information. The Methodology Bias is listed as 0.00310. This is in agreement with Section 1.4.2 and previous tables. However, the footnote indicates the Methodology Bias is 0.00259. Confirm that the footnote is in error.

28. With respect to calculation of the initial enrichment and assembly burnup for each storage configuration/reactivity category provide the following information.

a. With respect to Tables 3-19, 3-24, 3-26, and 3-30, explain why the axial burnup profile from Section 3.3 was not used.

b. With respect to Table 3-26 provide the following information.

i. The k_{eff} for the 2.961 w/o U^{235} initial enrichment and zero burnup is 0.97462. This exceeds the target k_{eff} for Category 3 fuel assemblies listed in WCAP-16513-P Section 3.5.1.2.1 as 0.97454. Explain why it is acceptable to use 2.961 w/o U^{235} initial enrichment as the zero burnup reactivity equivalent for Category 3 fuel assemblies when its k_{eff} exceeds the target k_{eff}.

ii. What enrichment/burnup combination was modeled for the Category 5 and Category 7 fuel assemblies? How does this affect the analysis?

c. With respect to Table 3-28 provide the following information. What enrichment/burnup combination was modeled for the Category 3 and Category 7 fuel assemblies? How does this affect the analysis?

d. With respect to Table 3-30 provide the following information.

i. The k_{eff} for the 3.860 w/o U^{235} initial enrichment and zero burnup is 0.97355. This exceeds the target k_{eff} for Category 7 fuel assemblies listed in WCAP-16513-P Section 3.5.1.2.3 as 0.97312. Explain why it is acceptable to use 3.860 w/o U^{235} initial enrichment as the zero burnup reactivity equivalent for Category 7 fuel assemblies when its k_{eff} exceeds the target k_{eff}.

ii. What enrichment/burnup combination was modeled for the Category 3 and Category 5 fuel assemblies? How does this affect the analysis?

e. With respect to Table 3-48, the keff for the fresh fuel equivalent enrichment of 1.172 w/o U^{235} is 0.97488, which is higher than the target keff of 0.97438. Explain why this is acceptable.

f. With respect to Table 3-54 provide the following information. The k_{eff} for the fresh fuel equivalent enrichment of 1.665 w/o U^{235} is 0.97684, which is higher than the target keff of 0.97660. Explain why this is acceptable.

g. In Tables 3-54, 3-56, and 3-65, there are instances of k_{eff} increasing as Pu^{241} decay increases. Explain this phenomena. Are there other examples of this phenomena in WCAP-16513-P?

29. With respect to the tables and equations showing fuel assembly burnup versus initial enrichment for each storage configuration/reactivity category provide the following information.

a. Enrichment is shown to three decimal places. Provide the justification for this precision. Are the enrichments nominal values?

b. The factors in the polynomial equations indicate a high degree of precision. Provide a justification for the precision of the factors.

c. The polynomial equations are typically a fit to four points. Three of those points are the result of second degree polynomial fits to three points from the computer case runs. The fourth point is the result of a separate computer case run. Each computer case has an uncertainty associated with it. Explain how this does not create a new uncertainty that must be accounted for in the analysis. For example:

i. Staff analysis of the 3.0 w/o enrichment values at 0 (zero) Pu^{241} decay in Table 3-46, indicates the minimum burnup to reach a target k_{eff} of 0.97515 is approximately 31090 MWD/MTU not the 31005.51 MWD/MTU listed in Table 3-47.

ii. Staff analysis of the 3.0 w/o enrichment values at 0 (zero) Pu^{241} decay in Table 3-48, indicates the minimum burnup to reach a target k_{eff} of 0.97438 is approximately 32052 MWD/MTU not the 31962.27 MWD/MTU listed in Table 3-49.

iii. Staff analysis of the 3.0 w/o enrichment values at 0 (zero) Pu^{241} decay in Table 3-50, indicates the minimum burnup to reach a target k_{eff} of 0.97082 is approximately 31593 MWD/MTU not the 31521.17 MWD/MTU listed in Table 3-51.

iv. Staff analysis of the 3.0 w/o enrichment values at 10 years of Pu^{241} decay in Table 3-52, indicates the minimum burnup to reach a target k_{eff} of 0.97661 is approximately 23336 MWD/MTU not the 23293.43 MWD/MTU listed in Table 3-53.

d. With respect to Table 3-55 provide the following information. The target k_{eff} for the Region 2 “2-out-of-4 RCCA” Storage Configuration is 0.97660. By inspection of Table 3-54 the minimum burnup to achieve this target for 3.0 w/o U^{235} should be between 25,000 and 35,000 MWD/MTU for all Pu^{241} decay intervals. Similarly, inspection of Table 3-54 indicates the minimum burnup to achieve this target for 4.0 w/o U^{235} should be between 35,000 and 45,000 MWD/MTU for all Pu^{241} decay intervals. Yet the minimum burnup for 3.0 w/o U^{235} in Table 3-55 never exceeds 20,000 MWD/MTU and the minimum burnup for 4.0 w/o U^{235} never exceeds 32,000 MWD/MTU. Explain this discrepancy.

e. Have any confirmatory calculations been performed to verify these enrichment and burnup combinations actually provide a k_{eff} that meets the specific configuration's target k_{eff}?

30. The caption for Figure 4-12 indicates Category 28 fuel assemblies may or may not contain a RCCA. This option is not discussed elsewhere in the analysis. This possibility is not included in the Category 28 definition in the STP TS Design Features section 5.6.1.2. Provide clarification with respect to Category 28 fuel assemblies containing a RCCA.

31. The caption for Figure 4-14 indicates Category 32 fuel assemblies may or may not contain IFBA pins. This option is not discussed elsewhere in the analysis. This possibility is not included in the Category 32 definition in the STP TS Design Features section 5.6.1.2. Provide clarification with respect to Category 32 fuel assemblies containing IFBA pins.

32. The caption for Figure 4-15 indicates Category 34 fuel assemblies may or may not contain IFBA pins. This option is not discussed elsewhere in the analysis. This possibility is not included in the Category 34 definition in the STP TS Design Features section 5.6.1.2. Provide clarification with respect to Category 34 fuel assemblies containing IFBA pins.

33. The caption for Figure 4-16 indicates "Category 36 represents a depleted fuel assembly that is surrounded by a poison insert and meets the requirements of Figure 4-35." The description of the poison inserts in Section 2.3 and their depiction in Figure 3-17 indicates they only cover two sides of a storage cell, not all four. Provide clarification that there is only one poison insert in each storage cell.

34. WCAP-16513-P Section 3.5.2.13 indicates that all the inserts have the same orientation. This aspect of the storage configuration is not included in the STP TS Design Features section 5.6.1.2 definition of Category 36 or Figure 5.6-16 of STP TS Design Features section 5.6.1.4. How is this controlled?

35. The STP TS Design Features section 5.6.1.2 definition of Category 36 states, "The cell in which a Category 36 fuel assembly is placed SHALL contain a rack insert." It is presumed that a 'rack insert' is the same as a 'rack cell insert' described in STP TS Design Features section 5.6.1.1. To avoid confusion, change the proposed TS so that the wording is consistent between different sections.

36. Section 3.5.1.2.4 of WCAP-16513-P discusses the development of IFBA credit for the Category 3 and Category 7 fuel assemblies in the Region 1 "Checkerboard #1" Storage Configuration. With respect to the development of IFBA credit for the Category 3 and Category 7 fuel assemblies, provide the following information.

a. Section 3.5.1.2.4 of WCAP-16513-P states, "The resulting polynomial was then used to determine the required number of IFBA rods to meet the target k_{eff} value of 0.97454 for Category 3, and 0.97312 for the Category 7 fuel assemblies. Note that these are the target k_{eff} values used to determine the bumnup requirements for these categories." Explain how the 5% manufacturing tolerance and 10% calculational uncertainty on the B^{10} loading of the IFBA pins is used in the analysis.

i. Table 3-72, ‘Reactivity Change due to IFBA Manufacturing Uncertainty in the Region 1 “Checkerboard #1" Storage Configuration,’ indicates some values for the 5% manufacturing tolerance have been calculated. However, there is no discussion on how the numbers in the table were derived, their basis, or applicability. Additionally, they don’t appear to have been used in the analysis. Clarify whether or not the information in Table 3-72 was used in the analysis. If the information in this table was used in the analysis, explain where and how. Include a discussion of how the values were derived, their basis, and applicability.

b. Section 3.5.1.2.4 of WCAP-16513-P does not indicate what IFBA patterns were used in the analysis.

i. Confirm whether or not the IFBA patterns in Figures 3-3 and 3-4 were those used in the analysis.

ii. Figure 3-3 indicates that it is sheet 1 of 2, but there is no Figure 3-3 sheet 2 of 2. Figure 3-4 indicates that it is sheet 2 of 2, but there is no Figure 3-4 sheet 1 of 2. Clarify the actual number sheets for these figures and provide any missing pages.

iii. What is the sensitivity of the analysis to the IFBA patterns? Provide the justification for that conclusion. Identify any restrictions on the IFBA loading patterns. Provide the justification for those restrictions.

c. Tables 3-32, 3-33, and 3-34 contain the results of cases for Category 3 fuel assemblies with various IFBA B^{10} loadings and number of IFBA pins. Presumably, the Category 5 and Category 7 fuel assemblies are being held constant throughout these cases. What are the key parameters for the Category 5 and Category 7 fuel assemblies in these cases, e.g. number of IFBA pins, IFBA loading, initial enrichment, and burnup? How does this affect the analysis?

d. Tables 3-35, 3-36, and 3-37 contain the results of cases for Category 7 fuel assemblies with various IFBA B^{10} loadings and number of IFBA pins. Presumably, the Category 3 and Category 5 fuel assemblies are being held constant throughout these cases. What are the key parameters for the Category 3 and Category 5 fuel assemblies in these cases, e.g. number of IFBA pins, IFBA loading, initial enrichment, and burnup? How does this affect the analysis?

i. Explain why the Category 7 Table 3-30 k_{eff} entry for 5.000 w/o U^{235} initial enrichment with zero burnup and presumably zero IFBA is different than the k_{eff} entry in Tables 3-35, 3-36, and 3-37 for what appear to be the same conditions.

e. With respect to Table 3-38 provide the following information.

i. The number of IFBA pins is shown to two decimal places. How does are fractional IFBA pins dealt with?

ii. Accompanying Table 3-38 are three second degree polynomial equations describing the relationship between initial enrichment and IFBA pins. The values in Table 3-38 are the result of third degree polynomial fits to the values in Tables 3-32, 3-33, and 3-34. Explain how this does not create a new uncertainty that must be accounted for in the analysis.

iii. As noted above, the k_{eff} for 2.961 w/o U^{235} initial enrichment and zero burnup does not meet the target k_{eff} for Category 3 fuel assemblies listed in WCAP-16513-P Section 3.5.1.2.1. Explain why it is acceptable to use 2.961 w/o U^{235} initial enrichment in determining the IFBA crediting for Category 3 fuel assemblies.

iv. Table 3-38 indicates that for Category 3 fuel assemblies with an initial enrichment of 4.000 w/o U^{235} and an IFBA loading of 1.5X, 30.70 IFBA pins are required to meet the Category 3 fuel assemblies target k_{eff} of 0.97454. Reconcile that with the results in Table 3-33 which indicate the target k_{eff} falls between 32 and 48 pins.

v. Have any confirmatory calculations been performed to verify these enrichment and burnup combinations actually provide a k_{eff} that meets the specific configuration's target k_{eff}?

f. With respect to Table 3-39 provide the following information.

i. The number of IFBA pins is shown to two decimal places. How does are fractional IFBA pins dealt with?

ii. Accompanying Table 3-39 are three linear equations describing the relationship between initial enrichment and IFBA pins. The values in Table 3-39 are the result of third degree polynomial fits to the values in Tables 3-35, 3-36, and 3-37. Explain how this does not create a new uncertainty that must be accounted for in the analysis.

iii. As noted above, the k_{eff} for 3.860 w/o U^{235} initial enrichment and zero burnup does not meet the target k_{eff} for Category 7 fuel assemblies listed in WCAP-16513-P Section 3.5.1.2.3. Explain why it is acceptable to use 3.860 w/o U^{235} initial enrichment in determining the IFBA crediting for Category 7 fuel assemblies.

iv. Have any confirmatory calculations been performed to verify these enrichment and burnup combinations actually provide a k_{eff} that meets the specific configuration's target k_{eff}?

37. According to the technical justification provided in WCAP-16513-P Section 3.5.1.4 the Region 1 interface requirements were determined by taking a single array of a specific storage configuration and surrounding it with repeating arrays of a different storage configuration, presumably until Region 1 of the spent fuel pool was filled. The arrangement was considered acceptable if the k_{eff} of the composite was less than the maximum k_{eff} of the fuel categories in the reactive infinite storage configurations. The SFP pool dimensions are provided in Table 2-1. The composite SFP analysis was presumably performed at a moderator temperature of 20°C and a density of 1.0 gm/cc. Per Table 3-67 the interface between storage configurations is limited to low or medium reactive fuel assemblies. With respect to the storage configuration interface requirements please provide the following information.

a. Sections 2.2, 3.1.3, Table 2-1, and Figure 2-1 of the technical justification provided in WCAP-16513 provide various dimensions for the SFP.

i. How are these dimensions used?

ii. What is the tolerance/uncertainty associated with them?

iii. How is that factored into the SFP criticality analysis?

b. Results of the analysis are provided in Table 3-43, where the k_{eff} of the composite is compared to the maximum k_{eff} of the most reactive Category from the infinite storage configuration. With respect to Table 3-43 provide the following information.

i. Since the maximum k_{eff} of the Category 11 fuel has not been determined how can this comparison be made when the Region 1 “Checkerboard #2" Storage Configuration is involved?

ii. Inherent in this comparison is the assumption that the uncertainties and biases of the Categories do not change with the new configuration. Given the wide range of uncertainties and biases of the Categories, even within the Region 1 “Checkerboard #1" Storage Configuration, this assumption is problematic.

(1) Justify the assumption that the uncertainties and biases of the Categories do not change with the new configuration.

(2) Explain why this assumption was not listed in Section 1.5 with other assumptions.

iii. Since it is impossible to surround an individual 2x2 array storage configuration with repeating 2x2 arrays of a different storage configuration and continue to meet the definition of a repeating array and the meet the requirements in Table 3-67, explicitly describe how these composite arrangements were modeled.

iv. Were sensitivity studies performed to determine the most reactive moderator temperature and density? If not, why not?

38. With respect to Section 3.1.2.3 provide the following information. There is a footnote to this section which states “The term “non-blanketed” fuel assembly includes both blanketed and non-blanketed fuel assemblies.” Explain what this means.

39. With respect to Table 3-20 explain how the 5% manufacturing tolerance and 10% calculational uncertainty on the B^{10} loading of the IFBA pins is used in the analysis.

40. With respect to Table 3-20, what is the sensitivity of the analysis to the IFBA patterns? Provide the justification for that conclusion. Identify any restrictions on the IFBA loading patterns. Provide the justification for those restrictions.

41. WCAP-16513-P Section 3.5.2.14 is intended to address storage configuration interface requirements for the Region 2. Section 3.5.2.14 directs the reader to Table 3-67 for a listing of the requirements, with no discussion of how those requirements were derived. With respect to the storage configuration interface requirements in Region 2 provide the following information.

a. A discussion of how the requirements were derived.

b. The results of the analyses used to derive the requirements in Table 3-67.

c. Address the same considerations expressed in the Staff’s questions with respect to the storage configuration interface requirements of Region 1.

d. With respect to the Region 2 “1-out-of-4 Blanketed” Storage Configuration, explain how the requirement to place only Category 6 fuel assemblies on the boundary interface with another storage configuration will actually be met, since there is only one Category 6 fuel assembly in the “1-out-of-4 Blanketed” Storage Configuration. Extend the discussion to include the “1-out-of-4 RCCA,” “3-out-of-4 Checkerboard,” and “4-out-of-4 Blanketed with 1 RCCA” Storage Configurations as they would have similar issues meeting the Table 3-67 requirements.

e. The Region 2 “1-out-of-4 5.0 w/o Fresh No IFBA” Storage Configuration essentially requires the Category 32, 5.0 w/o Fresh No IFBA, fuel assembly to be surrounded by eight empty cells. The footnote for this storage configuration in Table 3-67 appears to allow fuel assemblies to be loaded on the corners of a Category 32 fuel assembly when it would be on an interface with another storage configuration. Provide clarification with regard to the interface requirements for the Region 2 “1-out-of-4 5.0 w/o Fresh No IFBA” Storage Configuration.

42. WCAP-16513-P Section 3.5.2.15 addresses storage configuration interface requirements between Region 1 and Region 2. Section 3.5.2.15 directs the reader to Table 3-68. Since the analysis is stated as being similar to that performed for the Region 1 interface requirements the information in Table 3-68 is the largest k_{eff} of the two storage configurations balanced against the k_{eff} of a composite of the two. According to the technical justification provided in WCAP-16513-P Section 3.5.1.4 the Region 1 interface requirements were determined by taking a single array of a specific storage configuration and surrounding it with repeating arrays of a different storage configuration, presumably until Region 1 of the spent fuel pool was filled. The arrangement was considered acceptable if the k_{eff} of the composite was less than the maximum k_{eff} of the fuel categories in the reactive infinite storage configurations. The SFP pool dimensions are provided in Table 2-1. The composite SFP analysis was presumably performed at a moderator temperature of 20°C and a density of 1.0 gm/cc. Per Table 3-67 the interface between storage configurations is limited to low or medium reactive fuel assemblies. With respect to the intra region storage configuration interface requirements please provide the following information.

a. Sections 2.2, 3.1.3, Table 2-1, and Figure 2-1 of the technical justification provided in WCAP-16513 provide various dimensions for the SFP.

i. How are these dimensions used?

ii. What is the tolerance/uncertainty associated with them?

iii. How is that factored into the SFP criticality analysis?

b. Results of the analysis are provided in Table 3-68, where the k_{eff} of the composite is compared to the maximum k_{eff} of the most reactive Category from the infinite storage configuration. With respect to Table 3-68 provide the following information.

i. Since the maximum k_{eff} of the Category 11 fuel has not been determined how can this comparison be made when the Region 1 “Checkerboard #2" Storage Configuration is involved?

ii. Explain why four Region 2 storage configurations are not included in Table 3-68.

iii. Inherent in this comparison is the assumption that the uncertainties and biases of the Categories do not change with the new configuration. Given the wide range of uncertainties and biases of the Storage Configurations, this assumption is problematic.

(1) Justify the assumption that the uncertainties and biases of the Categories do not change with the new configuration.

(2) Explain why this assumption was not listed in Section 1.5 with other assumptions.

iv. Explicitly describe how the SFP was modeled with respect to the various storage configurations.

v. Were sensitivity studies performed to determine the most reactive moderator temperature and density? If not, why not?

43. WCAP-16513-P Section 3.5.2.16 addresses storage configuration interface requirements between more than two storage configurations with in a region. The conclusion is that as long as the interface requirements from Table 3-67 for each storage configuration can be met, then the interface between each configuration is acceptable. Do I have any questions on this? I might, depending on the responses to the other questions.

44. WCAP-16513-P Section 3.5.2.17 states, "For storage configurations that credit ^{241}Pu decay, burnup requirements for intermediate decay time points should be determined using at least a second order polynomial." What data is the second order polynomial being fitted to?

45. Section 3.6 of WCAP-16513-P states,

"The NRC Safety Evaluation Report (SER) for Westinghouse report WCAP-14416-P is given in Reference 2. Page 9 of the enclosure to Reference 2 defines the soluble boron requirement as follows. The total soluble boron credit requirement is defined as the sum of three quantities.

$$SBC_{TOTAL} = SBC_{95/95} + SBC_{RE} + SBC_{PA}$$

where,

SBC_{TOTAL}	is the total soluble boron credit requirement (ppm),
$SBC_{95/95}$	is the soluble boron requirement for 95/95 k_{eff} less than or equal to 0.95 (ppm),
SBC_{RE}	is the soluble boron required to account for burnup and reactivity uncertainties (ppm),
SBC_{PA}	is the soluble boron required for k_{eff} less than or equal to 0.95 under accident conditions (ppm).

Each of these terns is discussed in the following subsections."

However, the definition of SBC_{RE} is actually found on Page 10 of the enclosure to the cited reference (Reference 10 herein.). The correct definition of SBC_{RE} is "soluble boron credit required for reactivity equivalencing methodologies (ppm)." The soluble boron required to account for burnup and reactivity uncertainties is to be included with $SBC_{95/95}$, as its definition states. It can't be the 95/95 keff unless the biases and uncertainties have already been applied. Correct the definition of SBC_{RE} in section 1.2

as well as 3.6.

46. Section 3.6.1 of WCAP-16513-P states, “Table 3-69 contains the KENO-calculated k_{eff} values for the spent fuel pool from 0 to 600 ppm of soluble boron, in increments of 200 ppm. These KENO models assume that the pool is filled with a number of allowable fuel assembly storage configurations. The initial enrichment and burnup chosen to represent each storage configuration was based on minimizing the soluble boron worth. The soluble boron worth decreases as burnup increases. The reactivity worth, Δk_{eff}, of the soluble boron was determined by subtracting the k_{eff} value, for a given soluble boron concentration, from the k_{eff} value for zero soluble boron. The soluble boron concentration and reactivity worth data was then fitted to a third degree polynomial, the most limiting of which is shown on the bottom of Table 3-69. This polynomial was then used to determine the amount of soluble boron required to reduce k_{eff} by 0.05 Δk_{eff} units, which is 373.1 ppm (for the limiting "All-Cell" storage configuration).” With respect to Section 3.6.1 provide the following information.

   a. Provide a full description of the analyses used to derive the equation associated with Table 3-69. Include the number, type, and arrangement of the storage configurations used in each model. Identify all assumptions associated with the analyses. Include the results of all of the analyses.

   b. The method of determining reactivity worth described in Section 3.6.1 leaves three (3) data points. Explain how three (3) data points are fitted to a third order polynomial.

   c. In the third degree polynomial equation describing the relationship between Δk_{eff} and soluble boron factors are given with up to five decimal places. The second and third factor have nine significant digits. Provide a justification for the precision of the factors in that equation.

   d. On page 9 of the SER to WCAP-14416 it states, “To determine the amount of soluble boron required to maintain $k_{eff} \leq 0.95$, KENO-Va is used to establish a nominal reference k_{eff} and PHOENIX-P is used to evaluate the reactivity effects of possible variations in material characteristics and mechanical manufacturing dimensions. These calculations contain the same assumptions, biases, tolerances, and uncertainties previously described except for the assumption regarding the moderator soluble boron concentration. Borated water is assumed instead of pure water. The tolerance calculations are, therefore, performed assuming the presence of soluble boron. The final 95/95 k_{eff} calculation is determined as described in Section 3.2 above and must be less than or equal to 0.95 with allowances for biases, tolerances, and uncertainties including the presence of the determined concentration of soluble boron.”

      i. Provide a full description of the analyses used to derive the biases, tolerances, and uncertainties including the presence of the determined concentration of soluble boron. Include the number, type, and arrangement of the storage configurations used in each model. Identify all assumptions associated with the analyses. Include the results of all of the analyses.

      ii. As stated above the 95/95 k_{eff} is to include the biases, tolerances, and uncertainties. Determining the amount of soluble boron required to effect a 0.05 Δk_{eff} change does not include the biases, tolerances, and uncertainties. Recalculate the soluble boron credit for 95/95 k_{eff} less than or equal to 0.95 including the biases, tolerances, and uncertainties.

47. Section 3.6.2 of WCAP-16513-P is titled "Soluble Boron Requirements for Reactivity
48. Uncertainties." However, the discussion is a mix of reactivity equivalencing and uncertainty. As stated above the uncertainties are to be included in the 95/95 k_{eff}. The SER for WCAP-14416 discusses two types of reactivity equivalencing; fuel assembly burnup credit and IFBA credit. These reactivity equivalencing technics are to allow storage of fuel assemblies with higher initial enrichment than was determined in the base analysis. The base analysis in WCAP-14416 determined an initial enrichment requirement without regard to burnup, IFBA loading, or Pu^{241} decay. However, the analyses in WCAP-16513-P does use various combinations of burnup, IFBA loading, and Pu^{241} decay to determine the initial enrichment requirement. Therefore, it is unclear whether the reactivity equivalencing is being done appropriately. To clarify the use of reactivity equivalencing provide the following information.

a. Explain how burnup reactivity equivalencing is being done in WCAP-16513-P.

b. According to the SER for WCAP-14416 the "...uncertainty in fuel assembly reactivity, is calculated by employing a depletion reactivity uncertainty of 0.010 Δk_{eff} units per 30,000 MWD/MTU of burnup (obtained from Reference 2)..." is "...based on the PHOENIX-P comparisons to the measured isotopics from the Yankee Core 5 experiments and is used to account for any depletion history effects or calculational uncertainties not included in the depletion conditions that are used in PHOENIX-P." Since PHOENIX-P was not used in WCAP-16513-P, explain why it is appropriate to use the reactivity uncertainty associated with PHOENIX-P, rather than an uncertainty specific to the codes used in WCAP-16513-P.

c. Explain how IFBA reactivity equivalencing is being done in WCAP-16513-P.

d. The 10% calculational uncertainty on the B^{10} loading of the IFBA rods is also in the SER for WCAP-14416, and appears to based on the use of the PHOENIX-P code. Since PHOENIX-P was not used in WCAP-16513-P, explain why it is appropriate to use the 10% calculational uncertainty on the B^{10} loading of the IFBA, rather than an uncertainty specific to the codes used in WCAP-16513-P.

49. According to section 3.6.3 soluble boron required to mitigate accidents is based on the evaluation/analysis of three potential accident scenarios. A fuel assembly dropped onto the SFP storage racks is considered creditable, but not analyzed as the distance between the dropped assembly and the fuel in the storage racks is considered to be sufficient to neutronically decouple the configuration. The mishandling of a fuel assembly is considered creditable and is analyzed. So is an elevated SFP temperature. The potential effects of a seismic event was not considered. With respect to the soluble boron required to mitigate an accident provide the following information.

a. Why are the potential effects of a seismic event, or other natural occurrences not considered?

b. What is the distance between the top of a fuel assembly in the storage cell and the top of the storage racks?

c. Is it possible for the non-fissile materials, which may be stored in the SFP cell, to displace a sufficient amount of water such that a dropped assembly may become neutronically coupled with the fuel in the storage cells?

d. The fuel mishandling analysis events all assumed a fresh Westinghouse standard 17x17 fuel assembly enriched to 5.0 w/o U^{235} was misloaded. Justify this fuel assembly design as appropriate for the analysis.

e. The fuel misloading analyses all consist of a SFP filled with a single storage configuration. Why was the possibility of a misloading of a fuel assembly on the interface boundary between storage configurations not considered?

f. The fuel misloading analyses all consist of a misloading of a single fuel assembly. Over the past 7 years there have been several misloading events, Ref. 11, 12, 13, and 14, including three in which multiple assemblies were misloaded. Explain why the misloading of multiple assemblies does not need to be considered.

g. The fuel misloading analysis states the replacement of a depleted with a RCCA in the "1-out-of-4 RCCA" and the "2-out-of-4 RCCA" with a fresh 5.0 w/o U^{235} assembly bounds the misloading of a either a RCCA or BPRA. This assertion does not consider the possible misloading of multiple RCCAs or BPRAs. Explain why the misloading of multiple RCCAs or BPRAs does not need to be considered.

h. There is very little discussion of the cases that were used to derive the k_{eff} for the different accident scenarios listed in Tables 3-73 and 3-74. Provide a full description of the analyses used to derive the k_{eff} for each accident scenario. Include the number, type, and arrangement of the storage configurations used in each model. Identify all assumptions associated with the analyses. Include which fuel assembly was replaced with a fresh and why. Include the results of all of the analyses.

i. The Δk_{eff} in Tables 3-73 and 3-74 is indicated as being based on nominal k_{eff} in a footnote. However, only the Δk_{eff} of the Region 1 "All-Cell" Storage Configuration actually corresponds to the difference between the k_{eff} in the table and that in the footnote. Provide clarification for the basis of the Δk_{eff} in Tables 3-73 and 3-74 and what it is used for in the analysis.

j. The text in Section 3.6.3.2 says largest increase in spent fuel pool k_{eff} occurred with the "2-out-of-4 5.0 w/o Fresh with 16 1.5X IFBA" Storage Configuration, and that this configuration was run at progressively larger boron concentrations until the increase was reduced to zero, relative to the reference case. However, the "2-out-of-4 5.0 w/o Fresh with 16 1.5X IFBA" Storage Configuration" is not included in Table 3-74. Also, according to Table 3-74 the largest amount of boron required to offset the misloading did not occur with the largest increase in spent fuel pool k_{eff}, rather it occurred with the smallest increase presented in Table 3-74. Provide clarification in this regard.

k. The Table 3-74 only lists the results of three configurations, one of which isn't covered in the previous portions of the analysis. Explain and justify why the remaining Region 2 storage configurations were not analyzed.

50. NUREG-6683, "A Critical Review of the Practice of Equating the Reactivity of Spent Fuel to Fresh Fuel in Burnup Credit Criticality Safety Analysis for PWR Spent Fuel Pool Storage," (Ref. 9) addresses the effects of determining a reactivity equivalency between spent fuel and fresh fuel, a practice used throughout WCAP-16513-P. NUREG-6683 concluded, "...that the practice of equating the reactivity of spent fuel to fresh fuel is acceptable provided the conditions for which the REFFE (reactivity equivalent fresh fuel enrichment) was determined remain unchanged. Determination of the REFFE for a reference configuration and subsequent use of the REFFE for different configurations violates the basis used for the determination of the REFFE and has been shown to produce inaccurate and nonconservative estimates of reactivity." Adding soluble boron

to the configuration is changing the configuration. Taking a 2x2 array storage configuration out of an infinite lattice of that 2x2 array and surrounding it with a different 2x2 array is changing the configuration. There are also concerns within the individual storage configurations when combining REFFE and burned fuel. NUREG-6683 indicates the use of REFFE in the presence of soluble boron can result in non-conservative results of several percent. Within the individual storage configurations the results could be is non-conservative by a few tenths of a percent. Considering the analysis margin to the regulatory limit is 5 tenths of a percent, this is significant. Explain how the phenomena described in NUREG-6683 is addressed in this analysis.

51. With respect to the In-Containment Fuel Storage Area Racks (ICSA), provide the following information with respect to the Region 1 “All-Cell” Storage Configuration.

  a. With respect to Table 3-75 provide the following information.

    i. Provide the dimensions and tolerances used in each case that was run to obtain the data, tabular form is acceptable.

    ii. Explain how the Off-Center Assembly Positioning uncertainty was maximized.

    iii. How are the manufacturing tolerances of the fuel assemblies incorporated into the uncertainties?

    iv. With respect to the U^{235} enrichment uncertainty, the footnote does not provide sufficient information to make an assessment of adequacy of the value in the table. Provide a detailed explanation of how the U^{235} enrichment uncertainty was determined. Provide the results of computer cases used in the analysis.

    v. With respect to the methodology uncertainty, the footnote does not provide sufficient information to make an assessment of adequacy of the value in the table. Provide a detailed explanation of how the maximum KENO uncertainty was determined. Provide the results of computer cases used in the analysis.

    vi. With respect to the pool temperature bias, the footnote does not provide sufficient information to make an assessment of adequacy of the value in the table. Provide a detailed explanation of how the pool temperature bias was determined. Provide the results of computer cases used in the analysis.

  b. The accident analysis indicates that the ICSA has a negative moderator temperature coefficient, however the Temperature Bias determination indicates the ICSA has a positive moderator temperature coefficient. Explain this apparent contradiction. Explain how the presence of soluble boron affects this analysis.

  c. Why isn’t dropping a fuel assembly on to the top of the ICSA considered?

  d. Figure 3-26 shows one scenario for an extra fuel assembly adjacent to a fully loaded ICSA. Were sensitivity studies performed to determine the most reactive scenario?

    e. Table 3-76 states the Δk_{eff} in the table is calculated using the nominal keff of 0.93038. However, the difference between the Accident keff column and the nominal k_{eff} does not equal the Δk_{eff} listed in the table. Provide clarification for the basis of the Δk_{eff} in Table 3-76 and what it is used for in the analysis.

52. WCAP-16518-P Section 3.8 states, "The k_{eff} values were calculated for Region 2 "All-Cell" 2x2 storage configuration with one of the fuel assemblies replaced with an FRSC containing fresh 5.0 w/o ^{235}U fuel rods. The calculations were performed at 68 °F, with maximum water density of 1.0 g/cm^3 to maximize the array reactivity. The resulting k_{eff} (0.91244 ± 0.00048) was less than the nominal k_{eff} (0.97360 ± 0.00044) of the Region 2 "All-Cell" storage configuration. Therefore, FRSCs filled with fresh fuel rods with a maximum enrichment of 5.0 w/o ^{235}U and no burnable absorbers can be stored in an "All-Cell" storage configuration."

   a. The proposed TS 5.6.14 repeats the prohibition of the FRSC containing fresh fuel with burnable absorbers. Should the need arise, where would fresh fuel pins that contain a burnable absorber be stored? Should the need arise, where would depleted fuel pins, both with and without, a burnable absorber be stored?

   b. According to Section 3.1.5 the FRSC is modeled as a SS box. Please explain what this means.

   c. Section 2.3 of the technical justification provided in WCAP-16518-P provides various dimensions for the Fuel Rod Storage Canister. How are these dimensions used? What is the tolerance/uncertainty associated with them? How is that factored into the SFP criticality analysis?

   d. Were sensitivity studies performed to determine if one cell in the storage configuration was more limiting than another for the placement of a FRSC?

   e. Were any analyses performed to determine the effects of placing a FRSC on an interface boundary between storage configurations?

<u>REFERENCES</u>

1. STP Nuclear Operating Company (STPNOC) submitted letter NOC-AE-06002013, "South Texas Project, Units 1 and 2, Docket No. STN 50-498 and STN 50-499, License Amendment Request - Proposed Amendment to Technical Specifications: <u>Revision of the Spent Fuel Pool and In-Containment Storage Area Criticality Analysis</u>," June 7, 2006. (ADAMS ML061650071)

2. NRC Memorandum from L. Kopp to T. Collins, Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants," August 19, 1998. (ADAMS ML003728001)

3. R. E. GINNA Nuclear Power Plant - Amendment re: Revision to the Storage Configuration Requirements Within the Existing Storage Racks and Taking Credit for a Limited Amount of Soluble Boron (TAC NO. MA8443), dated December 7, 2000 (ADAMS ML003761578).

4. Diablo Canyon Nuclear Power Plant, Unit Nos. 1 and 2 - Issuance of Amendment re: Credit for Soluble Boron in the Spent Fuel Pool Criticality Analysis (TAC Nos. MB2982 and MB2984), dated September 25, 2002 (ADAMS ML022610080).

5. Millstone Power Station, Unit No. 2 - Issuance of Amendment re: Spent Fuel Pool Requirements (TAC No. MB3386), dated April 1, 2003 (ADAMS ML030910485).

6. Joseph M. Farley Nuclear Plant, Units 1 and 2 Re: Issuance of Amendments (TAC Nos. MC6987 and MC6988), dated June 28, 2005 (ADAMS ML051860200).

7. DOE/RW-0472, "Topical Report on Actinide-Only Burnup Credit for PWR Spent Fuel Packages," Rev. 1, May 1997. (ADAMS ML020670131)

8. NUREG/CR-6665, "Review and Prioritization of Technical Issues Related to Burnup Credit for LWR Fuel," (ADAMS ML003688150)

9. NUREG/CR-6683, "A Critical Review of the Practice of Equating the Reactivity of Spent Fuel to Fresh Fuel in Burnup Credit Criticality Safety Analyses for PWR Spent Fuel Pool Storage," (ADAMS ML003751298)

10. Letter, T. E. Collins (NRC) to T. Greene (WOG), "Acceptance for Referencing of Licensing Topical Report WCAP-14416-P, Westinghouse Spent Fuel Rack Methodology (TAC No. M93254)," October 25, 1996. (SER for WCAP-14416-P-A, "Westinghouse Spent Fuel Rack Criticality Analysis Methodology," November 1996)

11. Joseph M. Farley Nuclear Plant Unit 1, Licensee Event Report 2000-004-00, "Three Spent Fuel Assemblies in Spent Fuel Pool Locations Not Allowed By Technical Specification 3.7.15," April 20, 2000. (ADAMS ML003707402)

12. Diablo Canyon Unit 1, Licensee Event Report 1-2002-006-00, "Technical Specification LCO 3.7.17.2 Not Met During The 1R11 Refueling Outage When Two Fuel Assemblies Were Placed In Adjacent Locations," November 26, 2002. (ADAMS ML023390069)

13. Licensee Event Report 266/301/2006-002-00, "Fuel Assemblies in Spent Fuel Pool Do Not Meet Technical Specification Requirements," August 22, 2006 (ADAMS ML062420239)

14. Licensee Event Report 272/311/2006-004-00, "Fuel Assemblies Misloaded in The Spent Fuel Pool Racks ," December 11, 2006 (ADAMS ML063540119)

15. U.S. NRC letter "Non-Conservatisms in Axial Burnup Biases for Spent Fuel Rack Criticality Analysis Methodology," dated July 27, 2001 (ADAMS ML012080337)

16. NRC Regulatory Issue Summary 2001-12, "Nonconservatism in Pressurized Water Reactor Spent Fuel Storage Pool Reactivity Equivalencing Calculations," May 18, 2001 (ADAMS ML010990300)

17. NUREG/CR-6801, "Recommendations for Addressing Axial Burnup in PWR Burnup Credit Analyses," March 2003. (ADAMS ML031110292)

18. Letter, T. E. Collins (NRC) to T. Greene (WOG), "Acceptance for Referencing of Licensing Topical Report WCAP-14416-P, Westinghouse Spent Fuel Rack Methodology (TAC No. M93254)," October 25, 1996.