From:	Wang, Alan
To:	JACKSON, RITA R; SEITER, JEFFERY ALAN; Perino, Christina; Guy Davant
Subject:	Grand Gulf Nuclear Station Request for Additional Information Regarding Criticality Safety Analysis Amendment (ME7111)
Date:	Wednesday, July 25, 2012 11:05:00 AM
Attachments:	SRXB RAI 7-17-12.docx

Rita, Jeff, Guy, and Christina,

By letter dated September 9, 2011 (Agency-wide Documents Access and Management System (ADAMS) Accession No. ML112521287), Entergy Operations Incorporated (Entergy) requested the following: 1) a revision to the criticality safety analysis (CSA) for the spent fuel and new fuel storage racks; 2) additional requirements for the spent fuel and new fuel storage racks in TS 4.3.1, Criticality; and 3) deletion of the spent fuel pool loading criteria Operating License condition.

The NRC staff has determined that the following additional information is needed to complete our review of this request. This request for additional information (RAI) was discussed with Mr. Guy Davant on July 17, 2012, and it was agreed that a response would be provided by September 30, 2012. If circumstances result in the need to revise the requested response date, please contact me at (301) 415-1445 or via e-mail at Alan.Wang@nrc.gov.

The RAIs are attached and related to your amendment request dated September 9, 2012.

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Review of the Spent Fuel Pool Criticality Analysis in Support of Grand Gulf Nuclear Station License Amendment Request

A review of Grand Gulf Nuclear Station's (GGNS) license amendment request for a revision to spent fuel pool storage requirements. Responses to the requests for additional information (RAIs) below are necessary for the NRC to continue its review of the license amendment request.

Requests for Additional Information (RAIs)

1. In general, references are not provided to justify the degree of Boraflex degradation modeled. Relevant assumptions are stated in Section 3.6, but no justification is provided. Reading NEDC-33621P, REV 0, it would appear the analyst is merely assuming [[ ]] and [[ ]] Justify use of these values.

2. The text in Section 4.3 includes the following statement:

   "The fuel loadings considered for each lattice span a range of exposure, average enrichments, number of gadolinium rods, gadolinium enrichment, and void histories considered to be reasonably representative of any GGNS fuel design."

   10CFR50.68(b)(4) requires that 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% probability, 95% confidence level. Use of "reasonably representative" fuel assembly design and depletion parameters appears to be inconsistent with these requirements of 10CFR50.68. Provide justification that explains how use of reasonably representative values is consistent with 10CFR50.68.

3. Confirm that the Region I spent fuel storage rack modules include Boraflex panels on the all outside faces of all rack modules. If Boraflex panels are not present on the outside of all Region I spent fuel storage racks, the evaluation of normal and credible abnormal conditions should be revised to include consideration that some peripheral locations may not have Boraflex panels.

4. The following questions concern the modeling of the Region I Boraflex gaps.

   a. Total panel loss and gap location would appear to be correlated with high radiation dose rates. The total panel loss would be higher in all four panels around an assembly that had a high source term and axially the gap locations in all four panels around a high-dose assembly would be similarly correlated with a higher axial peaking source term. It is not clear that randomly sampling total panel loss and gap locations, assuming no correlations, is appropriate. Provide justification for ignoring potential correlations between the distributions and between panels in a cell.

   b. Monte Carlo sampling was performed for [[ ]] The reality of the situation is that a large number of the possible distributions will exist in the larger array of rack modules at the same time. Some of the more reactive configurations likely exist. Since criticality is a local phenomena rather than an average phenomena, using the average k_{eff} value does not appear to be appropriate. It seems appropriate to use the highest k_{eff} value as the normal k_{eff} for the Region I racks. Justify not using the highest k_{eff} value as the normal k_{eff} value for Region I.

The text on page 33 of NEDC-33621P, Rev 0, describes derivation of a gap modeling total uncertainty. A frequency plot of the results is provided below. It is not clear that the results are normally distributed. What statistical techniques were used to determine the 95% probability/95% confidence k_{eff} value?

[[

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c. The impact of gaps was estimated by simulating only [[ ]]. It is not clear that [[ ]] is enough to accurately quantify the impact of the gaps. One might check this by tracking the evolution of the mean k_{eff} value and k_{eff} population standard deviation as a function of the number of simulated configurations to assess convergence. Justify limiting the simulation to only [[ ]] and, if necessary, perform additional simulations.

d. NEDC-33621P, Rev. 0, Figure 16 shows a [[

]] This could indicate a problem introduced by post-sampling adjustment or the need for additional simulations. Explain and justify the differences and, if necessary, perform additional simulations.

e. Quantify the uncertainty associated with using the Monte Carlo sampling technique. Factors to be addressed include:

   i. Uncertainties associated with the measurements that were used to yield the sampling distributions. Issues of calibration and repeatability should be addressed.

   ii. Uncertainties associated with production of the sampling distributions from a finite set of measurements.

   iii. Uncertainties associated with correlations between sampling distributions.

   iv. Uncertainties associated with post-sampling adjustment of sampled data.

   v. Uncertainties associated with the continuing time-dependent evolution of the true distributions.

f. In NEDC-33621P, Rev 0, the target probability distribution for the number of gap per panel, total panel loss per panel, the gap size per panel, and gap axial location per panel were shown in Table 12, Table 13, Table 14, and Table 15 respectively. Please provide the methodology and algorithm used to derive the probability distribution. In addition, explain the correlation of the probability distribution against the accumulated gamma dosage exposure in the Region I spent fuel pool.

g. In NEDC-33621P, Rev 0, section 6.8, the reactivity [[ ]] It was not clear how the value was derived. It was not consistent with the In-rack K_∞ in the Table 18- Spent fuel Storage Rack In-Rack K_∞ results – Region I. Please explain and justify how this value was derived.

h. In NEDC-33621P, Rev 0, Table 13 states the target probability distribution for the total panel loss per panel. According to the probability distribution in the table, it indicates that the cumulative probability more than 50% of the panel have more than 10 inches (or more) of panel loss. However, none of twenty cases was studied with panel loss exceed 10 inches. Please provide explanation of the discrepancy between Table 13 - the target probability distribution and Figure 11- [[ ]] in the report.

i. On NEDC-33621P, REV 0, Page 26, it indicated the [[ ]] Please provide the explanation on the mathematical model used to generate [[ ]]. Please provide justification for how the output is compatible with MCNP-05P?

j. According to the response to RAI 32 in the licensee's April 21, 2011, letter only 18 of approximately 9000 Region I Boraflex panels were tested. Justify this limited testing in establishing the Boraflex modeling methodology and any additional bias and uncertainty that are inherent in that limited testing scope.

k. Enclosure 1 to the licensee's April 21, 2011, letter indicates un-irradiated Boraflex panels are degrading. With respect to this degradation provide the following information:

   i. Explain the degradation mechanism for un-irradiated panels.

   ii. Explain how this degradation mechanism is incorporated into the Boraflex monitoring program.

   iii. Explain how this degradation mechanism is incorporated in the nuclear criticality safety (NCS) analyses for the GGNS SFP.

5. NEDC-33621P, Rev. 0, Sections 6.1 and 6.2 describe the Region II storage configuration and models. As presented, the analysis appears to support only [[ ]] that are similar to the configuration shown in Figure 18 and, for example, would not support a 3x4 Region II storage area. Describe the minimum acceptable Region II storage area.

6. NEDC-33621P, Rev. 0, Section 6.2.3 presents the model that was used to evaluate the interface condition. [[ ]] This model likely does not yield the most reactive interface k_{eff} value. Confirm that the most limiting interface condition has been modeled.

7. NEDC-33621P, Rev. 0, Section 6.3 describes the selection of the "design basis lattice." From the text and Table 17, it appears that only 15 lattices were evaluated. Justify the selection of the design basis lattice (DBL) from such a limited set of lattices. Include in the justification the logic supporting that using the DBL will ensure that limiting all past, present and future lattice variations that meet the SCCG k_∞ limit will also meet the limits described in 10CFR50.68, including the 95% probability and 95% confidence requirement. Justify not specifying a range of acceptable assembly Gd loading consistent with the evaluated lattices.

8. NEDC-33621P, Rev. 0, Section 6.4.1 notes that [[ ]]. The impact [[ ]] should have been evaluated. Justify the limited evaluation of [[ ]].

9. NEDC-33621P, Rev. 0, Section 6.4.1 includes the following statement:

   [[

   ]], possibly increasing k_{eff}. In fact, many of the parametric variations and abnormal conditions should be evaluated [[ ]] to ensure that the most reactive condition is identified. Provide justification for limiting the analysis to [[ ]].

10. NEDC-33621P, Rev. 0, Table 18 shows that impact of [[ ]] Provide justification for use of this [[ ]].

    Tables 18 and 20 include different k_{eff} values for the Region I rack k_{eff} with [[ ]]. The value in Table 20 appears identical to the value in Table 18 for [[ ]]. Additionally, the value listed in Table 20 for [[ ]] appears to be identical to the value in Table 18 [[ ]]. Describe and justify the differences, or correct any errors in the data and report.

11. NEDC-33621P, Rev. 0, Table 18 shows the impact of modeling variations on the Region I k_{eff} value. [[ ]] Justify not evaluating the impact of parameter variations with [[ ]].

12. NEDC-33621P, Rev. 0, Table 19 shows the impact of modeling variations on the Region II k_{eff} value. The following issues are noted concerning the information provided in Table 19.

    a. Parameter variations should have been examined [[ ]]. Justify not examining parameter variations [[ ]].

    b. Considering which storage cell positions may be used in Region II, it is not clear that [[ ]] will yield the highest k_{eff} value. Justify considering only the [[ ]] case.

    c. In Region I, bundle rotations were evaluated [[ ]]. If [[ ]] were evaluated in Region II the same way, additional [[ ]] should have been considered. Justify examining only the [[ ]].

    d. The impact on k_{eff} of moderator density appears to be significantly higher [[ ]]. Since the impact was evaluated only at [[ ]], it is not clear that the peak value has been identified. Justify evaluating moderator densities at only [[ ]].

13. NEDC-33621P, Rev. 0, Section 6.5.1 lists "[[ ]]" to be an abnormal or accident condition.

    a. Describe how the Δk_{eff} value of the insert was derived. If it does not include an insert in all cells required to be empty, then adjust it as appropriate so that it does.

b. No description of the rack inserts is provided. From Provide a description of the permitted rack inserts.

c. The presence of the rack inserts are a normal condition. Consequently, their presence should be considered when evaluating the impact of tolerances, parameter variations, and accidents/abnormal conditions. Justify not evaluating the impact of tolerances, parameter variations, and accidents/abnormal conditions.

14. NEDC-33621P, Rev. 0, Section 6.5.1 addresses abnormal conditions evaluated. The following items are related to abnormal conditions.

a. No abnormal conditions are identified related to the degraded Boraflex that is credited in Region I. There are at least three abnormal conditions that should be considered. They are (1) the impact of a seismic event on the continued effectiveness of credited Boraflex, (2) the impact of a dropped load on the continued effectiveness of credited Boraflex, and (3) that the Boraflex degradation is more extensive generally or locally than measurements and analysis indicate. Provide justification for not evaluating abnormal conditions related to Boraflex degradation.

b. Fuel handling activities are listed under "abnormal" conditions. Fuel handling is not an abnormal condition. The evaluation provided in Section 6.5.1 does not indicate how close the [[

]].

Further, the analysis presented states that [[

]]. From the analysis presented, it is not clear that some other spacing between [[ ]] would not yield a higher k value than the [[ ]] cm spacing case. Confirm that the [[ ]] case is yields the peak k_{eff} value.

15. NEDC-33621P, Rev. 0, Table 21, [[ ]]. This parameter involves [[

]]. One expects the fuel reactivity to increase as the fuel temperature at which it was depleted increases. Confirm that the fuel temperatures used in both the nominal and very high temperature case were modeled correctly.

16. NEDC-33621P, Rev. 0, Table 22 presents results for fuel and rack manufacturing tolerances and uncertainties for the Region I racks. The following comments concern the information provided or not provided in this table:

a. Provide justification for why the following were not evaluated:
[[
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[[

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b. The text on page 10 states [[ ]], while the text on page 46 states [[ ]]. Confirm that the correct value was used for Table 22.

17. NEDC-33621P, Rev. 0, Table 23 presents results for fuel and rack manufacturing tolerances and uncertainties for the Region II racks. The following comments concern the information provided or not provided in this table:

    a. Provide justification for why the following were not evaluated: [[

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    b. The text on page 10 states [[ ]], while the text on page 46 states [[ ]]. Confirm that the correct value was used for Table 23.

18. NEDC-33621P, Rev. 0, Table 24 includes [[ ]]. This term should be a bias rather than an uncertainty. See RAI 4.b above for additional discussion. Justify inclusion of this quantity as an uncertainty rather than a bias.

19. With respect to the validation work provided in NEDC-33621P, Rev 0, provide the following information:

    a. Table 3 lists [[

    ]]. Clarify [[ ]] in the validation benchmarks and justify any difference with the GGNS SFP.

    b. The validation set does not describe how many of the critical experiments have Gd. Considering the importance of Gd in the calculation of peak reactivity, Gd should be significantly represented in the validation set. Identify the Gd experiments used in the validation set and justify their adequacy for validating Gd.

    c. No trending analysis of benchmark results is provided. Trends should have been evaluated as a function of EALF, enrichment, Pu content (e.g., g Pu / (g Pu + g U), Gd worth, pin pitch, etc. The safety analysis models should be compared to the ranges of these trends. Credit for reduced bias and bias uncertainty should be taken only where statistically significant trends exist. Evaluate the bias and bias uncertainty as a function of trend parameter.

    d. Page 4 in section 3.3 contains the following text:

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[[

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While this may be small, it is probably not "insignificant." Evaluate the impact of the variation of cross sections with temperature.

e. Section 3.3 identifies a [[ ]]. The text does not say [[ ]]. The calculation of [[ ]] presented in Table 21 shows [[ ]] by [[ ]]. Describe which actinides were retained and which were removed in this determination.

f. In NEDC-33621P, REV 0, Page 3, Table 2 – Summary of the critical benchmark experiments: [[ ]]. According to ICSBEP (September 2010), both of them were identified with borated stainless steel plate. However, based on the GE14 and GNF2 fuel description in Section 4.0 Fuel Design Basis, no borated stainless steel plate is found in the fuel assembly or the GGNS SFP storage racks. Please provide appropriate justification how the selected criticality experiments validate the criticality analysis on the cross section data in the AOA (Area of Applicability) of spent fuel assembly.

20. In NEDC-33621P, REV 0, Table 16 it is unclear what is meant by the Error column. Describe what that column means, how it is used, and its justification.

21. As the Region I cells are converted to Region II cells the capacity of the SFP decreases. The SFP capacity is listed in TS Spec 4.3.3. According to the response to RAI 35 in the licensee's April 21, 2011, letter the RACKFILE code prediction shows significant increase in number of Region II storage cells by Jan 1, 2015. How does the licensee plan to maintain compliance with TS 4.3.3 as the SFP capacity continues to decrease?

22. The list of assumptions and conservatisms listed in Section 3.6 includes a statement that [[ ]]. This is not a conservatism. Provide a list of the nuclides credited in the analysis. Justify the use of any nuclide whose half life less than the life of the plant.

23. The analysis incorrectly identifies some depletion parameter variations, and expected operations, such as [[ ]]. This is not correct. For example, [[ ]]. For most cases, this has little impact because the reactivity effect is added as a bias. Ensure that all variations of the appropriate normal conditions are considered when evaluating the impact of tolerances and uncertainties and the impact of truly abnormal and accident conditions.

24. The NRC staff has noted several typographical errors that should be addressed.

    a. Reference to Table 2 on page 4 should be to Table 3.

b. Text at the end of the first paragraph on page 5 says [[ ]] It should be covering the [[ ]].

c. Text at the end of the next bullet on page 5 says the [[ ]] It should be covering the [[ ]].

25. Verify that the fission source has converged for all MCNP cases. For any MCNP case for which the fission source has not converged, determine the effect on the estimation of keff.

26. Attachment 3 Figure 29-1 shows the event tree that models different avenues to correctly and incorrectly load fuel into the spent fuel pool. Based on the event tree analysis, the licensee states that the frequency of misloads is approximately 2.70E-7/year. The staff has sufficient indication that the industry misload frequency is approximately two per year or 1.92E-02/yr per unit. The licensee asserts that their practices and procedures regarding loading assemblies into the spent fuel pool are one hundred thousand times better than historical industry average. The staff finds no reason to believe this assertion.

    Furthermore, the staff finds the event tree calculation conducted by the licensee misleading. The licensee indicates two fuel movement plan errors with no dependency; whereas, the same code and organization are used for both plans indicating a clear dependence. The possibility of having a misload based solely on an incorrect fuel plan is not modeled; although, a large majority of actual misloads in industry are due primarily to an incorrect fuel plan.

    Standard Review Plan 2.2.3, "Evaluation of Potential Accidents" Section II provides criteria to determine credible scenarios:

    > *The identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant or plants of specified type is acceptable if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting from radiological dose in excess of the 10 CFR 50.34(a)(1) as it relates to the requirements of 10 CFR Part 100 is estimated to exceed the NRC staff objective of an order of magnitude of 1E-7 per year.*

    For those initiating events greater than 1E-7 per year, the staff finds the scenario credible for review. The initiating event for this scenario is the incorrect fuel plan as all additional steps are categorized as mitigating actions. The staff does not find a misload as an initiating event. The incorrect fuel plan (FMP ERROR) is 1.00E-3; and for an additional error in the fuel plan (FMP ERR2), the total continues to stay above 1E-7 so this event is credible.

    The staff also recognizes that in June 2008, Grand Gulf inadvertently loaded thirty four fuel assemblies into four casks (NUREG/CR-6998[7] Event Notification Report #44306 June 20, 2008). The misload was preliminary attributed to an error in the Cask Loader Database and was discovered during a data update of the database. Clearly, the organizational practices and procedures in place for cask loading are not representative of 1E-7/year.

The NRC staff finds that this event is credible because the historical industry record indicate large frequency of occurrence and the occurrence probability of the initiating event is greater than 1E-7. Please provide the criticality analysis for the limiting misload accident at GGNS.