From: Michelle Honcharik
To: DMILLAR@entergy.com
Date: 3/21/03 11:06AM
Subject: RAI on Changes to Spent Fuel Pool Loading Restrictions

Dana,
Please see the attached RAI from the Reactor Systems Branch Other branches are reviewing the amendment, so there may be additional RAI submittals at a later date.
Thank you,
Michelle

CC: Thomas Alexion

REQUEST FOR ADDITIONAL INFORMATION
REACTOR SYSTEMS BRANCH
REQUEST FOR CHANGES TO THE SPENT FUEL POOL LOADING RESTRICTIONS
ARKANSAS NUCLEAR ONE, UNIT 2 (ANO-2)

1. The licensee's amendment described a methodology used to calculate the maximum effective multiplication factor (k_{eff}). The US Nuclear Regulatory Commission (NRC) staff has outlined two acceptable methodologies to perform spent fuel pool criticality analyses in a memorandum entitled "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants," from L. Kopp to T. Collins dated August 19, 1998. The two methodologies are (1) a worst-case combination with mechanical and material conditions set to maximize k_{eff}, or (2) a sensitivity study of the reactivity effects of the tolerance variations. The licensee's amendment is unclear on which methodology was used. The NRC staff requests the licensee identify which methodology was employed to calculate the maximum k_{eff}.

2. The licensee calculated maximum effective multiplication factors by statistically combining all of the reactivity effects due to tolerances and uncertainties for each of the ANO-2 spent fuel pool regions. However, the licensee's amendment does not contain the equations used to calculate these values. The NRC staff requests the licensee provide the equations used to perform the maximum k_{eff} calculations and a detailed quantitative example demonstrating how the reactivity effects of each tolerance and uncertainty were calculated. The licensee's example should clearly and numerically demonstrate the methodology used to calculate the reactivity associated with each uncertainty or tolerance. Additionally, the NRC staff requests the licensee calculate the values presented in one of the reference cases of the amendment as the example. The licensee should include a detailed description of the statistical methods employed and the values used in the calculation of any statistical uncertainties.

3. By letter dated October 6, 1998, the NRC granted Entergy Operations, Inc. an exemption from the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 70.24. The NRC granted the 1998 exemption based on certain conditions the licensee was able to meet. The proposed amendment does not satisfy those conditions listed in the exemption and, therefore, will invalidate the exemption. The licensee's amendment does not request a new exemption to these requirements. The NRC staff requires the licensee to perform one of the following: (1) the licensee may install equipment to comply with the requirements of 10 CFR 70.24, (2) the licensee may request a new exemption to the requirement based on a different technical justification, or (3) the licensee may demonstrate compliance with the requirements of 10 CFR 50.68. The NRC staff requests the licensee inform them of which option will be pursued.

4. The licensee's amendment included a mechanical tolerance uncertainty term in the calculation of the maximum k_{eff}, however, specific details of which uncertainties were included and how they affected the criticality analysis were not presented. The NRC staff requests the licensee provide a table containing the following: (1) the mechanical tolerances considered, (2) the value for the tolerance used in the analysis, (3) whether the tolerance represents a maximum/minimum acceptable value or a statistical uncertainty, and (4) the resulting change in reactivity which can be attributed to the tolerance.

5. The licensee's amendment identifies Combustion Engineering (CE) 16 x 16 spent and fresh fuel assemblies as the fuel types stored in the spent fuel pool and, therefore, used in the criticality analysis. The NRC staff requests the licensee specify whether any other fuel types are currently stored in the ANO-2 spent fuel pool. If additional fuel types are stored in the pool, the NRC staff requests the licensee demonstrate quantitatively that the CE 16x16 assemblies provide the most conservative criticality analyses. Additionally, if CE 16x16 assemblies are currently the only type of fuel stored in the spent fuel pool, the NRC staff requests the licensee describe what licensing actions will be taken to amend the spent fuel pool licensing basis if different fuel types are used in the future.

6. The licensee credits fuel burnup and cooling time to permit storage of higher enrichment spent fuel assemblies within the pool. The licensee's amendment states that interpolation on the curves of burnup and cooling time versus enrichment will be permissible. The process of interpolating between curves on a graph introduces additional error not accounted for in the licensee's analysis. The NRC staff requests the licensee identify the maximum uncertainty possible from the interpolation and account for it with an appropriately conservative reactivity addition to the criticality analyses.

7. The licensee has placed considerable emphasis on credit for burnup of the spent fuel for storage in the Region 2 racks. The NRC staff requests the licensee provide detailed information describing the methods that will be in place, either administratively or experimentally, to independently confirm the fuel burnup before an assembly is placed in the storage racks.

8. The licensee's analysis stated that Region 3, which will contain the Metamic® inserts, had a negative moderator temperature coefficient (MTC), while the analyses for Region 1 and Region 2 had a positive MTC. In the Region 3 analysis, the licensee treated temperatures less than 20°C as uncertainties and statistically combined its reactivity effect with other uncertainties in the criticality analysis, while in the Region 1 and Region 2 analyses higher temperatures were treated as biases and directly added to the calculated k_{eff} value. Temperature was not a nominal design value in this analysis; instead, it was a reference point for the calculation using the MCNP4a code. The differences in how the licensee includes reactivity variations due to temperature differences results in an inconsistent licensing basis and a nonconservative maximum k_{eff} in the Region 3 criticality analysis. Therefore, it is inappropriate to handle temperatures less than 20°C as uncertainties, while including higher temperatures as biases, since both are measurable values permitted in the licensee's spent fuel pool. The NRC staff requests the licensee amend its analysis of the Region 3 racks to include temperature as a bias.

9. The licensee stated that the maximum k_{eff} values were calculated assuming an infinite radial array of storage cells with a finite axial length, water reflector. The NRC staff requests the licensee specify the amount of water reflector assumed in the axial direction.

10. The licensee provided tables showing the minimum burnup required for storage of spent fuel assemblies in each of the racks as a function of cooling time and average fuel enrichment. The NRC staff requests the licensee specify whether the table values and the figures generated from them assumed the uncertainty in the fuel enrichment. For example, in Table 4.2.2 the burnups necessary for an enrichment of 4.95 weight percent are depicted as a function of cooling time. If the uncertainty (± 0.05 weight percent) was not considered then the burnup or cooling times presented may be under predicted. Longer cooling and a higher burnup would be necessary to lower the reactivity to the levels calculated in the analyses. If uncertainties were not considered by the licensee in calculating the values of burnup presented, the NRC staff requests that the licensee either provide detailed technical justification for their omission or revise the tables and figures to reflect their inclusion.

11. The licensee stated that linear interpolation between the points in both Table 4.2.2 and Table 4.2.6 is acceptable since the data is "nearly" linear. Proposed Technical Specification (TS) Figures 3.9.2 and 3.9.3 provide a graphical representation of the data present in the aforementioned tables. Additionally, Tables 4.2.3 and 4.2.7 provide the bounding polynomial fit equations for the proposed TS figures. These equations for Region 1 and Region 2 racks are fourth and third order polynomials, respectively, implying a nonlinear relationship. The NRC staff requests the licensee provide information describing the following: (1) the basis for assuming a linear relationship, (2) the maximum error that can be introduced by assuming a linear relationship, (3) how this error was accounted for in the criticality analyses, (4) how the error will be limited when using the TS figures, and (5) the effects of assuming a conservatively bounding second or first order polynomial.

12. The licensee's criticality analysis has identified the misloading of a fresh fuel assembly into a Region 2 cell intended to remain empty as an event which requires 825 ppm of soluble boron to assure the max k_{eff} does not exceed 0.95. The NRC staff requests the licensee identify controls which either will be put into place or are already in place to prevent this event from occurring.

13. The licensee described a limitation of the MCNP calculations which prevented modeling some fission product nuclides in the criticality analyses. The licensee described a process to calculate an equivalent amount of boron which provides nearly the same reactivity in MCNP as the CASMO4 result. The licensee stated this would compensate for the inability of MCNP to model these nuclides which account for approximately 1 percent of the reactivity. The NRC staff requests the licensee provide detailed technical information demonstrating that this alternate methodology is conservative or provides bounding results. Additionally, the NRC staff requests the licensee provide a table of the nuclides not modeled in the MCNP correlation and a quantitative summary of the equivalent boron-10 used to account for their reactivity.

14. The licensee's accident analyses did not include a discussion of the effects of pool temperatures greater than 150°F. The positive MTC in Regions 1 and 2 will cause a reactivity addition when pool temperatures increase. The NRC staff requests the licensee analyze this event and provide a detailed analysis of the results.

15. For the most limiting dropped fuel assembly analysis, the licensee assumed that all of the Metamic® poison panels would be lost in Region 3. The licensee identified the need for a soluble boron concentration of 2000 ppm to maintain k_{eff} at or below 0.95. The NRC staff requests the licensee provide a list of assumptions and their justifications used in the analysis. Examples of the information the licensee should provide include (a) the type of assembly dropped (fresh, spent, burnup, enrichment, cooling time, etc.), (b) the loading of the rack during the accident, and (c) the temperature of the spent fuel pool.

16. The licensee specified a loss flow rate of 2 gallons per minute would dilute the spent fuel pool to at concentration of 400 ppm in 111 days under normal operating conditions. The NRC staff requests the licensee identify the loss flow rate which would dilute the pool to less than 400 ppm in 31 days. Additionally, the NRC staff requests the licensee identify all means which could provide this loss rate and describe the controls in place to limit the potential for their occurrence.

17. In reviewing Tables 4.2.1, 4.2.4, 4.2.5, 4.2.8, and 4.2.9 of the licensee's submittal, the NRC staff identified differences in the reactivity effect of the manufacturing tolerance uncertainty between the analyses. The differences appear not only between regions but within one region when the spent and fresh fuel analyses are compared. The NRC staff requests the licensee describe and justify the reasons for the differences.

18. In each of the analyses presented in Tables 4.2.1, 4.2.4, 4.2.5, 4.2.8, and 4.2.9, the licensee includes a term identified as "MCNP4a Statistics (95/95) Uncertainty." The NRC staff requests the licensee describe, in greater detail, how this value is obtained. Additionally, the NRC staff requests the licensee include relevant equations and numerical data which demonstrate how the value was calculated.

19. The licensee's application does not discuss the interfaces which may occur between regions, racks, or within a rack. The NRC staff requests the licensee identify any interfaces which may occur with the proposed configurations, such as a fresh fuel assembly in a Region 1 rack adjacent to a fresh fuel assembly in a Region 2 rack, or a spent fuel assembly adjacent to a fresh fuel assembly either in the same rack or adjacent racks. The NRC staff requests the licensee provide a response to either of the following concerns.

    a. If these types of interfaces are possible but bounded by other normal conditions described in the amendment, the NRC staff requests the licensee provide a detailed justification of the basis for claiming the interface conditions are bounded.

    b. However, if these types of interfaces are possible but not bounded by other conditions described in the amendment, the NRC staff requests the licensee provide a detailed quantitative analysis of the reactivity affects associated with the interface conditions.

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