[redacted]

RAI 6-4

Clarify if axial and horizontal variations of enrichment are allowed in the ATRIUM fuel assembly. If so, provide justification that the assumptions in the uniform axial enrichment analyses bound the axially varied enrichment configurations.

One of the requested allowable new contents for the TN-B1 package is the ATRIUM BWR fuel assembly. As a common design feature, BWR fuel assembly designs often include variation of fuel enrichment along the axial direction as well as across the planar direction. However, it is not clear from the application if the ATRIUM fuel has this feature. The applicant needs to clarify whether axial and horizontal variations of enrichment are allowed in the ATRIUM fuel assembly. If so, the applicant needs to provide updated criticality safety analyses for the case of axial varying enrichment or justify that the assumptions in the uniform axial and horizontal enrichment is bounding.

This information is needed to determine compliance with 10 CFR 71.55(a), 71.55(b), 71.55(d), 71.55(d), 71.59(a), 71.59(b), and 71.59(c).

AREVA Response

Executive Summary

ATRIUM-11 fuel features axial and horizontal variations in enrichment. The SAR has been updated to state this explicitly. It is a generally accepted practice to model BWR fuel with a uniform enrichment corresponding to the lattice average enrichment. This approach is not unique to the TN-B1 package or to 11x11 fuel. The conservatism of this modeling simplification is demonstrated explicitly for two lead test assembly (LTA) designs in the section "Radial U235 Enrichment Distribution."

[[redacted]]

It is important to note that when comparing a fuel assembly against the limits in Table 6-1, *each axial region is treated separately*, as the average enrichment and number of UO_2-Gd_2O_3 rods may be different for each region in an actual 11x11 fuel assembly.

Background

During clarification of RAI 6-4, the NRC suggested that AREVA look at NUREG/CR-7224 and NUREG/CR-7158. It is noted that both of these documents are related to burnup credit for BWR fuel.

[redacted]

[redacted]

RAI 6-4 continued

The criticality safety analysis for the TN-B1 shipping container is limited to unexposed fuel assemblies; therefore, the reactivity trends associated with previously exposed fuel are generally not applicable to the fresh fuel. For unexposed fuel assemblies, the reactivity is dominantly dependent upon the concentration of fissile material and the number of UO_2-Gd_2O_3 rods. Less significant contributors include the geometry of the fuel, and the distribution of the U235 and Gd_2O_3 materials.

[redacted]

This last step was repeated to determine the number of UO_2-Gd_2O_3 rods needed to maintain the system reactivity below the USL for each average U235 enrichment. The results of this are seen in Table 6-1, in Table 6-57, and on page 421/511 of FS1-0014159, Revision 5.0. The UO_2-Gd_2O_3 rod requirements were established by considering each axial region separately and then combining the most reactive configurations for each axial region into a 3-D model. For these cases, all axial regions contain the same U235 enrichment.

[redacted]

RAI 6-4 continued

[[redacted]]

Radial U235 Enrichment Distribution

[[redacted]]

Axial U235 Enrichment Distribution

[[redacted]]

[redacted]

RAI 6-4 continued

[[redacted]]

For both the NCT single package and package array and the HAC single package evaluations, the uniform axial enrichment resulted in a higher reactivity than did the variable axial enrichment.

The SAR has been revised to show the results of the variable axial enrichment configurations for the NCT and HAC single package evaluations and for the NCT and HAC package array evaluations.

RAI 6-4 continued

These configurations bound all axially enrichment configurations. Any alternative lattice description adhering to the UO_2-Gd_2O_3 rods requirements would lower the reactivity of the lattice and would, thus, lower the reactivity of the system.

Axial Blanket Consideration

[[redacted]]

As expected, addition of the axial blankets lowers the reactivity of the system. Thus, the criticality analysis bounds 11x11 fuel assemblies that contain blanket regions.