RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**364-8421**
SRP Section:	**09.01.01 - Criticality Safety of Fresh and Spent Fuel Storage and Handling**
Application Section:	**DCD Tier 2, Section 9.1.1**
Date of RAI Issue:	**01/11/2016**

Question No. 09.01.01-29

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria 62 requires preventing criticality in the fuel storage and handling system through the use of physical systems or processes.

In DCD Tier 2, SAR Section 9.1.1.3.3 the applicant states the following:

c. Credit is taken for the neutron absorption in the rack structural materials and neutron absorbing materials. The steel plate thickness is conservatively set to a minimum, and only 75 percent of B-10 density in the neutron absorbing materials is assumed in order to reflect the deformation of the neutron absorbing material.

Provide additional information the "deformation of the neutron absorbing material."

1. Is this deformation different than the neutron absorber tolerances discussed in technical report APR1400-Z-A-NR-14011-P?

2. Provide that staff with a discussion on how the deformation is related to using 75% of B-10 in the neutron absorbing material.

3. Does the deformation originate during fabrication of the material?

Response

The criticality analysis for the spent fuel pool (SFP) of the APR1400 has been performed assuming only 75 % of B-10 areal density in the neutron absorber plates. This assumption is based on the recommendation of NUREG-1567 and 1617, which deal with spent fuel dry storage (NUREG-1567) and transportation packages for spent nuclear fuel (NUREG-1617).

However, the recommendation provided in NUREG-1567 and 1617 can be applied to the criticality analysis for the SFP as a conservative assumption because the integrity of neutron absorber plates including B-10 areal density is verified by the coupon surveillance program during the life time of the fuel storage racks as discussed in DCD Tier 2, Subsection 9.1.2.4. Therefore, considering 75 % of B-10 areal density is a conservative assumption and it provides additional margin in the analysis results.

However, this assumption does not take account any specific deformation/degradation phenomena. Therefore, it is not related with tolerances and deformation occurred during the fabrication.

DCD Tier 2, Subsection 9.1.1.3.3 will be revised to clarify the assumption applied to the neutron absorber plates.

Impact on DCD

DCD Tier 2, Subsection 9.1.1.3.3 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environment Report.

Spent Fuel Storage Rack

The following analysis conditions are considered in the design of the spent fuel storage racks:

a. The fuel assembly is assumed to have a maximum enrichment of 5 wt% of U-235 in the criticality calculation for spent fuel storage rack region I. For the normal condition, an infinite array of fresh fuel assemblies is modeled in the criticality calculation. Criticality for damaged fuel assemblies is separately evaluated and the effects of gap between racks are also evaluated.

b. For the region II analyses, an infinite array of 2 × 2 fuel assemblies with various U-235 enrichments, from 1.8 to 5.0 wt%, is used for the criticality calculation. The moderator of pure water is at the temperature (density) within the design limits that yields the largest reactivity. The full density of unborated water is assumed to be 1,000 kg/cm^3 (62.4 lbm/ft^3).

c. Credit is taken for the neutron absorption in the rack structural materials and neutron absorbing materials. The steel plate thickness is conservatively set to a minimum, and only 75 percent of B-10 density in the neutron absorbing materials is ~~assumed in order to reflect the deformation of the neutron absorbing material.~~ credited in the analysis. These assumptions provide additional margin in the event that deformation, degradation, or damage to the neutron absorber occur.

d. The neu
SFP water are neglected in the criticality analysis for normal operations and are considered for the postulated accidents. The SFP boron concentration is assumed to be about one-half of the minimum concentration level defined in the Technical Specifications.

e. No cooling time is assumed to avoid fission product accumulation and Xe-135 is not included in the criticality calculation to conservatively evaluate the K_{eff}.

f. The nuclear characteristics of the spent fuel are affected by the core operation parameters, such as coolant temperature, soluble boron concentration in the coolant, and axial burnup profile. Thus, the most severe operating conditions are conservatively assumed in the fuel burnup calculation.

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Question No. 09.01.01-32

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria 62 requires preventing criticality in the fuel storage and handling system through the use of physical systems or processes.

Technical report APR1400-Z-A-NR-14011-P, Section 5.3 has a requirement for the areal density of the neutron in the "Spent Fuel Pool Limitations" section. The areal density requirement is not consistent with the Tables 3.1-1 and 3.1-2 in the same technical report.

Correct or clarify the information in the technical report.

Response

Inconsistencies in the areal density requirements presented in Section 5.3 of criticality analysis technical report will be corrected.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

Section 5.3 in the criticality analysis TeR will be revised as indicated in the Attachment.

5 LIMITATIONS OF ANALYSIS

The APR1400 design is an advanced PWR design that is functionally similar to existing plants. The following design input data to this analysis will be checked in order to ensure compliance with the criticality safety design basis.

5.1 Fuel Limitations

1. This analysis is applicable to the PLUS7 16x16 fuel design.

2. The initial stack density shall be less than [ ]^{TS} of the theoretical density of uranium dioxide ([ ]^{TS} g/cm^3).

5.2 Operational Limitations

1. The cycle averaged soluble boron concentration for all fuel assemblies shall be less than [ ]^{TS} ppm.

2. Fuel assemblies that do not meet operational limits and assumptions will be specifically evaluated and classified following the same methodology used in this report.

5.3 Spent Fuel Pool Limitations

[ ]^{TS}

1. An areal density of each neutron absorber material (METAMIC^{TM}) shall be greater than or equal to [ ]^{TS} B-10 g/cm^2 for spent fuel pool region I.

2. An areal density of each neutron absorber material (METAMIC^{TM}) shall be greater than or equal to [ ]^{TS} B-10 g/cm^2 for spent fuel pool region II.

[ ]^{TS}

3. The center to center spacing of region I shall be greater than or equal to 27.5 cm and the center to center spacing of region II shall be greater than or equal to 22.5 cm.