RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Topical Reports

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

Docket No. PROJ 0782

RAI No.:	**TOP 6-8322**
SRP Section:	**TR PLUS7 Fuel Design for the APR1400**
Application Section:	**PLUS7 Fuel Design for the APR1400 (APR1400-F-M-TR-13001-P)**
Date of RAI Issue:	**10/27/2015**

Question No. TR PLUS7 Fuel Design for the APR1400-24

GDC 10 requires that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences (AOOs). GDC 27 requires that the reactivity control system is designed with appropriate margin and, in conjunction with the ECCS, is capable of controlling reactivity and cooling the core under post-accident conditions. SRP Section 4.2 (II)(1)(B)(viii) and Appendix A provides review guidance related to mechanical fracturing based on seismic and LOCA applied loads. It is also stated specifically that control rod insertability must be maintained.

This topic is addressed in Section 2.2.2 of APR1400-F-M-TR-13001-P, in the response to Question 2 of RAI 4-7542 (ML14177A220), and in the response to Question 23 of RAI 5-7954. In Question 23 of RAI 5- 7954 (ML15169A118), the staff requested supporting technical justification that the proposed guide tube stress limits would meet GDC 27. The response provides an analysis which compares the calculated stresses for the PLUS7 fuel assemblies under seismic and LOCA loads with the material's yield stress and concludes that the yield stress is never exceeded. This response does not address the staff’s concerns because the original RAI requested justification for the proposed limits, not an analysis of the applied loads.

Provide a discussion that covers the proposed stress-strain limits and what level of damage could occur to the components based on those limits. If damage could occur to the guide tubes, include a description of the tests and results that demonstrate control rod insertability. Update the topical report, as necessary, to capture these points.

Response

For the evaluation of guide tube stresses induced by the lateral displacements and the axial loads on fuel assembly during seismic and LOCA events, Appendix F of ASME Section III is

used as the general stress criteria: 1) the general primary membrane stress intensity P_m shall not exceed the lesser of $2.4S_m$ and $0.7S_u$, 2) the primary membrane plus primary bending stress intensity P_m+P_b shall not exceed 150% of the limit for P_m. The proposed stress limit (i.e., $1.05\ S_u$) and the associated strain ($\varepsilon_{1.05}$) for the SRA ZIRLO guide tube are depicted in Figure 24-1.

Since the ASME stress criteria are based on an elastic analysis, the triangular strain energy density over yield stress can be converted to equivalent strain energy on the actual stress-strain curve as shown in the figure. Therefore, the actual strain ($\varepsilon'_{1.05}$) is slightly increased by the equivalent strain energy density and the resulting damage will be slightly greater than proportional permanent strain. The following considerations explain that the damage will not create an excessive deformation of the guide tube that would prevent control rod insertability.

- The loadings during the seismic and LOCA events are not a static load, but an oscillating dynamic load that will be diminished after several seconds, so the actual stress on the guide tube is lower than the one given by the static elastic analysis that is based on an instantaneous deflection,
- Only a portion of the guide tube's cross section has stresses that exceed yield at a particular elevation,
- Only a limited portion of the axial length of the guide tube has stresses that exceed yield, and
- Strain hardening of the guide tube when loaded beyond yield increases the elastic stain range of the material, thereby decreasing the permanent deformation of the guide tube associated with a loading beyond yield.

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Figure 24-1 PLUS7 Guide Thimble Stress-Strain Relation

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 Report

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