

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.: 275-8294
SRP Section: 04.02 – Fuel System Design
Application Section: 4.2
Date of RAI Issue: 10/27/2015

Question No. 04.02-5

GDC 2 requires that SSCs important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A Section (II)(1) provides review guidance stating that the numerical solution techniques used in performing structural response analyses should be reviewed for appropriateness.

Appendix A of APR1400-Z-M-NR-14010-P presents the fuel assembly test program which were used to verify the PLUS 7 fuel assembly mechanical characteristics or seismic and pipe rupture analyses. The mid-grid crush test program specifically states that beginning of life (BOL) and end of life (EOL) conditions were modeled, but it is unclear if the other tests considered burnup effects on the tests in order to provide a conservative analysis approach.

Staff requests the applicant clarify burnup ranges investigated in the tests presented in Appendix A of APR1400-Z-M-NR-14010-P. If only one burnup was assumed (e.g. BOL or EOL), provide justification that the appropriate burnup was assumed. Update the technical report, if appropriate.

Response

KHNP is planning a series of tests and seismic analyses to resolve the seismic issues. After completion of the seismic response analyses using the results of spacer grid and fuel assembly tests, KHNP will address the “End of Life Fuel Seismic” issues identified in RAI 275-8294 in the revised report that will be submitted to the NRC in Feb. 2017. The response to the RAI 275-8294 Question 04.02-5 will be revised by end of Feb. 2017.

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

Technical Report of APR1400-Z-M-NR-14010-P will be revised after the tests and analyses.

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Question No. 04.02-6

GDC 2 requires that SSCs important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A Section (II)(1) provides review guidance stating that the numerical solution techniques used in performing structural response analyses should be reviewed for appropriateness.

Section 5.2.2 and Appendix A.2 of APR1400-Z-M-NR-14010-P presents the vibrational testing and model development. The staff notes that the term “natural frequency” is used here to refer to the fuel assembly’s first lateral bending mode frequency. The linear vibrational model described in the technical report is then tuned to a single natural frequency, while in reality the natural frequency of a fuel assembly varies according to the amplitude of vibration. Although not referenced directly in this section of the technical report, CENPD-178-P Rev. 1 is referenced through the CESHOCK code used in the seismic analysis and it indicates that the natural frequency choice is made: “on a conservative basis for each analysis within the bounds provided by the results from the forced vibration test.” The staff is concerned that the chosen natural frequency might not bound the realistic response to the excitation.

Staff requests the applicant provide a detailed explanation how the natural frequencies of the lateral vibration model were chosen for BOL and EOL conditions and justify the chosen value. Update the technical report, if appropriate.

Response

KHNP is planning a series of tests and seismic analyses to resolve the seismic issues. After completion of the seismic response analyses using the results of spacer grid and fuel assembly tests, KHNP will address the "End of Life Fuel Seismic" issues identified in RAI 275-8294 in the revised report that will be submitted to the NRC in Feb. 2017. The response to the RAI 275-8294 Question 04.02-6 will be revised by end of Feb. 2017.

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

Technical Report of APR1400-Z-M-NR-14010-P will be revised after the tests and analyses.

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Question No. 04.02-7

GDC 2 requires that SSCs important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A (III)(1) provides guidance regarding determination of grid crushing load.

Appendix A.6 of APR1400-Z-M-NR-14010-P presents the mid crush tests used to determine the grid crush load. The text refers to a Figure A.6-2 which is stated to contain plots of grid impact force as a function of impact velocity. This information is used by the staff to understand the amount of plastic deformation that would occur in a grid at the crush strength. The staff notes that Figure A.6-2 is missing and is unable to ascertain the severity of plastic deformation that occurs at the grid crush strength.

Staff requests the applicant describe the amount of plastic deformation resulting from loads corresponding to the grid crush strength and compare against the grid dimensional tolerances. If the plastic deformation exceeds the dimensional tolerances, justify the chosen impact model. Update the technical report if necessary to capture these points, and also to include the missing Figure A.6-2.

Response

KHNP is planning a series of tests and seismic analyses to resolve the seismic issues. After completion of the seismic response analyses using the results of spacer grid and fuel assembly tests, KHNP will address the “End of Life Fuel Seismic” issues identified in RAI 275-8294 in the revised report that will be submitted to the NRC in Feb. 2017. The response to the RAI 275-8294 Question 04.02-7 will be revised by end of Feb. 2017.

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

Technical Report of APR1400-Z-M-NR-14010-P will be revised after the tests and analyses.