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.:	**346-8434**
SRP Section:	**15.04.02 – Uncontrolled Control Rod Assembly Withdrawal at Power**
Application Section:	**15.04.02**
Date of RAI Issue:	**12/22/2015**

Question No. 15.04.02-1

REQUIREMENTS AND GUIDANCE

In 10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the core and associated coolant, control, and protection systems to 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 or anticipated operational occurrences (AOOs). GDC 20 requires, in part, that the protection system be designed to initiate automatically the operation of appropriate systems to ensure that SAFDLs are not exceeded as a result of AOOs. GDC 25 requires the protection system to be designed to ensure that SAFDLs are not exceeded for any single malfunction of the reactivity control systems.

Section 15.4.2 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Subsection III, “Review Procedures,” states the following under Item 1: “*the review considers the entire power range from low to full power and the allowed extreme range of reactor conditions during the operating (fuel) cycle, including rod configurations, power distribution, and associated reactivity feedback components… The review considers a full range of rod or bank withdrawals, up to maximum rod or bank worths and rates of reactivity addition.”* In addition, Item 3 states that “*the reviewer ascertains that a full range of AOO conditions are analyzed…*” and gives a list of parameter ranges to consider, including: (a) initial power levels from low to full power, and (b) reactivity insertion rates from very low to maximum possible, including allowances for uncertainties. The reviewer is guided to verify that these ranges of conditions have been examined, and that the most limiting case has been analyzed.

ISSUE

In DCD Section 15.4.2.3.2, the applicant indicates that the initial power level is assumed to be 102% of the core thermal power. The applicant also states that beginning power levels from low to full power are analyzed in the design stage for the core operating limit supervisory system

(COLSS) and the core protection calculator system (CPCS). Such analyses would partially address the requirement that the analysis include the entire power range from low to full power. The applicant's statement implies that such analyses have been completed, though a review of available documentation has not located sufficient information about the results of the power study. In particular, documentation addressing the results for rod withdrawal scenarios beginning at a range of power levels has not been provided.

Section 15.4.2.3.2 of the DCD also states that the rod withdrawal rate was selected based on the calculated control element assembly (CEA) worth and associated uncertainties to produce the worst transient. A calculated differential CEA worth and the maximum CEA withdrawal rate were used to compute the maximum expected reactivity insertion rate. The maximum rate was used in the analysis. The application also states that "*reactivity insertion rates from very low to maximum possible for the control system, including allowance for uncertainties, are analyzed in COLSS/CPCS design stage*". Again, review of the available supporting documentation has not located any discussion of the analysis or results that address the requirement that a range of reactivity worths and insertion rates be evaluated for this scenario. The peak linear heat generation rate (PLHGR) for this event is 19.27 kW/ft and the AOO limit is 20 kW/ft. Thus, the PLHGR is close enough to the limit that further review is needed to verify that the limiting event is being analyzed. Additional documentation is needed for showing acceptable performance of the system in response to rod withdrawals using a range of reactivity insertion rates.

INFORMATION NEEDED

Please provide documentation supporting the assertion that ranges of power levels and reactivity insertion rates were examined for DCD Section 15.4.2, "Uncontrolled Control Element Assembly Withdrawal at Power." Please include results from any sensitivity analyses that were performed.

As appropriate, the applicant should update the DCD and referenced technical reports.

Response

The transient results of the CEA bank withdrawal at power provided in DCD Section 15.4.2 are the transient results of a typical CEA bank withdrawal at power. A full range of initial power levels and reactivity insertion rates for the CEA bank withdrawal at power is covered by the on-line reactor protection system. The core protection calculator system (CPCS) is a safety grade system primarily designed to provide departure from nucleate boiling ratio (DNBR) and local power density (LPD) protection for anticipated operational occurrences (AOOs).

The CPCS continuously calculates DNBR and LPD and initiates a reactor trip when needed during certain transients to prevent violation of the DNBR and centerline melt fuel design limits. Fast power increasing transients are protected by CPCS variable overpower trip and slow power increasing transients are protected by CPCS DNBR trip or CPCS LPD trip. The CPCS must be reliable so as to provide protection for the design basis AOOs and accidents. The CPCS calculations must be biased so as to be conservative to offset their inaccuracy.

The above analyses shall be performed in COLSS/CPCS setpoint analysis stage for the real plant, not in the design certificate stage for the standard plant. Hence, the results and documentations for a sensitivity analysis on ranges of power levels and reactivity insertion rates

are not available at this moment in time.

The peak linear heat generation rate (PLHGR) for this event, 19.27 kW/ft, was calculated with a conservative initial condition of the linear heat generation rate (LHGR), 14.5 kW/ft, rather than a real initial condition of LHGR, 13.6 kW/ft.

Impact on DCD

There is no impact on DCD.

Impact on PRA

There is no impact on PRA.

Impact on Technical Specifications

There is no impact on Technical Specifications.

Impact on Technical/Topical/Environmental Report

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