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.:	**340-8395**
SRP Section:	**15.04.08 – Spectrum of Rod Ejection Accidents (PWR)**
Application Section:	**15.04.08**
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Question No. 15.04.08-5

General Design Criteria (GDC) 28 requires reactivity control systems be designed with appropriate limits on potential reactivity increases so the effects of a rod ejection accident can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor pressure vessel internals to impair significantly the capability to cool the core.

Analysis of the control element assembly ejection (CEAE) event credits the variable overpower trip (VOPT) to initiate a reactor trip. The modeling of the VOPT uses values for [CEILING], [STEP], and [EXCORE PENALTY]. The values used for [CEILING] and [STEP] in the safety analysis appear to include an additional margin of 6.9% and 1.5% over the values provided in Table 7.2-4 of the APR1400 Design Control Document. Additionally, an 11% value is provided for the [EXCORE PENALTY] to account for potential deficiencies in the excore detector response resulting from a CEAE event. A description of how these values are obtained is missing from the application, which has caused staff to question the basis for the chosen values. NRC staff requests:

1. Explain how the values for [CEILING] and [STEP] used in the safety analysis sufficiently account for uncertainty in the VOPT setpoint.

2. Explain how an 11% value for the [EXCORE PENALTY] is suitably conservative.

Response

1. Explain how the values for [CEILING] and [STEP] used in the safety analysis sufficiently account for uncertainty in the VOPT setpoint.

The CEILING analysis setpoint of 116.5% is determined by adding the total channel error of 6.9% to the nominal CEILING setpoint of 109.6%. The STEP analysis setpoint of 14% is determined by adding the plant protection system (PPS) periodic test error of 1.5% to the nominal STEP setpoint of 12.5%. Since the total channel error and PPS periodic test error are expected maximum values, the analysis setpoints sufficiently account for uncertainty in the VOPT setpoint.

2. Explain how an 11% value for the [EXCORE PENALTY] is suitably conservative.

The excore decalibration factor is defined as follow.

Excore decalibration factor (%) = P_{VOPT} x (1 - D_x^{post} / D_x^{pre})

where:
P_{VOPT} = Post-ejected Power at VOPT (% Power)
D_x^{post} = Post-ejected excore detector signal with pre-ejection power (Min. value among 4 signals)
D_x^{pre} = Pre-ejected excore detector signal (Average value of 4 signals)
x = Excore detector A, B, C, D

The pre ejected and post ejected excore detector signals in the above equation are calculated by the neutronics code ROCS, integrating the product of core peripheral assembly powers and shape annealing functions over core height. To get the maximum value for the excore decalibration factor, the minimum value among the four detector signals from Table 1 is chosen as the D_x^{post}. The excore decalibration factors are calculated for the ejected case, which shows the maximum ejected rod worth at each power level. Table 2 shows the excore decalibration factors calculated for APR1400 design. Therefore, the 11% excore penalty is conservative for ejection analysis because it is greater than the highest decalibration factor calculated.

Table 1 Excore Detector Signals for APR1400

TS

Table 2 Excore Decalibration Factor for APR1400

TS

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 Reports

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