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.:	**388-8502**
SRP Section:	**15.04.07 – Inadvertent Loading and Operation of a Fuel Assembly in an Improper Position**
Application Section:	**15.04.07**
Date of RAI Issue:	**02/01/2016**

Question No. 15.04.07-1

In DCD Tier 2, Section 15.4.7.2, "Sequence of Events and Systems Operation," the applicant states that the worst case undetectable misloading at BOC would be the interchange of a shimmed with an unshimmed assembly at the core center. In DCD Section 15.4.7.3.2, "Input Parameters and Initial Conditions," the applicant states the worst undetectable misloading at startup (i.e., BOC) is the interchange of Assemblies 12 and 24. The staff notes that assembly locations 12 and 24 are near the core periphery as shown in DCD Figure 15.4.7-1, "Location of the Worst-Case Misloading." The staff believes there is a potential inconsistency regarding the location of the worst misloaded assembly. Update the DCD as necessary.

Response

DCD Tier 2, Section 15.4.7.2 will be revised to correct this inconsistency.

Impact on DCD

DCD Section 15.4.7.2 will be revised as shown in the attached markup.

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.

performed in which the reactivity worths of symmetrically located CEAs are compared with one another. The interchange of two or more fuel assemblies with greatly different K_∞'s destroys the octant symmetry of the core flux distribution and would produce significant variations in the worths of symmetrically located CEAs. This asymmetry would be corroborated by symmetry checks performed for other symmetric rod groups, thereby confirming and possibly even locating a fuel assembly misload.

In addition, many misloadings could be detected by either the ex-core detectors directly or the in-core detector channels, which are analyzed at power levels greater than 20 percent during the power ascension test at beginning of cycle (BOC) and periodically throughout the cycle.

Thus, most of the fuel assembly misloadings that can be postulated are detectable both during the rod symmetry checks and during power range operation. However, there are a small number of misloadings that are undetectable during the rod symmetry testing or even early in the cycle with in-core instrumentation during power range operation. Of this small class, the worst case is the interchange of a shimmed assembly with an unshimmed assembly ~~at the center of the core.~~ in the core. This case, although not detectable at BOC, would cause local power peaking as the shims burn out.

Chapter 16, Technical Specifications, requires that the planar radial peaking factor (F^m_{xy}) be measured at least once per 31 effective full-power days (EFPDs) and that the measured planar radial peaking factor (F^m_{xy}) be less than or equal to the planar radial peaking factor (F^c_{xy}) used in the core operating limit supervisory system (COLSS) and in the core protection calculator (CPC). Even if the increase in radial peak is not large enough to alert the reactor engineer to the possibility of a misloading, the measured radial peak would be used in the COLSS and the CPC. This would reduce the operating band to compensate for the reduction in the thermal margin caused by these misloads.

15.4.7.3 Core and System Performance

15.4.7.3.1 Evaluation Model

Because no transient occurs for this event, the typical transient analysis codes are not used. The ROCS Code is used to calculate both a normal expected radial power distribution and the radial power distributions resulting from the assumed fuel loading errors. ROCS is a

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Question No. 15.04.07-2

In DCD Tier 2, Section 15.4.7.3.3, "Results," the applicant states that maximum increase in planer peaking factor is less than 15 percent, including measurement uncertainties, due to the misloading. It is unclear to the staff if the 15 percent increase is between incore measurements intervals or the maximum change during the cycle between the as-designed core and the misloaded loading pattern. Clarify what the 15 percent change is relative to and revise the DCD as necessary.

Response

The 15 percent is the maximum change of Fxy during the cycle between the as-designed core and misloaded loading pattern. DCD Section 15.4.7.3.3 will be revised to state the 15 percent of Fxy is from misloaded loading pattern.

Impact on DCD

DCD Section 15.4.7.3.3 will be revised as shown in the attached markup.

Impact on PRA

There is no impact on PRA.

Impact on Technical Specifications

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Impact on Technical/Topical/Environmental Report

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three-dimensional, two-group diffusion core calculation code based on the nodal expansion method, as described in Subsection 4.3.3.1.

15.4.7.3.2 <u>Input Parameters and Initial Conditions</u>

Several single assembly interchanges of this type were postulated and investigated using the fine-mesh neutronics methods described in Subsection 4.3.3.1. Most were shown to be detectable when estimates of the symmetric rod worths were calculated. Of those misloads that were not conclusively demonstrated to be detectable during startup at BOC, the interchange of Assemblies 12 and 24 (see Figure 15.4.7-1) was shown to result in the highest F_{xy} value during subsequent full-power operation over the first cycle. This limiting case is determined through s

The maximum F_{xy} change during the cycle between the as-designed core and the misloaded loading pattern is less than 15 percent including consideration of increased measurement uncertainties.

15.4.7.3.3 <u>Results</u>

~~Maximum F_{xy} increase is less than 15 percent including consideration of increased measurement uncertainties due to the misloading.~~ An increase of 20.5 percent in integrated radial peak is considered in the CEA drop analysis and shown to result in a DNBR greater than the 95/95 DNBR limit (see Subsection 15.4.3). The consequences of this event are less severe than those of the CEA drop event, and the resultant DNBR for this event is greater than the 95/95 DNBR limit.

15.4.7.4 <u>Barrier Performance</u>

This event causes changes only in the local heat flux and distribution of power within the core. The core power, flow, and RCS pressure of the whole core are not changed. Therefore, the integrity of the reactor coolant pressure boundary is not challenged.

15.4.7.5 <u>Radiological Consequences</u>

The radiological consequence of this event is bounded by the CEA ejection accident described in Subsection 15.4.8.