**Discussion Initiators for KHNP/NRC Reactor Systems Public Teleconference**
**March 16, 2016**

## A. SBLOCA Safety Analysis Topics (45 minutes)

(Shanlai Lu)

### a. Boron Dilution

As it is attached, NRC staff has issued a RAI regarding Boron Dilution after the loop seal clearing during a SBLOCA. Staff was made aware that KHNP responded to similar questions from KINS and documented in Korea SSAR Chapter 6 Appendix 6. Staff would like to discuss with KHNP about the analysis and the testing results supporting similar issue resolutions. (**See attachment**)

### b. Core PCT

NRC staff also would like to discuss the path forward regarding core PCT increase during SBLOCA loop seal formation. In particular, we would like to discuss the following sub-topics:

a. ATLAS loop seal formation/clearing test data
b. RELAP 5 code/model benchmark
c. CEFLASH code usage justification

## B. Section 15.4-Related Safety Analysis

(Matt Thomas)

a. Rod Withdrawal Analysis

The staff reviewed the applicant's response to RAI 346-8434, Question 15.04.02-1 and noted the applicant stated that the analyses for examining the full range of power levels and reactivity insertion rates shall be performed in the COLSS/CPCS setpoint analysis stage for the real plant; "hence, the results and documentations for a sensitivity analysis on ranges of power levels and reactivity insertion rates are not available at this time." GDC 10 requires the core and associated coolant, control, and protection systems to be designed with appropriate margin to assure that SAFDLs are not exceeded during any condition of normal operation, including the effects of AOOs. GDC 20 requires 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. Section 15.4.2 of the Standard Review Plan provides guidance to the staff on how to make the safety finding for the APR1400 DC regarding GDC 10 and 20. It includes reviewing the entire power range from low to full power and the allowed extreme range of reactor conditions during the operating cycle, including rod configurations, power distribution, and associated reactivity feedback components. It also includes reviewing the full range of rod or bank withdrawals, up to maximum rod or bank worths and rates of reactivity addition. The reviewer is guided to verify that these ranges of conditions have been examined and that the most limiting case has been analyzed. At this time, the staff is unable to make a safety finding regarding GDC 10 and 20 for DCD 15.4.2 because the applicant has not provided an analysis of the full range of power level and the full range of rates of reactivity addition. The staff asks the applicant to supplement the

RAI response addressing how the APR1400 is in compliance with GDC 10 and 20 with additional analyses and/or justifications.

### b. Rod Insertion Analysis

The staff reviewed the applicant's response to RAI 347-8435, Question 15.04.03-1 and noted the applicant stated "all possible single CEA drop simulations for all combinations of initial CEA configurations at different cycle conditions were performed." However, the applicant also stated that "12-finger CEA drops have not been evaluated, but will be in future analyses." GDC 10 requires the core and associated coolant, control, and protection systems to be designed with appropriate margin to assure that SAFDLs are not exceeded during any condition of normal operation, including the effects of AOOs. GDC 20 requires 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. Section 15.4.3 of the Standard Review Plan provides guidance to the staff on how to make the safety finding for the APR1400 DC regarding GDC 10 and 20. It guides the reviewer to verify that the cases which result in a limiting fuel rod condition should be presented by the applicant. It provides guidance regarding reviewing the application to ensure conditions such as power level and distribution, initial rod configuration, reactivity addition rate, and reactivity feedback coefficients are chosen appropriately and justified with sensitivity analyses or discussion. The staff seeks clarification regarding if the applicant has completed 12-finger CEA drop analyses. The staff asks the applicant to supplement the RAI response with justification and/or analyses showing why the 4-finger drop analysis presented in DCD 15.4.3 is more limiting than a 12-figure drop.

## C. Vessel Fluence Method Benchmark

COL Information Item 5.3(2) in DCD, Tier 2 requires the COL applicant to develop P-T limit curves based on plant-specific data. However, the staff notes that a COL holder should perform plant-specific benchmarking when surveillance capsule data becomes available to demonstrate the applicability of the fluence methodology in APR1400-Z-A-NR-14015-P, Rev. 0. For example, in an RAI regarding the U.S. EPR design (ADAMS Accession No. ML101600032), NRC staff requested that a COL information item be added to the U.S. EPR DCD for collection of plant specific surveillance capsule data to be used to benchmark the applicability of the fluence calculation methodology to the specific plant.

## ATTACHMENT

## Boron Dilution Following SBLOCA

### 1) REGULATORY BASIS

Title 10 of the Code of Federal Regulations, Part 50, Appendix A, General Design Criterion (GDC) 28—*Reactivity limits* requires that the reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents 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. These postulated reactivity accidents shall include consideration of rod ejection (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold water addition.

### 2) DESCRIPTION OF ISSUE

Generic Safety Issue (GSI) 185 (Control of Recriticality Following SBLOCAs) concerns the potential return to criticality following a small break LOCA due to insertion of unborated water in the core as a result of restoration of natural circulation or restart of a reactor coolant pump. The unborated water results from condensed steam from the steam generator tubes collecting in the loopseal piping. As noted in DCD, Tier 2 Table 15.0-12, GSI-185 was resolved, and consequently, no analysis was performed for the APR1400.

The basis for closure was an analysis performed for an operating B&W plant which was believed to be bounding for Westinghouse and C-E plants (including the System 80+) due to unique B&W plant loopseal arrangement relative to the core.

### 3) REQUEST

Because of the higher reactor power of the APR1400 compared with the System 80+ and larger heat transfer surface area, as well as differences in loopseal volume, the staff cannot make the same qualitative conclusion for the APR1400 without an analysis. Therefore, demonstrate by analysis that a return to criticality cannot occur following a SBLOCA.