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.:	**327-8354**
SRP Section:	**06.02.01.01.A – PWR Dry Containments, Including Subatmospheric Containments**
Application Section:	**6.2.1.1 Containment Structure**
Date of RAI Issue:	**12/03/2015**

Question No. 06.02.01.01.A-4

Containment Initial and Boundary Conditions for the LOCA Analyses

General Design Criteria (GDC) 50, “Containment design basis”, and GDC 16, “Containment design”, of Appendix A to 10 CFR Part 50 require, in part, that the reactor containment structure and associated heat removal system shall be designed with sufficient margin to accommodate the calculated pressure and temperature conditions resulting from any loss-of-coolant accident (LOCA). NUREG-0800, SRP Section 6.2.1.1A, Acceptance Criterion No. 1 specifies that the containment design pressure should provide at least a 10% margin above the accepted peak calculated containment pressure following a LOCA, or a steam line or feedwater line break, to satisfy the GDC 16 and 50 requirements for sufficient design margin. In addition, ANSI/ANS 56.4-1983, which has established detailed guidelines for containment response to design basis accidents, specifies that initial conditions should be chosen to yield a conservatively high peak containment atmosphere pressure and temperature. In selecting the initial dry primary containment atmospheric conditions and structural temperatures, consideration should be given to the competing effects of the initial air mass and the active and passive heat sink thermal capacities.

In this backdrop, the staff seeks the following additional information to gain safety insights into the initial and boundary conditions the applicant used for the limiting LOCA analysis for the containment. The applicant is also requested to update the APR1400 DCD and/or the Technical Report (TeR), “LOCA Mass and Energy Release Methodology,” APR1400-Z-A-NR-14007-P, Rev.0, to appropriately document the respective explanations.

The initial containment atmosphere temperature is an important parameter such that its upper value constitutes a technical specification. The initial atmosphere temperature not only affects the containment response to a design basis LOCA but also other aspects of the accident such as the safety injection water temperature from safety injection tanks (SITs). As discussed in Appendix C of the TeR, “Case studies for modeling characteristics”, and given in Table C-1A, the

maximum containment temperature is 120 °F beyond which the limiting conditions for operation apply. An instrument uncertainty of 5 °F is commonly used by the industry in containment response analysis. If the value listed in Table C-1A includes an instrument uncertainty then the initial atmosphere temperature of 115 °F would not be conservative; and if it doesn't, then an initial atmosphere temperature of 125 °F should have been used for all the analyses. Please explain whether the containment initial atmosphere temperature is based on the typical value commonly used in the containment response analysis or obtained from an energy balance analysis for the reactor coolant system (RCS) heat loss versus fan coolers heat removal.

Response

When selecting conservative initial temperature, the competing effects of the initial air mass and capability of heat absorption of the passive heat sinks for lower and upper bounding temperatures were taken into consideration. The higher temperature makes lesser air density, which results in a slight decrease in atmospheric pressure following the accident, and vice versa for the lower temperature. The upper bounding temperature was chosen as the initial containment temperature for the APR1400 containment response analyses. The value of 120 °F in Table C-1A is chosen from the temperature limiting conditions for operation (LCO) of the Technical Specification (TS) 3.6.5 that describes "the containment average air temperature shall be less than 49 °C (120 °F)". No uncertainty in the initial atmosphere temperature is assumed.

The APR1400 containment HVAC system is designed to maintain the average containment atmosphere temperature at a value no greater than the LCO upper temperature. The heat removal capacity of the containment HVAC system is determined from the energy balance between the maximum estimated RCS heat loss during normal operating conditions and the RCFC heat removal rate, with appropriate margin. The HVAC system is designed to be continually operated during normal conditions, not operated intermittently by temperature instruments and controls. Thus, the actual average containment atmosphere temperature is ensured not to exceed the LCO limit by the HVAC heat removal capacity without regard to the instrument uncertainty.

Since the actual average air temperature is ensured not to excess the LCO, the maximum value of 120 °F within the LCO range is chosen as the most conservative initial temperature in calculating the APR1400 containment peak pressure and temperature.

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

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

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Question No. 06.02.01.01.A-7

In Section A.2.3.1 of the TeR, it is stated that “The containment free volume is calculated by subtracting the volume occupied by equipment inside containment from the gross volume calculated from the building dimensions.” The section tabulates the containment atmosphere design value and the value used for LOCA that is conservatively smaller. Please clarify the basis for the uncertainty that was applied to estimate the containment free volume for vapor expansion. This will demonstrate the level of conservatism exercised in the analysis.

Response

The design value (3,172,175 ft3) presented in the containment atmosphere table in Section A.2.3.1 of the TeR is the estimated minimum containment free volume which considers volume uncertainties due to complex shapes and dimensions of internal structures and components in the containment building.

A containment free volume which is smaller than the design value (3,172,175 ft^3) is used in the containment pressure and temperature analysis for additional conservatism. The containment free volume was determined by subtracting approximately 1.4 percent of the design value to account for the small variance of containment free volume due to the changing of components or structural dimension changes that may be caused by design and construction improvements.

The additional margin (-1.4 percent) applied to the containment free volume increases the containment peak pressure and temperature by 0.5 psi and 0.6 °F, respectively.

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

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

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Question No. 06.02.01.01.A-8

Please explain whether heat transfer to the containment basemat is credited or is conservatively ignored.

Response

As described in Section A.2.3.3 and Table A-3A of Appendix A to “LOCA Mass and Energy Release Methodology” (APR1400-Z-A-NR-14007-P, Rev.0), the surface of the containment floor, including the basemat, is assumed to be insulated. Heat transfer to the containment basemat is conservatively neglected.

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

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