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.:	**114-8041**
SRP Section:	**03.04.01 – Internal Flood Protection for Onsite Equipment Failures**
Application Section:	**3.4.1**
Date of RAI Issue:	**07/27/2015**

Question No. 03.04.01-3

DCD Tier 2, Sections 3.4.1.3 and 3.4.1.5 identify the in-containment flooding sources as coming from a loss of coolant accident (LOCA) or from a break in the fire protection system. The applicant states that the worst-case flooding event is a double-ended discharge leg LOCA with the minimum safety injection because it results in the most limiting flooding source for the reactor containment building.

The applicant is requested to provide the following information relating to the determination of the worst case:

a) Provide a comprehensive explanation of the calculation method for using “maximum break”, instead of “maximum flood water volume” to determine the worst case flooding event. In general, flood level is determined by the water volume. Provide design requirements (such as the drain capability) and the basis to support the method being used by APR1400.

b) Explain the basis for the determination of the worst case being LOCA with duration of 50 second. It should be noted that LOCA has higher peak flow but drops quickly lasting much longer than 50 second, while fire protection water could leak indefinitely without isolation resulting in larger volume of flood water. If isolation is used, provide the design basis and justifications.

c) Explain how other in-containment water sources (such as main feedwater line, main steam line, auxiliary feedwater system, shutdown cooling system, component cooling system, safety injection tank (SIT), and other water carrying piping) compare against the worst case LOCA?

Response

a) Flood height at the bottom level of containment is determined by the maximum flood water volume and flood area; whereas, flood height of the containment upper level is determined by comparing inflow and outflow rates through openings and drainage paths. Flood height of the reactor containment building is based on the maximum flood water volume of a LOCA occurring during the initial 50 seconds of the accident. DCD Tier 2, Subsection 3.4.1.5.1 will be revised to change the term from 'break flow' to 'flood water volume'.

b) For a postulated LOCA event, most of the water is released into containment within the first 50 seconds based on analysis. For conservatism, the entire volume released is taken to accumulate at El.100 ft of containment with no drainage to the HVT at a lower elevation. This volume corresponds to a flood level in containment of 2 ft. After 50 seconds, the outflow rate of water is greater than the inflow rate such that 2 ft is the maximum flood level height.

   Though flooding events from large water volumes such as the fire protection system could leak water at a lower rate, but for a substantially longer time, KHNP has determined this not to be the worst case flooding scenario. Adequate flood protection measures, including operator actions, can be taken to identify and isolate any indefinite flood source. The reactor containment is equipped with safety related level instruments at El.106 ft 3 in that can measure level from 100 ft 4 in to 102 ft 10 in and provides indication to the control room. Operating procedures would provide guidance based on abnormal indications and alarms to identify the source of the leakage. Actions can then be taken to isolate the leak.

   The fluid flow rate of fire protection system due to a through-wall crack is calculated to be 0.0116m^3/sec (0.41ft^3/sec). The postulated through-wall crack is based on a circular opening of area equal to that of a rectangle, one half pipe diameter in length, and one half pipe wall thickness in width. The time that it would take to flood containment up to 0.61 m (2 ft) height from the El.100 ft (e.g., that flood height calculated for the LOCA case) is 36.5 hours. This time is considered to be more than sufficient time for operators to identify and isolate the fire protection system in a flooding event.

   Since operator action is taken credit for in the identification and isolation of fire water sources, DCD Tier 2 Subsection 3.5.1.5.1 will be revised to describe isolation of flood sources that could have a larger volume and credit taken for operator action.

c) Flooding sources inside the reactor containment building other than the reactor coolant system include main feedwater, auxiliary feedwater, component cooling water, fire protection and the chemical and volume control systems. With respect to flow rate, the LOCA case has the largest flow rate compared to the other piping system failures. Outflow rate to the HVT at 2 ft water level (El.102 ft) is about 136 ft^3/sec. Total water volume to be reserved in the air space (under El.102 ft) is approximately 55,000 ft^3. The CV, CC, and SD systems are bounded by LOCA in terms of instantaneous break flow rate and the total floodable water volumes of these systems are less than 55,000 ft^3.

An AF line break downstream of the check valve is bounded by the FW break case. For the FW line break case, the total runout flow rate of the three main feedwater pumps is estimated to be about 190 ft^3/sec. To fill the floodable volume of 55,000 ft^3, it would take about 289 seconds (4.8 minutes).

From DCD Tier 2, Table 15.2-8-2, the main feedwater isolation valves located outside containment will be closed in approximately 168 seconds (2.8 minutes) in the feedwater line break event. Outflow through the break area can be stopped before discharged water volume reaches the 2 ft flood level from containment El.100 ft. Therefore, the FW line break case is also bounded by the LOCA event.

Water volumes of high- and moderate- piping systems inside reactor containment building are summarized in Table 1.

Table 1. Water sources inside reactor containment building

System	Total water volume	Piping failure flow rate	Energy line
RC(LOCA)	15,036 ft^3 (112,480 gal)	2,100 ft^3/sec	High-energy line
SD	11,396 ft^3 (85,246 gal)	15 ft^3/sec	High-energy line
AF	81,763 ft^3 (611,627 gal)	68 ft^3/sec	High-energy line
FW	65,301 ft^3(488,477 gal)	190 ft^3/sec	High-energy line
CV	42,978 ft^3 (321,500 gal)	28 ft^3/sec	High-energy line
CC	26,736 ft^3 (200,000 gal)	<1 ft^3/sec	Moderate-energy line
FP	116,302 ft^3 (870,000 gal)	<1 ft^3/sec	Moderate-energy line
SI[1)]	N/A	N/A	High-energy line
SC[1)]	N/A	N/A	High-energy line

Note:

1) These systems are included in RCS boundary and therefore the water volume and flow rate are enveloped by the LOCA case.

Impact on DCD

DCD Tier 2, Subsection 3.4.1.5.1 will be revised as indicated in the attached markup.

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 Reports

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

maximum

The worst-case flooding event is a double-ended discharge leg LOCA with the ~~minimum~~ SIP flow, because it results in maximum ~~break flow~~ to the reactor containment building as a flooding source.

flood water volume

Operator action is credited for identification and isolation of flood sources that could result in larger volumes to containment than a worst case LOCA.

Discharged water first fills up the volume below elevation El. 100 ft 0 in. and then spreads the volume above the grade level of the reactor containment building. Water released by a LOCA is collected in the IRWST through the floor opening. It then flows back to the reactor coolant system or is sprayed into the containment and recirculated.

The total discharged volume of double-ended discharge leg break of a LOCA is 425.7 m^3 (15,036 ft^3). The net floodable volume under El. 100 ft 0 in., including volume of air space of IRWST 753 m^3 (26,592 ft^3), holdup volume tank 242.3 m^3 (8,557 ft^3), and normal sump 6.7 m^3 (237 ft^3) is 1,002 m^3 (35,385 ft^3). The total discharged water volume due to LOCA is smaller than the total floodable volume.

The flood water level is determined as 0.61 m (2 ft) above El. 100 ft 0 in. The maximum flood level of containment does not affect safety-related equipment. There are no submerged SSCs required for safe shutdown. Table 3.4-1 provides a list and the locations of SSCs inside the reactor containment building that require flood protection. These SSCs are located above the maximum internal flood level.

3.4.1.5.2 <u>Auxiliary Building</u>

The auxiliary building is designed to provide physical separation to prevent spreading of fluids to the areas housing safety-related equipment and components.

<u>Elevation 55 ft 0 in</u>

The primary means of flood protection is the divisional or quadrant walls, which serve as flood barriers between redundant trains of safe shutdown systems and components. Flood barriers provide separation between the quadrants, while maintaining equipment removal capability.

On the divisional wall, penetrations are sealed and no doors are provided up to El. 64 ft 0 in., which is the potential flood level from the bottom elevation. Watertight doors are