REVISED 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. 03.04.01-6

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

During the audit review of the calculations, the staff found in Containment Flooding Analysis (1-035-N385-001), Table 2 (Sheet 9 of 41) that the non-safety drainage system appears to be taking credit for the determination of flood levels.

The applicant is requested to address the following concerns relating to the use of non-safety drainage system in the internal flood protection:

a) Table 2 lists drain discharge (gpm) vs. depth of water (in.) up to 6 inch. What is the drain discharge flow for the flood level of 2 ft? Provide the basis for the determination.

b) How many drains are required to perform the function in each of the flood areas?

c) Specify and justify the required functional capability of the drainage system in the DCD.

d) A failure of the drainage system may prevent a safety-related system to perform its safety function. A failure modes and effects analysis should be provided in the DCD, in accordance with SRP Section 3.4.1, Subsection III.4.

e) The drainage system, as described in DCD Section 9.3.3, does not appear to recognize this safety function. Clarify this safety function and seismic classification in the DCD, including Section 9.3.3 and Table 3.2-1.

f) This functional capability should be tested and maintained throughout the life of the plant. The DCD should include information on initial testing, ITAAC, programmatic control for this system function.

g) The potential clogging of the drain path due to debris (resulting from dynamic forces or left behind in the building due to previous activities) is a plausible event and needs to be addressed in the DCD.

Response – (Rev. 1)

a) Table 2 is based on the NFPA Fire Protection Handbook and is applicable to floor drains having a configuration that of a scupper. Discharge flow through the floor drains is not credited in the calculation of flood level of the reactor containment building for a conservative approach. The released water volume from a LOCA is considered to be the calculated flood height in the containment building.

b) The information on the drainage systems which are used in the flood calculation of the auxiliary building will be incorporated in Table 3.4-2 as submitted in the response to RAI 114-8041 Question 03.04.01-1 (ref. KHNP submittal MKD/NW-15-0201L dated October 20, 2015; ML15293A483).

c) The functional capability of the equipment and floor drainage system (EFDS) is to drain the flooded water to the sump located in the lowest elevation of the building. Although the piping of the drainage system is classified as seismic Category II, it is embedded into the concrete of seismic Category I structures, such as the reactor containment building and auxiliary building. Therefore, the integrity of the embedded piping is practically assured since the floors and/or walls that contain the piping in the seismic Category I buildings remains intact and the intended function of drainage system can be accomplished. Additionally, procedures and administrative controls to prevent clogging of the floor drains are to be established by the COL applicants. The DCD will be revised to clarify the functional capability of the drain system.

d) A failure of the EFDS would not prevent a safety related system from performing its safety function for the following reasons:

- Drain paths of the EFDS do not have any active components that would require an evaluation of the effects of their failure. Therefore, a failure modes and effects analysis is not necessary to demonstrate the capability of a safe shutdown using the drain paths of the EFDS in a flood event. The EFDS containment isolation valves and the associated piping are designed as safety related.

- The piping system of the drainage systems is designed in accordance with a divisional and quadrant separation concept in the buildings. Divisional and quadrant separation of flood barriers protect each quadrant against propagation of flood water from one quadrant to another. Flooded water in a quadrant will be collected in the bottom sump of the auxiliary building by gravity. The sumps have enough capacity to hold flooded inventory within a quadrant without pumping the accumulated water to liquid treatment systems. Appropriate operator actions are necessary in cases of large inventory flood events, such as a fire protection system piping failure.

- A postulated failure of a drainage system drain path does not affect the safe shutdown function due to redundancy and diversity in the design of essential systems and components needed for safe shutdown.

e) The drainage system does not have any safety functions other than the containment isolation safety function as described in DCD subsection 9.3.3. Drainage system drain paths are classified as non-safety related and seismic Category II. Clarification of the function and classification of the drainage system is described in DCD Tier 2 Table 3.2-1 and subsection 9.3.3.1.2.

f) The plant initial test to verify the functional capability of drain paths is not required due to the passive component feature of the embedded piping. System flushing to ensure adequate drainage after construction will be performed as part of system turnover to the operating licensee. To ensure that the functional capability and availability of the drain system is maintained throughout the life of the plant, the COL applicant is to establish procedures and programmatic controls. The DCD will be revised to incorporate a COL Item to address this issue.

g) The potential blockage of drain paths is not an issue in terms of draining the discharged water to the sump due to a high energy line break (HELB) in the reactor containment building because floor drains are conservatively not credited (i.e., assumed to be entirely blocked) in the calculation. The areas where high energy line breaks are postulated in the auxiliary building have large emergency flood relief paths to discharge the flooded water out of the auxiliary building. Floor drains are not credited for those HELB areas in the flooding analysis; thus, potential clogging of the drainage system does not impact on the results of the flood height in the HELB areas. The DCD will be revised to state that the floor drains are conservatively assumed to be clogged due to debris resulting from dynamic forces in the HELB areas.

Impact on DCD

DCD Tier 2, Section 3.4.1.3 and Table 1.8-2 will be revised as indicated in the Attachment.

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 Report.

are sealed on the inside of the penetration to eliminate the potential of flooding through the penetration. The penetration seals are periodically inspected to ensure their functionality.

3.4.1.3 Flood Protection from Internal Sources

The APR1400 arrangement provides physical separation of redundant safety-related SSCs. The flood protection mechanisms related to minimizing the consequences of internal flooding include the following:

a. Structural enclosures or barrier walls

b. Drainage systems

c. Emergency sump

d. Internal curbs or ramps

e. Watertight doors

The functional capability of equipment and floor drainage system is maintained because the piping of the drainage system is designed as seismic Category II and embedded into the concrete of seismic Category I structures such as reactor containment building and auxiliary building.

The APR1400 minimizes penetrations through enclosures or barrier walls below the flood level. Enclosures and barrier walls below the flood level are sealed to maintain watertightness. Barrier walls, floors, and penetrations are designed to withstand the maximum anticipated hydrodynamic loads associated with a pipe failure, as described in Section 3.6.

Divisional and quadrant separation by flood barriers with watertightness is provided for internal flood protection. Each quadrant is protected against propagation of internal flood event from one quadrant to any other.

floor

The ~~flood~~ drainage systems are separated by quadrants with no common drain lines between the quadrants. Floors are gently sloped to allow for good drainage to the quadrant sumps.

The COL applicant is to establish procedures and programmatic controls to ensure the availability of floor drainage (COL 3.4(10)).

The safety-related equipment and components are elevated above the flood level so that flooding events do not affect components. Therefore, the electrical equipment and related cubicle cooler are not flooded.

Elevation 120 ft 0 in

Flood water above El. 120 ft 0 in. drains to the lower elevation through floor drains, stairwells, and openings. To avoid flooding adjacent quadrants, a curb or ramp is installed at each quadrant intersection. The emergency diesel generator is separated by distance and protected by flood barriers. The radiation control area is also separated by flood barriers.

The equipment to be protected from flooding at El. 120 ft 0 in includes the Class 1E motor control center, related cubicle coolers, safety injection containment isolation valves, and AF modulating valves.

The following potential flooding sources are considered:

a. A postulated pipe failure of a moderate-energy line is considered.

b. A high-energy line break is considered for the 0.10 m (4 in) steam generator blowdown system line.

c. There is no break of non-seismic moderate-energy piping because piping in the auxiliary building is designed as seismic Category I or II.

d. Firefighting equipment represents internal flooding sources from at least the nearest two fire hose stations that could reach the fire zone. The discharge rate for firefighting equipment is assumed to be 0.044 m^3/s (700 gpm).

Based on flooding sources, the worst-case flooding scenario is the HELB of a 0.10 m (4 in) steam generator blowdown system line. The flood relief opening is installed toward the outside to remove flood water. A watertight door is installed to protect against spreading flood water to adjacent areas in the steam generator blowdown regenerator heat exchanger room.

The floor drains are conservatively assumed to be clogged due to debris resulting from dynamic forces in the high-energy line break areas.

A rupture of a feedwater system line is the worst case of flooding for the main steam valve room. The cross-section area of the break is based on 0.09 m^2 (1.0 ft^2), as defined in Standard Review Plan, Branch Technical Position 3-3 (Reference 6). In addition, a main feedwater pump is assumed to operate at the maximum flow rate. The floor drains are conservatively assumed to be clogged due to debris resulting from dynamic forces in the high- energy line break areas. An emergency flood relief path is installed to drain out at each room. The potential flood level is 1.82 m (6 ft) above El. 137 ft 6 in. and the safety valves are located above the flood level, so these valves are not flooded.

In other areas except the main steam valve room, the fire suppression system is considered a flooding source. The flood water is drained to lower elevations through the drain system and openings. The potential flood level at this elevation is assumed as 0.15 m (6 in).

The safety-related equipment and components are elevated above the flood level. Therefore, the Class 1E motor control center, switchgear, and remote shutdown panel are not flooded.

<u>Elevation 156 ft 0 in</u>

Flood water above El. 156 ft 0 in drains to the lower elevation through the floor drain and stairwells.

The equipment to be protected from flooding at El. 156 ft 0 in includes I&C equipment, cubicle coolers, and the console in main control room. The main control room area is protected from flooding in that no water lines are routed above or through the control room or computer room. Water lines routed to HVAC air handling units around the control room are contained in rooms with curbs that preclude the potential for water leakage from entering the control room or computer room.

The following potential flooding sources are considered:

a. A postulated pipe failure of a moderate-energy line is considered.

b. A high-energy line break is not considered because there is no piping break in this area.

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3.4.3 Combined License Information

COL 3.4(1) The COL applicant is to provide site-specific information on protection measures for the design basis flood, as required in Subsection 2.4.10.

COL 3.4(2) The COL applicant is to provide flooding analysis with flood protection and mitigation features from internal flooding for the CCW Heat Exchanger Building and ESW Building.

COL 3.4(3) The COL applicant is to confirm that the potential site-specific external flooding events are bounded by design basis flood values or otherwise demonstrate that the design is acceptable.

COL 3.4(4) The COL applicant is to identify any site-specific physical models that could be used to predict prototype performance of hydraulic structures and systems.

COL 3.4(10) The COL applicant is to establish procedures and programmatic controls to ensure the availability of the floor drainage .

3.4.4 References

1. Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," Rev. 2, U.S. Nuclear Regulatory Commission, August 1977.

2. ANSI/ANS 2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites," American Nuclear Society, 1992.

3. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," Rev. 1, Nuclear Regulatory Commission," September 1976.

4. ANSI/ANS 56.10-1987, "Subcompartment Pressure and Temperature Transient Analysis in Light Water Reactors," American Nuclear Society, 1987.

5. ANSI/ANS 56.11-1998, "Design Criteria for Protection against the Effects of Compartment Flooding in Light Water Reactor Plants," American Nuclear Society, 1988.

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Table 1.8-2 (3 of 29)

Item No.	Description
COL 3.4(1)	The COL applicant is to provide site-specific information on protection measures for the design-basis flood, as required in Subsection 2.4.10.
COL 3.4(2)	The COL applicant is to provide flooding analysis with flood protection and mitigation features from internal flooding for the CCW Heat Exchanger Building and ESW Building.
COL 3.4(3)	The COL applicant is to confirm that the potential site-specific external flooding events are bounded by design-basis flood values or otherwise demonstrate that the design is acceptable.
COL 3.4(4)	The COL applicant is to identify any site-specific physical models that could be used to predict prototype performance of hydraulic structures and systems.
COL 3.5(1)	The COL applicant is to provide the procedure for heavy load transfer to strictly limit the transfer route inside and outside containment during plant maintenance and repair periods.
COL 3.5(2)	The COL applicant is to perform an assessment of the orientation of the turbine generator of this and other unit(s) at multi-unit sites for the probability of missile generation using the evaluation of Subsection 3.5.1.3.2 to verify that essential SSCs are outside the low-trajectory turbine missile strike zone.
COL 3.5(3)	The COL applicant is to evaluate site-specific hazards induced by external events that may produce more energetic missiles than tornado or hurricane missiles, and provide reasonable assurance that seismic Category I and II structures are designed to withstand these loads.
COL 3.5(4)	The COL applicant is to evaluate the potential for site proximity explosions and missiles due to train explosions (including rocket effects), truck explosions, ship or barge explosions, industrial facilities, pipeline explosions, or military facilities.
COL 3.5(5)	The COL applicant is to provide justification for the site-specific aircraft hazard and an aircraft hazard analysis in accordance with the requirements of NRC RG 1.206.
COL 3.6(1)	The COL applicant is to identify the site-specific SSCs that are safety related or required for safe shutdown that are located near high- and moderate-energy piping systems and that are susceptible to the consequences of piping failures.
COL 3.6(2)	The COL applicant is to provide a list of site-specific high- and moderate-energy piping systems including layout drawings and protection features and the failure modes and effects analysis for safe shutdown due to the postulated HELBs.
COL 3.6(3)	The COL applicant is to confirm that the bases for the LBB acceptance criteria are satisfied by the final as-built design and materials of the piping systems as site-specific evaluations, and is to provide the information including LBB evaluation report for the verification of LBB analyses.
COL 3.6(4)	The COL applicant is to provide the procedure for initial filling and venting to avoid the known causes for water hammer in DVI line.
COL 3.7(1)	The COL applicant is to determine the site-specific SSE and OBE that are applied to the seismic design of the site-specific seismic Category I and II SSCs and the basis for the plant shutdown. The COL applicant is also to verify the appropriateness of the site-specific SSE and OBE.
COL 3.7(2)	The COL applicant is to confirm that the horizontal components of the SSE site-specific ground motion in the free-field at the foundation level of the structure satisfy a peak ground acceleration of at least 0.1 g.

COL 3.4(10) The COL applicant is to establish procedures and programmatic controls to ensure the availability of the floor drainage.