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.:	**75-8023**
SRP Section:	**3.4.2 - Analysis Procedures**
Application Section:	**3.4.2**
Date of RAI Issue:	**07/15/2015**

Question No. 03.04.02-1

10 CFR 52.47 requires, in part, that the applicant's final safety analysis report (FSAR) must include sufficient information to allow NRC to make a final safety finding. In addition, GDC 2 requires that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions as it relates to natural phenomena. The design bases for these SSCs shall reflect appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena.

During the review of Section 3.4.2 "Analysis Procedures," the staff found that the applicant did not provide a clear description on how the water heads transform into hydrostatic and hydrodynamic loadings on seismic Category I structures as per "areas of review" specified in SRP 3.4.2, Section I.2. In the first paragraph of the section, the applicant only makes a brief description at a high level of detail, and refers more details to Section 3.8. In accordance with 10 CFR 52.47 and GDC2, the applicant is requested to address following issues in Section 3.4.2 of the DCD:

a. Provide design input from all sources of water heads including but not limited to: (i) design basis flood level, Table 2.0-1; (ii) maximum ground water level, Table 2.0-1; (iii) PMWP, Table 2.0-1; (iv) maximum precipitation rate, Table 2.0-1; (v) probable maximum water level, PMF and PMP described in Sec. 2.4.

b. How are those various water heads transformed into hydrostatic or hydrodynamic loadings (including buoyant forces)? [such as hydrostatic load, (L_h), Flooding load,(Y_f), Design flood/precipitation, (H), PMF/PMP, (H_s). Hydrodynamic load in seismic loads (E_s)—See Sec. 3.8.4.3.and Table 3.8-9A, Footnote (2)]

c. How are those effective loadings being classified into various categories of loadings such as normal load, abnormal load, severe environmental load or extreme environmental load? Note that assignment to a proper class of loading will assure correct load combinations for the design input in compliance with the code specifications.

d. How are those loadings applied in the design of seismic Category I structures?

Response

a. The requested design input sources are provided as follows:

(i) Design Basis Flood Level in Table 2.0-1

According to Table 1.2-6 of EPRI Advanced Light Water Reactor (ALWR) Utility Requirements Document (URD) (Reference 1), maximum flood elevation is determined to be 0.30 m (1 ft) below plant grade in the vicinity of the SSCs important to safety.

(ii) Maximum Groundwater Level in Table 2.0-1

According to Table 1.2-6 of EPRI Advanced Light Water Reactor (ALWR) Utility Requirements Document (URD) (Reference 1), maximum groundwater level is determined to be 0.61 m (2 ft) below plant grade in the vicinity of the SSCs important to safety.

(iii) PMWP in Table 2.0-1

Probable Maximum Winter Precipitation (PMWP) in the U.S. can be obtained from Hydro Meteorological Reports (HMRs) of U.S. Department of Commerce, National Oceanic and Atmosphere Administration (NOAA).

Based on Figures 26, 27, 35, 36, 37 and 45 of HMR-53 (Reference 5), the maximum 48-hour probable maximum winter precipitation of the U.S. is calculated by averaging and comparing the 24-hour and 72-hour probable maximum precipitations during the winter season (December through March).

The 48-hour probable maximum winter precipitation for the APR1400 is determined to be 914.4 mm (36 in.) which bounds the U.S..

(iv) Maximum Precipitation Rate in Table 2.0-1

Based on the HMRs, the Probable Maximum Precipitation (PMP) for 1-hour over 1 mi^2 in each HMR is identified as shown in Table 1 below.

Table 1. Probable Maximum Precipitation from HMRs

HMR No.	PMP (in) [for 1-hour over 1 mi^2]
58 (Reference 9), 59 (Reference 10)	12.0
57 (Reference 8)	10.2
56 (Reference 7)	18.2
55a (Reference 6)	13.0
51 (Reference 3), 52 (Reference 4), 53 (Reference 5)	19.4
49 (Reference 2)	12.5

Therefore, the Maximum Precipitation Rate of 1-hour over 1 mi^2 is determined to be 19.4 in. (492.7 mm) which is the highest value in the U.S..

Based on Figure 24 and 36 of HMR-52 (Reference 4), the Maximum Precipitation Rate of 5-min. over 1 mi^2 is determined to be 6.2 in. (157 mm).

(v) Probable Maximum Water Level, PMF and PMP in Section 2.4

As mentioned in item (i) above, the Probable Maximum Water Level is 0.30 m (1 ft) below plant grade in the vicinity of the SSCs important to safety as referenced in the EPRI URD (Reference 1).

As mentioned in item (iv) above, the PMP values over 1 mi^2 in Table 2.0-1 are determined to be 492.7mm (19.4in.) over 1 hour and 157mm (6.2in.) in 5 minutes referring to the applicable HMRs.

Probable Maximum Flood (PMF) is site-specific hydrologic information which is to be provided by the COL applicant.

b. The hydrostatic loading is calculated as linearly distributed pressure on external walls depending on the design water level according to the basic equation of hydrostatics. The dynamic groundwater pressure is calculated based on the hydro-dynamic formula suggested by Matsuo and O'Hara which can be found in "Principles of Soil Dynamics" written by Braja M. Das. Based on the hydro-dynamic formula, the hydrodynamic water pressure due to seismic load is expressed as a parabolic distributed pressure. In addition, the buoyancy load (taken as a uniform pressure corresponding to the design water level) has been applied to the bottom of the basemat for all loading condition. The buoyant force, a force that acts in the direction opposite to the gravitational force, is the weight of the water displaced by the building.

c. The effective loadings are classified as follows:

- Hydrostatic load(L_h) : normal load

- Flooding load,(Y_f) : abnormal load
- Design flood/precipitation(H) : severe environmental load
- PMF/PMP(H_s), Hydrodynamic load in seismic loads (E_s) : extreme environmental load.

This classification complies with ACI 349 Chapter 9 specifications.

d. These loadings are used as design inputs for the load combinations in designing the seismic Category I structures. For the reactor containment building, the load combinations of Table 3.8-2 are used and for the other seismic Category 1 structures, the load combinations specified in Table 3.8-9A are used.

In addition to the design load combinations, the acceptance criteria for the stability of seismic Category I structures are checked in accordance with Table 3.8-10 of the APR1400 DCD. The buoyant forces of normal and flood conditions are considered in the stability check of overturning, sliding, and flotation as shown in Table 3.8-10.

References

1) EPRI ALWR Utility Requirement, Volume II, Electric Power Research Institute (EPRI), 2008

2) Hydrometeorological Report No. 49, “Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages”, U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), Reprinted 1984.

3) Hydrometeorological Report No. 51, “Probable Maximum Precipitation Estimates, United States East of the 105th Meridian”, U.S. Department of Commerce, NOAA, June 1978.

4) Hydrometeorological Report No. 52, “Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian”, U.S. Department of Commerce, NOAA, August 1982.

5) Hydrometeorological Report No. 53, “Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian”, U.S. Department of Commerce, NOAA, April 1980.

6) Hydrometeorological Report No. 55A, “Probable Maximum Precipitation Estimates - United States Between the Continental Divide and the 103rd Meridian”, U.S. Department of Commerce, NOAA, June 1988.

7) Hydrometeorological Report No. 56, “Probable Maximum and TVA Precipitation Estimates with Areal Distribution for Tennessee River Drainages Less Than 3,000 Mi2 in Area”, U.S. Department of Commerce, NOAA, October 1986.

8) Hydrometeorological Report No. 57, “Probable Maximum Precipitation - Pacific Northwest States Columbia River (including portions of Canada), Snake River and Pacific Coastal Drainages”, U.S. Department of Commerce, NOAA, October 1994.

9) Hydrometeorological Report No. 58, “Probable Maximum Precipitation for California – Calculation Procedures”, U.S. Department of Commerce, NOAA, October 1998.

10) Hydrometeorological Report No. 59, “Probable Maximum Precipitation for California”, U.S. Department of Commerce, NOAA, February 1999.

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 Reports

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