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.:	**319-8360**
SRP Section:	**03.09.03 - ASME Code Class 1, 2, and 3 Components**
Application Section:	**DCD Tier 2 Section 3.9.3**
Date of RAI Issue:	**11/24/2015**

Question No. 03.09.03-4

GDC 2 and 10 CFR Part 50, Appendix S, relate to structures and components important to safety being designed to withstand the effects of earthquakes without loss of capability to perform their safety functions. These requirements are evaluated in part in the staff's review of DCD Tier 2, Section 3.9.3, particularly in the use of seismic loads in the load combinations for ASME Class 1, 2, and 3 components and core support structures. The applicant has presented in Technical Report APR1400-E-S-NR-14004-P, Rev. 1, "Evaluation of Effects of HRHF [Hard Rock High Frequency] Response Spectra on SSCs [Structures, Systems, and Components]," an evaluation of the HRHF spectra on certain components (referred to below as the HRHF TR). The relationship of this report to the component structural analyses presented in DCD Tier 2, Section 3.9.3 is unclear. Therefore, the staff requests additional information in several areas related to this report.

1. The HRHF TR is referred to only in Appendix 3.7B of Chapter 3 of DCD Tier 2 and not in other sections that use seismic inputs in their evaluation of component structural integrity and dynamic qualification (e.g., DCD Tier 2, Sections 3.9.2, 3.9.3, 3.9.4, 3.9.5, 3.10, and 3.12). Because this report is incorporated by reference into the DCD through Tier 2, Table 1.6-2, however, it appears that the applicant intends these HRHF spectra to be part of the review of the APR1400 design certification application. The applicant is requested to describe, for each section that uses proposed certified seismic design response spectra (CSDRS) seismic inputs, how the HRHF spectra were also considered in the design, analysis, and testing of components (including piping). Appropriate changes to the DCD discussions in these and other sections may also be necessary. (Note that a similar observation was made specific to DCD Tier 2, Section 3.12 in RAI 8278, so these responses should be coordinated.).

2. In Section 6.2.2 of the HRHF TR, the applicant stated that "the RCS [reactor coolant system] component nozzles of the RV [reactor vessel], SG [steam generator], and RCP [reactor coolant pump] are included in the evaluation since a component nozzle has greater potential for failure than at other locations and the cold leg, hot leg, and

crossover leg are relatively sensitive to high frequencies when compared with other components.” The HRHF TR does not provide details of how these component locations were selected from the overall population and how the evaluation was performed. The applicant is requested to (1) describe the screening criteria used to select components (including piping) for evaluation of the effects of HRHF spectra, (2) list the components so evaluated, and (3) compare the calculated stresses using HRHF seismic inputs to the analyses conducted using CSDRS seismic inputs in the load combinations.

Response - (Rev.1)

1. DCD Appendix 3.7B, "Evaluation for High Frequency Seismic Input" and Technical Report APR1400-E-S-NR-14004-P, Rev. 1, "Evaluation of Effects of HRHF Response Spectra on SSCs," states that the effects of HRHF seismic input are limitedly evaluated. As an example, the evaluation of the HRHF effects on the piping systems and the electrical equipment are specified as COL items for the HRHF evaluations to be performed by the COL Applicants.

   The evaluation status of the HRHF effects for the DCD Sections is described as follows.

   - Section 3.9.2: For the Reactor Internals, as described in DCD Section 3.7B.7.2.1, the HRHF evaluation is performed by analyzing the reactor internals for the HRHF in the same manner as performed for the CSDRS. As mentioned in the HRHF TR Section 6.2.1, the effects of the HRHF seismic input are insignificant on the structural integrity of the reactor internals and core.

   - Section 3.9.3: For ASME Class 1, 2 and 3 Components, Component Supports and Class CS Core Supports, the HRHF evaluation is performed on RCS components by comparing the resulting loads for the HRHF and the CSDRS seismic input. As stated in DCD Section 3.7B.7.2 and HRHF TR Tables 6-7 and 6-8, the resulting loads from the HRHF seismic input are enveloped by the loads from the CSDRS.

   - Section 3.9.4: For Control Element Drive Mechanisms (CEDM), the HRHF evaluation is not performed per the Screening Criteria ‘c’ described in Section 3.7B.6 of Appendix 3.7B of Chapter 3 of DCD Tier 2. The first mode natural frequency of the CEDM is located in the low frequency region and its effective mass is approximately 65% of the total mass. None of the other modes has an effective mass larger than 10% of the total mass. Therefore, the dynamic response of the CEDM is mostly governed by low frequency excitation. The HRHF spectra at the Reactor Vessel Closure Head, which is the input spectra for the CEDM analysis, showed that the excitation level around the first mode natural frequency is less than the CSDRS spectra. It indicates that the loads and deflection of the CEDM due to the HRHF spectra will be enveloped by the results of the CSDRS spectra.

   - Section 3.9.5: For Reactor Pressure Vessel Internals, refer to the status of Section 3.9.2.

- Section 3.10: For Seismic and Dynamic Qualification of Equipment, the HRHF evaluation is not performed. As stated in DCD Appendix 3.7B.7.4 and HRHF TR Section 6.4, the HRHF evaluations of the electrical equipment shall be performed by the COL Applicants. The seismic qualification test/analysis will be performed for the components to envelop the in-structure response spectra resulting from the entire set of certified seismic design response spectra (CSDRS), including ground motions for the COL sites with high frequency content. DCD Tier 2, Section 3.10.1.2 and Section 3.10.6 will be revised to include evaluation of seismic Category I equipment for high frequency seismic input information.

- Section 3.12: For the piping systems, the HRHF evaluation had not been performed when the DCD was submitted. HRHF consideration for the graded approach for piping (ASME Class 1 and 2 piping) is stated in the response to RAI 311-8278 Question 03.12-9 (ref. KHNP submittal MKD/NW-16-0048L dated January 20, 2016).

2. Additional information on HRHF evaluations for RCS components

(1) The general screening criteria are described in HRHF TR Section 6.2. They are as follows:

- Importance to safety as used for component supports

- Dynamic characteristics as used for CEDMs described in Response 1

- High stress concentration region such as nozzles

(2) The following components are evaluated for HRHF effects.

- RCS components (reactor vessel, steam generator, reactor coolant pump, pressurizer)

- RCS loop piping

- RCS component supports

- RCS component nozzles

  Among the evaluated components, RCS component supports and nozzles are representatively described in DCD 3.7B.7.2.2 and HRHF TR Section 6.2.2. The evaluation method is described in Response 2,(3).

(3) The maximum RCS component loads obtained from the HRHF seismic input are compared with the design loads determined from the results of the CSDRS seismic input. Because the design loads from CSDRS seismic input envelope the component loads and support loads from the HRHF seismic input, (refer to HRHF TR Tables 6-7 and 6-8), a stress evaluation is not performed.

Impact on DCD

DCD Tier 2, Sections 3.10.1.2 and Section 3.10.6 will be revised as indicated in the attachment associated with this response.

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 the Technical Report

loads (loads induced by pump trip, safety-relief valve open-case, etc.). The applicable loads are combined as part of the qualification of seismic Category I equipment.

These postulated dynamic loads are generally defined by the required response spectra (RRS). For in-line mounted equipment, they are defined by seismic coefficients. The location(s) in the plant will determine which spectra to use. Floor response spectra (FRS) are generated for specific buildings and elevations (floors) within a building as described in Subsection 3.7.2.5. When equipment is not directly mounted on floors, RRS reflects the amplification of the FRS due to the flexibility of equipment supporting structure. Selection of damping values for equipment to be qualified is made in accordance with NRC RG 1.61 (Reference 8) and IEEE Std. 344-2004. Higher damping values are used only if justified by documented test data with proper identification of the source and mechanism. Margins are added to RRS for testing. Subsection 6.3.2.5 of IEEE Std. 323-2003 recommends a 10 percent margin.

(CSDRS)

In considering the high-frequency seismic effect, the COL applicant is to investigate if site-specific spectra generated for the COLA exceed the APR1400 design spectra in the high-frequency range. Accordingly, the COL applicant is to provide reasonable assurance of the functional performance of vibration-sensitive components in the high-frequency range (COL 3.10(2)).

3.10.1.3 Selection of Qualification Method

The dynamic qualification of equipment is performed by analysis, testing, or a combination of testing and analysis. The dynamic qualification of equipment is concerned with the following.

a. Identifying which equipment must be qualified

b. Identifying what the safety-related function(s) required of each piece of equipment is (are)

c. Defining the dynamic loads to be considered

The seismic qualification test/analysis will be performed for the components to envelop the in-structure response spectra resulting from the entire set of CSDRS, including ground motions for the COL sites with high frequency content. Evaluation of seismic Category I equipment for high frequency seismic input is addressed in DCD Tier 2, Section 3.7B.7.4 and Technical Report APR1400-E-S-NR-14004-P, Section 6.4.

8. Regulatory Guide 1.61, “Damping Values for Seismic Design of Nuclear Power Plants,” Rev. 1, U.S. Nuclear Regulatory Commission, March 2007.

9. SECY-93-087, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs,” U.S. Nuclear Regulatory Commission, 1993.

10. Regulatory Guide 1.9, “Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants,” Rev. 4, U.S. Nuclear Regulatory Commission, June 2007.

11. IEEE Std. 387-1995, “IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations,” Institute of Electrical and Electronics Engineers, 1995.

12. ANSI/AISC N690-1994, “Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities,” American National Standard Institute, 1994

13. APR1400-E-S-NR-14004-P, "Evaluation of Effects of HRHF Response Spectra on SSCs," Rev. 0, KHNP, November 2014.