

## KHNPDCDRAIsPEm Resource

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**Subject:** APR1400 Design Certification Application RAI 227-8274 (3.8.4 - Other Seismic Category I Structures)  
**Attachments:** image001.jpg; APR1400 DC RAI 227 SEB1 8274.pdf

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Thank you,

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## REQUEST FOR ADDITIONAL INFORMATION 227-8274

Issue Date: 09/25/2015  
Application Title: APR1400 Design Certification Review – 52-046  
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.  
Docket No. 52-046  
Review Section: 03.08.04 - Other Seismic Category I Structures  
Application Section: SRP 3.8.4

### QUESTIONS

#### **03.08.04-1**

10 CFR 50.55a and 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of seismic Category I structures. Standard Review Plan (SRP) 3.8.4, Section I.1.F, “Other Structures,” states “In most plants, there are several miscellaneous seismic Category I structures and other structures that may be important to safety but, because of other design provisions, may not be classified as seismic Category I (e.g., radwaste building).” SRP 3.8.4, Section I.4, “Design and Analysis Procedures,” last paragraph, states “The review of the design and analysis procedures used for other structures that are important to safety (e.g., radwaste structure) are reviewed against applicable staff guidance (e.g., RG 1.143 for the radwaste structure).”

In DCD Tier 2, Section 1.2.14.4, “Compound Building,” the applicant described the compound building housing the systems and components related to radwaste management, access control and operations support center, as well as identifying this structure as seismic Category II. In addition, the compound building is considered within the scope of the design certification. Therefore, the applicant is requested to address the following, and include this information in DCD Section 3.8.4:

Applicant is requested to provide a description of the compound building; applicable codes, standards, and NRC regulatory guidance; loads and load combinations; and analysis and design approach.

#### **03.08.04-2**

10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of seismic Category I structures. Standard Review Plan (SRP) 3.8.4, Appendix A, “Criteria for Safety-Related Masonry Walls Evaluation,” contains the acceptance criteria for safety-related masonry walls.

APR1400, DCD Tier 2, in Section 3.8.4, the applicant did not provide any discussions for the safety-related masonry walls. Therefore, the applicant is requested to address the following, and include this information in the DCD:

Applicant is requested to describe whether there are any safety-related masonry walls in APR1400 design. If there are, then provide the description of the masonry walls; applicable codes, standards, and NRC regulatory guidance; loads and load combinations; and analysis and design approach.

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### 03.08.04-3

10 CFR 50.55a and 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for design of seismic Category I structures. Standard Review Plan (SRP) 3.8.4, Section II.2 provides the applicable codes standards and specifications that are either applicable in their entirety or in portions for seismic Category I structures.

In APR1400 DCD, Tier 2, Section 3.8.4.2, "Applicable Codes, Standards, and Specifications," and Table 3.8-1, "Codes, Standards, Specifications, and Regulations," the applicant provides the applicable codes, standards, specifications, and regulations without any editions. This occurs throughout the DCD and the staff also identified discrepancies related to referring to the applicable codes, standards, specifications, and regulations.

Example of inconsistencies within the DCD:

- a) DCD Tier 2, Section 3.8.4.2.2 identifies some regulatory guides (RGs) that are applicable to the design, construction, testing, and inspection of seismic Category I structures. A comparison of the RGs with those listed in SRP 3.8.4 shows that some RGs are not included (e.g., 1.127, 1.136, 1.160, and 1.221). All Sections of the DCD including DCD 3.8.4 should be revised to include the applicable RGs consistent with those in SRP 3.8.4, or alternative methods should be described and justified.
- b) In subsection 3.8.4.6.1.1, "Concrete," the applicant referenced ASTM D1888-78, "Method of Test for Particulates and Dissolved Matter in Water," which was withdrawn in 1989 without a replacement.
- c) ASCE 4, ASCE 7, & ASCE 37 were referenced in various sections of the DCD, but are not included in Table 3.8-1 of the DCD. Furthermore, ASCE 4 was not reference in Section 3.8.7, "References."
- d) In subsection 3.8.4.6.1.2, "Reinforcing Steel," the applicant stated that "The fabrication of reinforcing bars, including fabrication tolerances, is in accordance with CRSI, MSP-1." However, the Manual of Standard Practice-1 (MSP-1) of Concrete Reinforcing Steel Institute (CRSI) was not referenced in Section 3.8.7 and no edition was provided. There were also other references included in Section 3.8.7 without identification of the year or edition. [JIB1]
- e) In subsection 3.8.4.6.1.4, "Stainless Steel," and Table 3.8-1 "Codes, Standards, Specifications, and Regulations," the applicant did not provide the welding code for the stainless steel material, and DCD Sections 3.8.3 and 3.8.4 did not identify other potentially applicable American Welding Society codes (e.g., AWS D1.4, 1.6, and 1.8). Furthermore, applicant referred to subsections 3.8.3.6.3, "Stainless Steel Pool Liners," and 3.8.3.6.4, "Stainless Steel Other Than Pool Liners" for additional requirements. In subsection 3.8.3.6.3, the applicant described that welding procedure are performed in accordance with ASME Sec. III, Div. 2, Article CC-4540, "Rules Governing Making Examining, and Repairing Welds." However, article CC-4540 does not provide any weld procedures for stainless steel materials. [JIB2]

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- f) In subsection 3.8.3.6.3, “Stainless Steel Pool Liners,” second paragraph “Welding procedures are in accordance with ASME Section, Division 2, Subarticle CC-4540 and ASME Section IX.” Should read “Welding procedures are in accordance with ASME Section III, Division 2, Subarticle CC-4540 and ASME Section IX.”

Therefore, the applicant is requested to ensure the completeness and accuracy of the codes, standards, and specifications, in the various sections of DCD 3.8, including Table 3.8-1, and Section 3.8.7. This should also include correcting discrepancies such as those described above and specifying the year or edition of each of these documents.

### 03.08.04-4

10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of seismic Category I structures. Standard Review Plan (SRP) 3.8.4, Section II.3 includes the various loads and load combinations to be considered which include dead load, live load, hydrodynamic loads resulting from LOCA and/or safety relief valve loads, earthquake loads, and floods.

In APR1400 DCD Tier 2, Section 2.4, “Hydrologic Engineering,” the applicant described the types of hydrodynamic loads on the safety-related structures. In subsection 2.4.15, “Combined License Information,” the applicant requires a COL applicant to provide the site-specific hydrological events in COL item 2.4(1). In Section 3.4, “Water Level (Flood) Design,” the applicant described the flood loads due to design basis flood levels from external and internal events on Seismic Category I structures. In subsection 3.4.3, “Combined License Information,” the applicant requires a COL applicant to provide site-specific internal and external flooding sources in COL items 3.4(2) and 3.4(3). In subsection 3.8.4.3, “Loads and Load Combinations,” the applicant requires a COL applicant to identify the site-specific loads such as effects of seiches, surges, waves, and tsunamis in COL item 3.8(2). However, it is not clear whether the applicant considered all the hydrological events described in Section 2.4 and 3.4 as loading and in the load combination(s) for the seismic Category I structures in Section 3.8.4, “Design of Seismic Category I Structures,” and is there enough allowable margin(s) in loading combinations to accommodate the potential flooding loads of site-specific internal and external flooding sources, including the factors of safety given in DCD Section 3.8A (Tables 3.8A-15 & -38), and Technical Report APR1400-E-S-NR-14006-P, Rev. 0, Table 4-5.

Therefore, the applicant is requested to address the following, and include this information in the DCD:

Applicant is requested to describe how the various water/flood related loads are classified (e.g., normal, severe environmental, abnormal, etc.), how they are calculated in terms of the loads used in DCD Section 3.8.4, how are they applied in the design of seismic Category I structures, and whether there is sufficient design margin(s) in the loading combinations to accommodate the potential flooding loads of site-specific internal and external flooding sources.

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### 03.08.04-5

10 CFR 50.55a and 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of seismic Category I structures. Standard Review Plan (SRP) 3.8.4.II.3, "Load and Load Combinations," identifies loads and load combinations that are acceptable for seismic Category I structures.

In APR1400 DCD, Tier 2, Section 3.8.4.3, "Loads and Load Combinations," the staff identified items that need to be addressed to ensure that the correct loads and load combinations are used. Therefore, the applicant is requested to address the following, and if applicable, include this information in the DCD:

- a) In DCD subsection 3.8.4.3.1, "Normal Loads," the applicant identified  $R_o$  as being applicable to pipe, cable tray, duct supports, and ties. This section indicates that this load includes their dead load, live load, thermal load, seismic load, thrust load, and unbalanced internal pressure under normal and severe environmental conditions.

Applicant is requested to explain why this definition is not consistent with the definition given in ACI 349 nor AISC N690, including Supplement 2. As an example, for ACI 349,  $R_o$  is applicable to piping and equipment (not limited to the four components given above). Also, it is applicable to normal and shutdown conditions excluding dead load and seismic load. The seismic load for piping and equipment should be under the load  $E_{ss}$ . A similar situation occurs for the definition of  $R_a$  in DCD subsection 3.8.4.3.2, "Abnormal Loads."

- b) In DCD subsection 3.8.4.3.4, "Extreme Environmental Loads," the applicant identified the use of the 100-40-40 percent method which is described in ASCE 4, Subsection 3.2.7, as an alternative to the square root of the sum of the squares (SRSS) method. This section of the DCD indicates that the 100-40-40 percent rule is based on the observation that the maximum increase in the resultant for two orthogonal forces occurs when these forces are equal. The maximum value is 1.4 times one component.

Applicant is requested to explain these statements because according to ASCE 4, the 100-40-40 method is based on the assumption that when the maximum response from one component occurs, the response from the other two components are 40 percent of the maximum. Also, the DCD indicates that the 100-40-40 percent rule may also be applied for combining responses in the same direction due to different components of motion. This statement should be explained because the term "also" implies that the 100-40-40 method covers two situations. It is the staff's understanding that the 100-40-40 method only applies when combining the responses acting in the same direction due to each of the three perpendicular seismic input motions. Lastly, for the 100-40-40 method, the applicant is requested to describe the approach used to determine the total response of a structural element when there is more than one response parameter, such as a column axial force and moment to be used in design. This can be exemplified by providing an example to demonstrate whether the maximum values for each response parameter is obtained first for the 24 plus and minus permutations, and then all plus and minus permutations are taken between the design parameters resulting in  $2^M$  power sets of response combinations (where M equals the number of response parameters) to be considered in design.

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- c) In DCD subsection 3.8.4.3.4, "Extreme Environmental Loads," in Item 2, "Combination of SSE Loads," the applicant stated that the stresses due to seismic loads from different directions are combined by the SRSS method using the following expression; however, no expression is provided.

Applicant is requested to provide the expression.

- d) In DCD Table 3.8-9A, "Seismic Category I Structures Excluding Containment Structure Reinforced Concrete – Ultimate Strength Design Load Combination Table," the applicant identifies a load labeled as "M<sub>w</sub>."

Applicant is requested to clarify or correct this load condition.

- e) In Table 3.8-9B, "Seismic Category I Structures Structural Steel – Elastic Design Load Combination Table," the applicant identified a load "S."

Applicant is requested to define the load "S."

- f) In Table 3.8-9B, "Seismic Category I Structures Structural Steel – Elastic Design Load Combination Table," the applicant used a load factor 1.33 for the construction and test load combinations (numbers 1 through 4).

Applicant is requested to describe why a factor of 1.33 times the design strength was used.

- g) In Table 3.8-9B, "Seismic Category I Structures Structural Steel – Elastic Design Load Combination Table," the applicant did not provided footnotes "a and i" from Table Q1.5.7.1, "Load Combinations And Applicable Stress Limit Coefficients," in AISC N690-94, including Supplement 2.

Applicant is to include footnotes "a and i" from Q1.5.7.1 in AISC N690-94, including Supplement 2.

- h) NRC DC/COL-ISG-7, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," clarify the NRC's position on identifying winter precipitation events as site characteristics and site parameters for determining normal and extreme winter precipitation loads on the roofs of Seismic Category I structures.

Applicant is requested to describe how the criteria of NRC DC/COL-ISG-7 were considered in the load combinations in Section 3.8.4.3.



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### 03.08.04-6

10 CFR 50.55a and 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of the seismic Category I structures. Regulatory Guide 1.29, "Seismic Design Classification," classifies spent fuel pool racks as Seismic Category I structures. Standard Review Plan (SRP) 3.8.4, Appendix D, "Guidance on Spent Fuel Pool Racks," describes the acceptance criteria for the spent fuel pool racks.

In APR 1400 DCD Tier 2, Section 3.8.4.1.3, "Spent Fuel Storage Rack" the applicant provided general description of the spent fuel storage racks. In DCD Section 3.8.4.4, "Design and Analysis Procedures," the applicant described that the spent fuel storage rack is designed to withstand the seismic loads applied simultaneously in orthogonal directions. In DCD Section 3.8.4.5, "Structural Acceptance Criteria," the applicant described that the spent fuel storage rack meets the load combinations in Table 3.8-9C, "Spent Fuel Storage Rack – Design Loading Combination Table," which is in accordance with SRP 3.8.4, Appendix D. However, the applicant did not reference DCD subsection 9.1.2, "New and Spent Fuel Storage," in DCD Section 3.8.4 and vice-versa to provide an association between these sections. In addition, DCD Section 3.8.4 does not discuss the new fuel storage racks which are classified as seismic Category I and are also described in DCD subsection 9.1.2. Therefore, the applicant is requested to address the following, and include this information in the DCD:

Applicant should revise DCD Section 3.8.4 to also describe the new fuel storage racks and then revise DCD Section 3.8.4 and DCD subsection 9.1.2 to cross reference each other to associate these sections.

### 03.08.04-7

10 CFR 50.55a and 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of seismic Category I structures. Standard Review Plan (SRP) 3.8.4, Section II.4.H indicates that consideration of dynamic lateral soil pressures on embedded walls is acceptable if the lateral earth pressure loads are evaluated for the governing of the following three cases. These are (1) lateral earth pressure equal to the sum of the static earth pressure plus the dynamic earth pressure calculated in accordance with ASCE 4-98, Section 3.5.3.2(2); (2) lateral earth pressure equal to the sum of the static earth pressure plus the dynamic earth pressure calculated using an embedded SSI/ Finite Element Model (FEM) analysis model; and (3) lateral earth pressure equal to the fraction of the passive earth pressure that is effectively mobilized, which is dependent on the relative magnitude of the wall displacements against the soil that may occur for a given wall configuration. For case (3), the analysis should include, as a minimum, the fraction of the passive earth pressure assumed in the stability calculations performed in accordance with SRP Section 3.8.5.

In APR 1400 DCD Tier 2, Section 3.8.4.4, "Design and Analysis Procedures," the applicant did not describe the analysis and design of below grade walls for lateral earth pressure loads. In DCD Appendix 3.8A, subsection 3.8A.2.4.2, "Shear Walls," for the auxiliary building, the applicant states that "The exterior walls below the grade are designed to resist the worst-case lateral earth pressure loads (static and dynamic), soil surcharge loads, and loads due to groundwater. Lateral earth pressure equal to the summation of the static earth pressure plus the dynamic earth pressure is calculated in accordance with ASCE 4. The hydrodynamic effect of pure water is determined based on the hydrodynamic formula suggested by Matuo and O'Hara." However, in DCD Appendix 3.8A, subsection 3.8A.3.4.2, "Shear Walls," the applicant did not

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provide design and analysis procedures for the below grade walls of the emergency diesel generator building and diesel fuel oil storage tank rooms.

Furthermore, in subsection 3.8.4.3.4, "Extreme Environmental Loads," the applicant stated that "For seismic Category I structures,  $E_s$  are the loads generated by the SSE. Hydrodynamic load and dynamic soil pressure are included in  $E_s$ ." However, it is not clear how the hydrodynamic load and dynamic soil pressure were included in loads generated by the SSE. Therefore, the applicant is requested to address the following, and include this information in the DCD:

- a) Applicant is requested to describe how all walls below grade were analyzed and designed for dynamic lateral earth pressures for all structures, and if the approach was consistent with that described in SRP 3.8.4 II.4.H. If not, provide the basis for using the alternative approach. In addition, for the calculation of the hydrodynamic effect of pure water, determined based on the hydrodynamic formula suggested by Matuo and O'Hara, the formula used should be provided and the full reference designation for this, as well as any other references discussed in the DCD should be identified in the DCD.
- b) Applicant is also requested to provide how the hydrodynamic load and dynamic soil pressure were included in loads generated by the SSE.

### 03.08.04-8

10 CFR 50.55a and 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of seismic Category I structures. Standard Review Plan (SRP) 3.8.4, Section III.6, "Materials, Quality Control, and Special Construction Techniques," last sentence states that "...evaluates any new quality control procedures or construction techniques[JIB1] to ensure that there will be no degradation of structural quality that might affect structural integrity."

In APR1400 DCD Tier 2, subsection 3.8.4.6.3, "Special Construction Techniques," the applicant described that the slab in AB will be constructed using in-place metal decks. The applicant further described in the second paragraph that "the corrosion protection of the AB reinforcing steel is provided by an adequate cover of high quality concrete over the reinforcing bar. Unless the concrete penetrated by chlorides or sulfide ions, the reinforcement bar remains passive and will not corrode." Therefore, the applicant is requested to address the following, and include this information in the DCD:

- a) Applicant is requested to describe how to ensure that the concrete will be prevented from the penetration of chloride or sulfide ions.
- b) Applicant is also requested to provide a list of the slabs constructed using in-place metal deck in other Seismic Category I structures.

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### 03.08.04-9

10 CFR 50.65 provides the regulatory requirements for structures monitoring and maintenance of seismic Category I structures. SRP 3.8.4, Section II.7 provides guidance on testing and inservice surveillance requirements which indicates that, for seismic Category I structures, monitoring and maintenance requirements for structures are given in 10 CFR 50.65, and RGs 1.127 and 1.160.

APR1400 DCD Tier 2, Section 3.8.4.7, "Testing and Inservice Inspection Requirements," states: "There is no testing or in-service surveillance beyond the quality control tests performed during construction, which is in accordance with ACI 349, AISC N690, or ANSI N45.2.5, in accordance with NRC RG 1.127 and NUMARC 93-01. However, the COL applicant is to monitor the safety and serviceability of seismic Category I structures during the operation of the plant, and appropriate maintenance will be provided as necessary (COL 3.8(5))." The staff notes that APR1400 DCD Tier 2, Section 3.8.4.2, "Applicable Codes, Standards and Specifications," refers to DCD Tier 2 Section 1.9, "Conformance with Regulatory Criteria," where Table 1.9-2, "APR1400 Conformance with Regulatory Guides," indicates that RGs 1.127 and 1.160 are "N/A" under the column heading "DCD Tier 2 Section." For the structures within the scope of design certification, the DCD should describe the testing and inservice inspection requirements even though they will be implemented by the COL applicant under COL 3.8(5).

Therefore, the applicant is requested to describe the testing and inservice inspection requirements including extent of compliance with 10 CFR 50.65, and RGs 1.160 and 1.127. Unless otherwise justified, these RGs are applicable to the testing and inservice inspection requirements of seismic Category I structures, and thus they should be included in the various applicable Sections of the DCD.