From:	Ciocco, Jeff
Sent:	Thursday, October 22, 2015 9:03 AM
To:	apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Andy Jiyong Oh; Erin Wisler
Cc:	Nie, Jinsuo; Xu, Jim; Betancourt, Luis; Umana, Jessica; Lee, Samuel
Subject:	APR1400 Design Certification Application RAI 267-8301 (03.07.03 - Seismic Subsystem Analysis)
Attachments:	APR1400 DC RAI 267 SEB2 8301.pdf

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, KHNP requests, and we grant, 60 days to respond to the RAI question. We may adjust the schedule accordingly.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

Jeff Ciocco
New Nuclear Reactor Licensing
301.415.6391
jeff.ciocco@nrc.gov

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

REQUEST FOR ADDITIONAL INFORMATION 267-8301

Issue Date: 10/22/2015
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 03.07.03 - Seismic Subsystem Analysis
Application Section: 3.7.3

QUESTIONS

03.07.03-1

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the safe shutdown earthquake (SSE) ground motion through design, testing, or qualification methods. In accordance with 10 CFR 50 Appendix S, the staff reviewed the adequacy of methods for seismic analysis of above-ground tanks, as described in DCD Section 3.7.3.9.   This section provides a brief and generic description of the methods for seismic analysis of tanks, but the actual analysis will be performed by the COL applicant (COL 3.7(7)). The DCD indicates that the above-ground tanks can either be anchored to reinforced concrete pads or directly on a building structure.

Section 3.7.3.9 states that "because of the symmetry of these vertical tanks, the larger of the two horizontal earthquake components, if they are not equal in magnitude, is combined by the SRSS method with the vertical earthquake component." Neglecting the input component in the other horizontal direction, which is smaller than but generally at the same level as the larger direction, can be unconservative due to the vector (combination) effect of two horizontal components of the input motion. The vector effect may not be an issue for a cylindrical tank mounted on the ground surface if the input motion is truly statistically independent in the two horizontal directions, but can be significant for tanks that are not cylindrical or tanks mounted in a structure that can yield highly correlated input motions to the base of the tanks. Therefore, the applicant is requested to provide a technical basis for considering only the larger of the two horizontal input motions in seismic analysis of tanks.

03.07.03-2

In accordance with 10 CFR 50 Appendix S, the staff reviewed the seismic subsystem analysis for the APR1400 standard design. Out of 13 areas reviewed following the SRP 3.7.3 Rev. 4 guidance, four of them reference DCD sections other than DCD Section 3.7, as listed below:

> Section 3.7.3.10, Basis for Selection of Frequencies, refers to Section 3.9.2.2.4, Basis for Selection of Frequencies
>
> Section 3.7.3.11, Interaction of Other Systems with Seismic Category I System, refers to Section 3.12.3.7, Non-Seismic/Seismic Interaction (II/I)
>
> Section 3.7.3.12, Multiply-Supported Equipment and Components with Distinct Inputs, refers to Section 3.9.2.2.8, Multiple-Supported Equipment Components with Distinct Inputs
>
> Section 3.7.3.13, Torsional Effects of Eccentric Masses, refers to Section 3.9.2.2.10, Torsional Effects of Eccentric Masses

However, the scope of subsystems covered by these DCD 3.7.3 sections may be broader than the scope covered by the referenced sections. For example, in addition to the inconsistency between the titles of DCD Section 3.7.3.11 and Section 3.12.3.7, Section 3.7.3.11 covers the interaction of all (non-Seismic Category I) systems with Seismic Category I systems, while the text of DCD Section 3.12.3.7 covers only the II/I interaction of piping systems. The applicant is requested to resolve this inconsistency and also to confirm there are no other scope inconsistency issues for the other three sections.

03.07.03-3

In accordance with 10 CFR 50 Appendix S, the staff reviewed the seismic subsystem analysis for the APR1400 standard design. The applicant is requested to provide the following additional information to assist the staff review:

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(a) DCD Section 3.7.3.6, Use of Constant Vertical Factors, states: "In general, seismic Category I subsystems are analyzed in the vertical direction using the methods specified in Subsection 3.7.3.1. No constant vertical static factors are used for subsystems." The phrase "in general" suggests that methods other than those in Subsection 3.7.3.1 may be used. As such, the applicant is requested to explain whether methods other than those in Subsection 3.7.3.1 are used for the APR1400 standard design, and if so, to describe these methods in the DCD.

(b) DCD Section 3.7.3.10 references DCD Section 3.9.2.2.4, Basis for Selection of Frequencies, which states: "The stiffness of the restraints and supports system is designed to be greater than the zero-period acceleration (ZPA)." The staff has interpreted that the intent of this sentence is "The fundamental frequency of the restraints and supports system is designed to be greater than the ZPA frequency of the applicable ISRS, to ensure no additional amplification of the seismic loads on the restrained/supported equipment and components." The applicant is requested to confirm the staff's interpretation and if confirmed, to revise the DCD accordingly. If there is a different intent, provide a detailed explanation of the meaning of the quoted sentence from DCD Section 3.9.2.2.4.

03.07.03-4

In accordance with 10 CFR 50 Appendix S, the staff reviewed the seismic subsystem analysis for the APR1400 standard design. The DCD Section 3.7.3.1.1 states that the equivalent static method would be used for the seismic analysis of components if a dynamic analysis would not be performed. The description of the load factor (1.5, or smaller if adequately justified) and the peak spectral acceleration of the applicable required response spectra is consistent with the SRP 3.7.2 guidance regarding the equivalent static load method described in SRP 3.7.2 II.1.B.iii (SRP 3.7.3 II.10, Use of Equivalent Vertical Static Factors refers to SRP 3.7.2, II.10 that references SRP 3.7.2 II.1.B). However, the DCD does not address the other two aspects of the SRP 3.7.2 guidance:

> II.1.B.i: Justification is provided that the system can be realistically represented by a simple model and the method produces conservative results in terms of responses; and

> II.1.B.ii: The simplified static analysis method accounts for the relative motion between all points of support.

These two aspects are important to ensure that the equivalent static load method is applicable to the subject subsystem. As such, per 10 CFR 50 Appendix S, the applicant is requested to augment the DCD description of the equivalent static load method to ensure that this method is appropriately justified and applied for the APR1400 subsystems.

03.07.03-5

In accordance with 10 CFR 50 Appendix S, the staff reviewed the modal combination method in response spectrum analysis of APR1400 subsystems, as described in DCD Subsection 3.7.3.5, Combination of Modal Responses. The DCD indicates that the SRSS method is used to combine the modal responses when the modal frequencies are well separated; otherwise, the modal responses are combined in accordance with NRC RG 1.92. However, the DCD does not provide the criteria to be used to determine whether the modal frequencies are well separated. Per SRP 3.7.3 II.7 guidance, an acceptable modal combination method in response spectrum analysis of subsystems is the same as described in SRP Section 3.7.2, Subsection II.7, which is consistent with the NRC RG 1.92, Rev. 3 including the definition of closely spaced modes. DCD Subsection 3.7.2.7 appears to be consistent with SRP 3.7.2 II.7 regarding the modal combination method. Since DCD Subsection 3.7.3.5 does not provide the necessary criteria, per 10 CFR 50 Appendix S, the applicant is requested to specify and justify the criteria to be used for the purpose of determining whether modal frequencies are well separated.