Bi-weekly Seismic Call Agenda

Date: 2016-06-01

Topics:

1. RAI 199-8223, Question 03.08.01-13

KHNP is to provide to the NRC a markup of DCD Tier 2, Section 3.8.1.6.3 which specifies the manufacturer and product designation of the tendon and anchorage system. KHNP has revised the response to include a change to the DCD which will add the manufacturer and product designation of the tendon and anchorage system in Section 3.8.1.6.3.

[During 05/18/2016 call, the staff stated that, based on a quick review, the draft response appears to have all of the information requested, but will review it more thoroughly over the next few weeks and discuss the results of their review on 06/01/2016 call.]

KHNP INPUT

KHNP provided the draft revised response prior to the meeting call on 05/18/2016. The definition of XR in the brochure was modified to make it clear. “Maximum” and “:” was changed to “the larger one of the two equations” and “or”, respectively. Accordingly, the word of “Maximum” in the Korean brochure has different meaning with the word of “minimum” in the statement “minimum edge distance” in VSL International brochure. The edge distance, XR is used for typical arrangement of tendon anchorage. Moreover, KHNP has confirmed from VSL Korea that one of the equations of XR should be corrected from “1/2H + Concrete cover” to “1/2F + Concrete cover”. The description for duct material was added to DCD Tier 2 Subsection 3.8.1.6.3.

The draft revised response includes the following issue items shown in the table below.

Status of Issues/Concerns

Description	KHNP Action	NRC Review Status
To provide English version of Attachment 2 to NRC and to be included with the Final RAI response.	Completed	Completed

Description	KHNP Action	NRC Review Status
Contact the vendor to provide an explanation of why maximum is used in the definition of X_R and clarify the equation listed underneath the definition. The current equation's use of a colon is not normal nomenclature. The NRC's concern is that the vendor might have used testing to determine X_R and though the ASME Code allows calculating the distance, it might not be the most appropriate approach. A comparison might be needed between the values specified by the vendor and the calculated values.	Completed	Completed
To verify that only ferrous duct material is used since the footnote at the bottom of the table is ambiguous and could mean that other materials can be used; some of which are not desirable. If ferrous material is the only material used in the APR1400, then it needs to be stated in the DCD and response.	Completed	Completed

KHNP is reviewing the Staff feedback which was provided on 05/31/2016.

Item to be discussed:

None

2. RAI 252-8299, Question 03.07.02-7

KHNP is to determine what slabs have been included in the live load study, re-perform the study if all slabs have not been included, and revise the RAI response to describe the modeling of all slabs and discuss the treatment of live loads with regard to those slabs (justify if excluded).

[During 05/18/2016 call, the staff re-iterated some of the points which were discussed during the 05/03/2016 call that need to be included in the KHNP review of the issue, including: local effects of the wall to slab interface, assurance that the mesh refinement is adequate, and the process to capture out-of-plane amplification. The staff is interested in having the connection details of the secondary shield wall and containment wall to floor slab.]

KHNP INPUT

See Attachment 1 for KHNP input.

Status of Issues/Concern

Description	KHNP Action Status	NRC Review Status
Discussion on the local effects of the wall-to-slab interfaces.	Completed	Pending
Describe the adequacy of the mesh size used in the finite element model.	Completed	Pending
Describe process to capture out-of-plane amplification.	Completed	Pending
To provide connection details of the secondary shield wall and containment wall-to-floor slab.	Completed	Pending

Item to be discussed:

Staff review and feedback on the response provided by KHNP is required.

3. RAI 183-8197, Question 03.07.02-4

KHNP is to provide the revised response which will include the EDGB & DFOT evaluation results discussion.

[During 05/18/2016 call, the staff re-iterated that the methodology on ground contact ratio used in the NI basemat uplift evaluation is acceptable and expects that the same methodology be used for the EDGB and DFOT evaluation. The staff also recognized that the technical challenges have been resolved and expects to review the draft response soon.]

KHNP INPUT

The evaluation of the EDGB and DFOT is on-going. However, the evaluation is expected to be completed by June 10, 2016.

Status of Issues/Concern

Description	KHNP Action Status	NRC Review Status
To clarify whether the specified ground contact ratios of the EDGB/DFOT basemat represent the min. ratio of the foundation area contacting the soil total area underneath the foundation in each time step throughout the SSI time history analysis. If not, provide technical basis to justify otherwise.	In-progress	

Item to be discussed:

None

4. RAI 199-8223, Question 03.08.01-9

The draft revised RAI response was provided to the NRC staff on April 19. The markup of DCD Section 3.8.2.7 has been added in the revised response.

[During 05/18/2016 call, the staff stated that KHNP still needs to provide a markup of Section 3.8.2. The second sentence of the first insert to 3.8.1 needs to be added to 3.8.2 along with the leakage test portion of the second insert. KHNP is also to provide a draft of the markup.]

KHNP INPUT

KHNP has revised the response to RAI 3.8.2 to include the second sentence of the first insert to 3.8.1 along with the leakage test portion of the second insert as commented in the 05/18/2016 seismic call.

KHNP will provide a draft RAI response including the markups to the staff for review by 06/03/2016.

Item to be discussed:

None

5. RAI 255-8285, Question 03.08.05-7, 9, 18

[During 05/18/2016 call, KHNP stated that the draft RAI response will be submitted for review as soon as the internal review process is completed.]

KHNP INPUT

The final RAI response will be submitted by 06/03/2016 which incorporates comments based on the staff feedback.

Item to be discussed:

None

6. RAI 255-8285, Question 03.08.05-16

[During 05/18/2016 call, the staff stated that the review of this draft RAI response is still on-going and will discuss the results on 06/01/2016 schedule call.]

KHNP INPUT

None

Item to be discussed:

1) Staff Review result of the draft RAI response.

11. RAI Schedule Slips

KHNP is to determine the level of confidence in a positive outcome and the risks associated with a negative outcome (body of work to be performed and schedule of that work should there be a negative outcome) for RAI 182-8160, Question 03.07.01-3. KHNP is to determine why a revised due date of 2016-06-03 has been provided for RAI 255-8285, Q 03.08.05-16 when a draft was provided to the NRC on 2016-04-19.

[During 05/18/2016 call, the staff elaborated on the verification efforts that the staff had performed to date. The staff and KHNP also discussed the use of the 5%-75% error method which shown difficulties in yielding acceptable results in four out of six cases for the frequency ranges below ten hertz. However, if the methodology in NUREG 4357 is used, the results could be

satisfactory. KHNP will continue to assess the appropriateness of the time histories.]

KHNP INPUT

KHNP is still evaluating the probability of a favorable outcome to the issues discussed in RAI 182-8160, Question 03.07.01-3, and the impacts of an unfavorable outcome. The draft provided to the NRC in response to RAI 255-8285, Q 03.08.05-16 is considered to be KHNP's final draft response, and no further work is being performed at this time. KHNP requested that the final due date be moved to 06/03/2016 so that multiple revisions to the final due date would not be necessary. However, KHNP hopes to produce a final response before that date, but finalization will be contingent upon the nature of feedback provided by the NRC staff.

KHNP stated that June 30, 2016 was provided due to the continuing parametric analyses that are being performed. Attempts will be made to improve schedule.

Discussions were held on the verification efforts that the NRC has performed to date. It was stated that by using the 5%-75% error method which showed difficulties in yielding acceptable results in four out of six cases for the frequency ranges below ten hertz. However, if the methodology in NUREG 4357 is used, the results could be satisfactory. KHNP will continue to assess the appropriateness of the time histories.

Item to be discussed:

1) An update on the preliminary results following NUREG 4357 method for verifying the appropriateness of the time histories.
2) June 30, 2016 commitment date.

12. RAI 182-8160, Question 03.07.01-1 and 2

1) All revised responses for Question 1 has been addressed and required no further action from KHNP.

2) Question 2, the response provided appears to be appropriate, but the NRC requested that KHNP to not finalize it until the NRC completes their confirmation. From 5/3/2016 call, one additional item was discussed in regards to the submitted information on low strain soil profiles. The staff requested KHNP to provide the generic soil profiles.

[During 05/18/2016 call, the staff stated that the generic soil profiles submitted by KHNP will be reviewed.]

KHNP INPUT

KHNP to provide final response for Question 1 by June 30, 2016.

Item to be discussed:

1) Staff Review result on the draft RAI response and soil profiles provided.

The following are other items discussed during 05/18/2016 call.

13. RAI 252-8299, Question 03.07.02-9

To assist the staff in reviewing the adequacy of the analysis methods used for seismic Category I structures and the use of the respective analysis results, KHNP is requested to expand the presentation of the ISRS to include the individual soil profiles (including the fixed-base condition) and both concrete stiffness cases, that contribute to determination of the envelope ISRS., In presenting the expanded results, only 5% damping curves need to be provided, and the ISRS corresponding to cracked and uncracked concrete cases should be provided in separate figures to facilitate readability.

This information is requested for the E-W, N-S, and Vertical Directions at representative nodal points for the following locations:

- PSW, EL. 191’-0”
- SSW, EL. 191’-0”
- Top and Foundation level of CS
- Top and Foundation level of IS
- Top and Foundation level of AB
- Top and Foundation level of EDGB
- Top and Foundation level of DFOT

KHNP INPUT

KHNP is still addressing this issue.

Item to be discussed:

This issue will be discussed when the conclusions are reached and a draft response can be provided as stated in the meeting notes of seismic call on 05/03/2016.

14. RAI 252-8299, Question 03.07.02-10

1) On Flexible Floors and Walls

(a)(i) The staff needs additional information to verify the adequacy of the ANSYS fine and coarse model mesh to accurately capture out-of-plane response of both floor slabs and walls. Therefore, for the most flexible floor slabs and walls, the staff requests the applicant to compare the fundamental frequencies obtained from the ANSYS fine and coarse mesh models with those predicted based on local floor slab and wall models with additional mesh refinement or with frequencies calculated based on classical plate vibration formulas, as applicable. For this comparison, the staff requests the applicant to provide the floor slab and wall fundamental frequencies corresponding to both cracked and uncracked concrete stiffness.

KHNP INPUT

KHNP will provide a draft RAI response to the staff for review by 06/15/2016.

Currently, following studies are being performed per NRC staff's request.

1. The fundamental frequency of the identified auxiliary building walls, which have fundamental frequencies lower than 50 Hz, will be determined using classical plate vibration formulas.
2. For identified walls, which have fundamental frequencies lower than 50 Hz, the modal analyses will be performed using ANSYS fine and coarse partial wall models.
3. A summary of the fundamental frequencies, dimensions, and the validity of the currently used mesh size of those partial wall models is being prepared.

Item to be discussed:

None

(a)(ii) To clarify the following information in APR1400-E-S-NR-14002-P related to the comparison of the fine model and coarse model fundamental frequencies for floor slabs. Table 4-8 of the Report shows the coarse model frequencies to be lower than the fine model frequencies. This behavior conflicts with the staff's expectation that as the mesh size increases; the model becomes stiffer and therefore should result in higher frequencies. Based on this staff observation, the staff requests the applicant to explain why the fundamental frequencies are lower for the coarse mesh than for the fine mesh.

KHNP INPUT

KHNP will provide a draft RAI response to the staff for review by 06/15/2016.

Also see KHNP input shown in Item 1).

Item to be discussed:

None

2) RCB and AB Fundamental Frequencies

(b) The staff is requesting KHNP to describe the nature and mass participation of the modes lower than those reported in DCD Tables 3.7-10, 3.7-11, and 3.7-12 and to correct any inconsistency between the DCD Tables 3.7-10, 3.7-11, and 3.7-12 and the tables in the technical report APR1400-E-S-NR-14002-P.

KHNP INPUT

KHNP will provide a draft RAI response to the staff for review by 06/15/2016.

Also see KHNP input shown in Item 1).

Item to be discussed:

None

3) Comparison of ANSYS and SASSI ISRS

(c) Staff review identified instances where the ANSYS response exceeds the SASSI response by as much as 25% (see Figure 5-29 for

example), at the peak spectral acceleration. Considering that the SASSI model results are used to obtain seismic demands for subsequent design analyses, the staff requests the applicant to provide the technical basis for differences such as that indicated above, and discuss whether it is necessary to make any corrections to the SASSI results.

KHNP INPUT

KHNP will provide a draft RAI response to the staff for review by 06/15/2016.

Also see KHNP input shown in Item 1).

Item to be discussed:

None

15. RAI 129-8085, Question 03.08.01-1

On Loads and Load Combination in DCD Tier 2, Section 3.8.1.3

a) Provide a description for load type not defined in DCD.
b) Explain the use of live load portion of SSE (E_S).
c) Describe the load combination associated with combustible hydrogen generated by fuel clad metal-water reaction and at what pressure used in the design.
d) Explain the difference between the use of LC13 and LC14 where the staff area of concern is when one load reduces the effects of other loads.
e) Provide the staff with DCD section that describe the load combinations that consider the safety/relief valve actuation loads on the containment and the containment internal structures.
f) DCD Section 3.8.1.3 does not describe the safety/relief valve actuation load, if applicable, and the method used for combining dynamic loads that include SSE, LOCA and safety/relief valve actuation. Provide this missing information and ensure that the SRP 3.8.1 and RG 1.136 provisions are met.

KHNP INPUT

A draft response associated with this RAI was provided to the Staff for review on 05/17/2016.

Item to be discussed:

1) Staff Review result on the draft RAI response.

16. RAI 129-8085, Question 03.08.01-4

On Codes, Standards, and Specifications
The staff requested that KHNP clarify the use of codes, standards, and specifications and its applicability. The staff also requested that KHNP is to provide complete titles and editions of the codes, standards, and specifications listed in DCD Table 3.8-1.

a) Inconsistency in the specified ASME codes in DCD. Also, the specified codes in DCD Table 3.8-1 does not provide code edition.
b) Codes and Specifications listed in DCD Table 3.8-1 do not have the full title and edition. Also, listed codes, specifications, and standards (e.g. AISC LRFD) have no usage or have not been cited in the DCD. Note that the AISC LRFD code is not an acceptable code under the SRP 3.8.1 provision and has not been endorsed by the NRC. Therefore, its use will be evaluated on a case-by-case basis.
c) Provide all of the codes, standards, specifications (e.g., AISC N690 and Supplement No. 2), and regulations as well as other references cited in DCD Section 3.8.

KHNP INPUT

KHNP has provided the revised draft response associated with this RAI which incorporates the staff feedback on 04/20/2016.

Item to be discussed:

1) Staff Review result on the draft RAI response.

17. RAI 226-8235, Question 03.07.02-5

On RCS masses and the convective (Sloshing) hydrodynamic masses
The staff requested that KHNP clarify whether the hydrodynamic masses are included or excluded in the seismic response forces and moments in the seismic analyses and/or have been reflected in the design of the SC-I structures.

If the hydrodynamic masses are included, describe the process of how the slosh height was estimated. If the hydrodynamic masses are

excluded, provide hydrodynamic load calculation and show the method used to combine with the seismic design loads.

KHNP INPUT

KHNP has provided the revised draft response associated with this RAI which incorporates the staff feedback on 04/27/2016.

Item to be discussed:

1) Staff Review result on the draft RAI response.

18. RAI 199-8223, Question 03.08.01-10

On Containment Structural Integrity Evaluation for Internal Pressure Loadings Above Design-Basis Pressure

The staff noted that information such as a description of the severe accidents that are being evaluated; the loads that are selected, the mathematical models that are being used, analysis approach and results are not included in the application.

KHNP is to describe the methods acceptable for demonstrating that the containment can maintain its role as a reliable, leak-tight barrier for approximately 24 hours following the onset of core damage and provide a description of its severe accident analysis approach in DCD Tier 2, Section 3.8.1.4.12 and how the approach can be compared with the RG 1.216, Position 3.

KHNP INPUT

The RAI 199-8223 Q.03.08.01-10 is related to RG 1.216, Position 3. As mentioned in the Response of RAI 199-8223 Question 03.08.01-10 (Rev.1), regarding RG 1.216 Regulatory Position 3.1 a, selection of accident sequences based on Level 1 probabilistic risk assessment study was made. The more likely severe accident sequences to be analyzed for the containment performance were selected using a combination of deterministic and probabilistic approaches. The top ten dominant sequences contributing to the core damage frequency (CDF) are selected from the Level 1 PRA results at the time of performing the analysis. Accident initiators for these sequences include: station blackout (SBO), large break LOCA (LLOCA), small break LOCA (SLOCA), loss of feedwater (LOFW), and steam generator tube rupture (SGTR). Details regarding the identification of the more likely severe accident challenges were given in the technical report 1-035-N389-501, Rev.4 “Containment Performance Analysis” which has been provided in the ERR. In addition, regarding RG 1.216

Regulatory Position 3.1b, the selected sequences were analyzed with cavity flooding system (CFS) and emergency containment spray backup system (ECSBS) availability by using MAAP4.0.8. The MAPP study for the selected based on the more likely severe accident sequences indicates that the pressure build-up inside the containment is bounded by the peak pressure of 112 psia in LLOCA during the 24-hour period following the onset of core damage. A constant temperature of 350°F, which bounds the transient response to a LLOCA, is conservatively employed as the temperature loading. Because the maximum pressure and temperature, which occur after the initial 24-hours after the onset of core damage, are enveloped by the maximum pressure and temperature during the initial 24-hour period as illustrated in the pressure curves of the three sequences. Therefore, the containment is capable of providing a barrier against the uncontrolled release of fission products for the more likely severe accident challenges, in accordance with RG 1.216 Regulatory Position 3.2 a. More details and evaluation discussions can be found in "Containment Performance Analysis (1-035-N389-501, Rev.4)"

DCD Tier 2, Section 3.8.1.4.12 is related to RG 1.216, Position 2 "Combustible Gas Control Inside Containment". To avoid confusion between Position 2 and 3 of RG 1.216, the subtitle of DCD Tier 2, section 3.8.1.4.12 has been changed to "Combustible Gas Control Inside Containment" from "Severe Accident Capability" in the response of RAI 199-8223 Question 03.08.01-08 (Rev.0). In addition, the detailed descriptions of combustible load, analysis approach and results were included in RAI 199-8223 Question 03.08.01-08 (Rev.1).

Item to be discussed:

Staff review and feedback on the response provided by KHNP is required.

19. RAI 208-8245, Question 03.08.03-5

On DCD Tier 2, Section 3.8A.1.4.3.1.3, "Analysis Methods and Results"

a) To clarify that the operating floor slabs between the secondary shield walls (SSWs) and the containment shell are included as masses in the FEM. If this is the case, then explain why it is acceptable to decouple these slabs from the overall FEM analysis of the internal structures and how is the analysis and design for such supplements performed for all of the various loadings.

The Staff Feedback: (Email from Vera to Mannon on 05/25/2016 11:22 AM)

The staff reviewed the applicant response and noted the following:

The response to part A is acceptable - Resolved/Closed

KHNP INPUT

None

Item to be discussed:

None

b) To explain the connection between the containment internal floors and the containment and in what directions (radial, tangential, and/or vertical) are the connections made and the details of how they are designed. Also, identify the gap provided between the containment and the floor slabs/connections to prevent impact/interaction and describe how the relative displacements between the containment and the floor slabs/connections from all loads including thermal and seismic were determined to demonstrate the gap is adequate.

The Staff Feedback: (Email from Vera to Mannon on 05/25/2016 11:22 AM)

The staff reviewed the applicant response and noted the following: The applicant stated in its response to part B that, "The gap between the end of the steel beam and the containment wall is 1 5/8” (1.625”) which is larger than the maximum displacement of 1.58” (containment wall displacement by earthquake, thermal displacement, displacement by post- tensioning, and installation tolerance)." To check adequate clearance, the applicant is requested to explain why the gap isn’t checked against the maximum differential displacement between the containment wall and the steel beam. Also, the RAI response did not explain how this differential displacement is calculated (e.g., assuming out of phase displacements for seismic and for tolerances, and for thermal what was assumed.

KHNP INPUT

KHNP is reviewing the staff feedback provided on 05/25/2016 about this item, and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

c) To clarify part (b) of Figure 3.8A-24, which is labelled Shell Element Model (SSW) that do not show the shell elements of the SSW.

The Staff Feedback: (Email from Vera to Mannon on 05/25/2016 11:22 AM)

The staff reviewed the applicant response and noted the following:

The response to part C is acceptable - Confirmatory Item

KHNP INPUT

None

Item to be discussed:

None

d) To provide the technical basis of the conclusion that the temperature profiles during normal operating condition are more severe than those of the accident condition which representing the limiting temperature for all plant conditions.

The Staff Feedback: (Email from Vera to Mannon on 05/25/2016 11:22 AM)

The staff reviewed the applicant response and noted the following:

The response to part D is acceptable because this item is being addressed under the applicant response to RAI 208-8245, Question 03.08.03-4 - Resolved/Closed

KHNP INPUT

None

Item to be discussed:

None

20. RAI 253-8300, Question 03.07.01-5

[The staff stated that the responses to sub-items 1, 2 and 3 in the provided update sheet are satisfactory.

The staff also stated that the draft RAI response for part b), second paragraph, second sentence pertaining to the explanation of the large dips in the site response transfer functions is not an accurate reflection of the KHNP intention. The staff believed that the intent is to state that the transfer function of the NI is lower than the EDGB across all frequencies. KHNP is to confirm and revise the wording and send the revised paragraph to the staff.]

KHNP INPUT

KHNP will provide a revised draft RAI response to the staff for review by 06/03/2016.

Item to be discussed:

None

22. RAI 208-8245, Question 03.08.03-1

a) Page 6-35 of the NRC FSER (NUREG-1462) states: “In Amendment N of CESSAR-DC, ABB-CE provided the requested information in Section 6.7.6, "Hydrodynamic Loads on the Safety Depressurization System (SDS)," and Section 6.8.4, "Hydrodynamic Loads on the In-containment Refueling Water Storage Tank," On the basis of its analyses, ABB-CE concluded that the loads on the SDS piping and IRWST are within the design capability of piping and supports for safety relief valve piping and the design capability of the IRWST structural elements. The staff concurs with this analysis and, on this basis, DSER Open Item 6.8-1 is resolved.”

From this description and the information in FSER Section 6.8, it is not possible to confirm that the methodology used for the APR1400 is the same as System 80+ and that the methodology in System 80+ is also applicable to APR1400. The structural staff is interacting with the appropriate NRC reviewers responsible for Chapter 6 for this area of review related to this methodology for acceptance.

Draft Response Provided:

"The hydrodynamic loads during the water and the steady steam discharge phases are bounded by that of the air discharge phase. The steam bubble oscillation issues can be neglected since discharged steam is fully condensed in the IRWST subcooled water."

The Staff feedback:

Additionally, the applicant is requested to clarify the following statement, *"The hydrodynamic loads during the water and the steady steam discharge phases are bounded by that of the air discharge phase. The steam bubble oscillation issues can be neglected since discharged steam is fully condensed in the IRWST subcooled water."* (i) The water and the steady steam discharge phases, and the air discharge phase should be explained. Does this mean, when activated, the water in the pipes submerged in water are first discharged, then the air between that portion and the POSRVs is discharged, and then the steam is discharged? (ii) Explain which of these phases correspond to Figure 1. If Figure 1 is not the air discharge, then the pressure transient for the air discharge should be described and a figure provided, since the RAI response indicates it governs.

KHNP INPUT

KHNP is reviewing the staff feedback provided on 05/26/2016 about this item, and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

b) The structural staff is interacting with the appropriate NRC reviewers responsible for Chapter 6 for this area of review related to this methodology for acceptance: (i) No methodology was described for determining the pressure on the walls and floor from the maximum gas cloud pressure described in Part a response above (presumably the pressure of the bubble at the sparger discharge). Is the methodology used for APR1400 the same as the System 80+ and is this acceptable to the NRC reviewer for Chapter 6? (ii) For the System 80+ methodology, was SRSS accepted to

combine the pressures on the IRWST boundaries caused by the individual sparger bubble discharges?

Draft Response Provided:

"The SRSS approach provides a simple conservative representation of the effects of bubble phase differences on the combined load without requiring a detailed mechanistic model for the bubble formation process. The phase differences are attributed to the key bubble formation parameters (e.g., valve actuation, opening time, line length, etc.). The combined load is further limited to no greater than the maximum individual air bubble source pressure."

The Staff feedback:

Additionally, the applicant is requested to clarify the following statement, "*The combined load is further limited to no greater than the maximum individual air bubble source pressure.*"

Also, why does the RAI response indicate that there are 12 spargers for the APR1400, while the DCD and Part c below refer to two spargers?

KHNP INPUT

KHNP is reviewing the staff feedback provided on 05/26/2016 about this item, and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

c) The applicant stated in its response, "Two spargers are located at Az. 90o (West Direction) and Az. 180o (North Direction), and the spatial distribution is expressed as a normalized factor. Figure 2 shows pressure distributions on the walls and the floor. The applicant is requested to explain what are the units of the pressures shown in Figure 2, "Pressure Distribution of Hydrodynamic Loads."

KHNP INPUT

The unit of the pressure shown in Figure 2 is kips per square foot, “ksf”.

Item to be discussed:

None

d) The applicant response to Part D is acceptable - Resolved/Closed.

KHNP INPUT

None

Item to be discussed:

None

23. RAI 208-8245, Question 03.08.03-3

Draft Response Provided:

“All loads described in DCD Section 3.8.4.3 are not used for the design of internal structures, but the appropriate loads for the design of internal structures are considered. DCD Section 3.8.3.3 will be revised to state hydrostatic and dynamic loads are applicable loads used for the design of the IRWST, as indicated on the attached markup.”

The Staff feedback:

For the first part of the question, the applicant stated in the first paragraph of its response that, "*All loads described in DCD Section 3.8.4.3 are not used for the design of internal structures, but the appropriate loads for the design of internal structures are considered.*" This statement is not adequate. DCD Table 3.8-9A identifies all of the loads that should be considered. For those loads that are obviously not applicable to containment internal structures like wind, tornado, and soil surcharge, no explanation is needed. For other loads that are not obvious, if they are not included, then some explanation is needed. Also, see feedback below regarding extrapolation from the Shin-Kori conclusions.

KHNP INPUT

KHNP is reviewing the staff feedback provided on 05/26/2016 about this item, and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

Draft Response Provided:

> "*Based on the design experience of Shin-Kori 3&4, the load combinations present in DCD Appendix 3.8A.1.4.3.1.2 were the most critical for the design of the primary shield wall (PSW). The maximum moment and shear force for the design of the PSW are due to these of all load combinations. The reinforcement of the PSW is determined by the maximum moment and shear force. Therefore, other load combinations in Table 3.8-9A are not evaluated for APR1400.*"

The Staff feedback:

For the second part of the question, the applicant stated in the second paragraph of its response that, "*Based on the design experience of Shin-Kori 3&4, the load combinations present in DCD Appendix 3.8A.1.4.3.1.2 were the most critical for the design of the primary shield wall (PSW). The maximum moment and shear force for the design of the PSW are due to these of all load combinations. The reinforcement of the PSW is determined by the maximum moment and shear force. Therefore, other load combinations in Table 3.8-9A are not evaluated for APR1400.*" The staff believes that extrapolation from the Shin-Kori NPP to identify the most critical load combination for design of the APR1400 plant may not be adequate. There may be some differences in the structural design details of the plants (e.g., thicknesses, reinforcements, materials used and their properties, differences in definition of some loads, differences in load combinations, differences in acceptance criteria, etc. Thus, all load combinations should be considered or justification should be provided to explain why certain load combinations from DCD Table 3.8-9A can be excluded. As indicated in the RAI, this should also be addressed with respect to DCD Section 3.8.3.4.1 – Analysis Procedures. Extrapolation from the Shin-Kori NPP to identify the most critical load combination for design of the APR1400 plant may not be adequate. There may be some differences in

the structural design details of the plants (e.g., thicknesses, reinforcements, materials used and their properties, differences in definition of some loads, differences in load combinations, differences in acceptance criteria, etc. Thus, all load combinations should be considered or justification should be provided to explain why certain load combinations from DCD Table 3.8-9A can be excluded. As indicated in the RAI, this should also be addressed with respect to DCD Section 3.8.3.4.1 – Analysis Procedures.

Also, in DCD Section 3.8.3.3, the use of phrase “typical loads and load combinations used for the internal structures are detailed in Subsection 3.8.4.3,” is still confusing, and should be more precise as discussed above.

KHNP INPUT

KHNP is reviewing the staff feedback provided on 05/26/2016 about this item, and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

Draft Response Provided:

> "*Ro and Ra are considered as the dead load (D) in the analysis. So, Ro and Ra are included in D. Also, there is no Ro and Ra at the primary shield wall (PSW). Based on the ACI 349 Appendix C, impactive and impulsive effects are treated separately because of the nature of the effects as well as the response characteristics of the structural members subjected to these loads. Yj and Ym act on the local area of the internal structures. So, Yj and Ym are evaluated with the design margin of the arranged reinforcement in the local area after design with load combinations. For the containment internal structures, Yf is offset by acting equally on both sides of the internal wall. So, Yf is not included in the load combination. The above discussion regarding Yj, Ym, and Yf are also applicable to the other containment internal structures (e.g., IRWST and SSW).*”

The Staff feedback:

For the later part of the second question, the applicant stated in the third paragraph of its response that, "Ro and Ra are considered

as the dead load (D) in the analysis. So, Ro and Ra are included in D." The inclusion of Ro and Ra in D is confusing and it is not clear to the staff. For example, different load factors are applicable to Ro and Ra than D. Also, the load combinations in DCD Appendix 3.8A.1.4.3.1.2 only identify D, with no description that it also includes Ro and Ra. The RAI response indicates that Ro and Ra are not applicable to the PSW. No explanation is given for the other internal structures. Based on the RAI response, Yj and Ym, are considered in the local affected area, and therefore, they should be included in the definition of load combinations for internal structures. If some particular structural members are not affected by these, it is understood that the loads Yj and Ym would be zero for those members. The applicant is requested to address all of the above items for all of the containment internal structures including any inconsistencies between the different loads and load combinations for internal structures. As examples of inconsistencies (but not a complete list), why is Ps used for the IRWST load combinations while Pa is used for PSW load combinations and why does load combination “a. Normal:” use “or” for two of the load combinations while the corresponding load combination “a. Normal:” use “and”? The applicant is also requested to confirm that the above issues do not exist for other structures (other than containment internal structures).

KHNP INPUT

KHNP is reviewing the staff feedback provided on 05/26/2016 about this item, and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

24. RAI 208-8245, Question 03.08.03-4

The staff reviewed the applicant response and noted that numerical values should be included in the above figure Figure 1, "Example of Temperature Profile," for at least the maximum and minimum temperatures inside and outside. Otherwise, it is not possible to judge which case is the worst case even if the slope of the left figure is greater than the slope of the right figure. In addition, the applicant is requested to explain what inside and outside mean, e.g., inside and outside of one of the containment internal structure wall. In which case, identify which wall and is this

considered to be one of the worst cases. For the accident condition, the thermal gradient would vary over time; therefore, the applicant is requested to explain whether Figure 1 (b) represents the worst case throughout the thermal transient.

KHNP INPUT

KHNP will provide the revised draft response associated with this RAI to the staff for review by 06/15/2016.

Item to be discussed:

None

26. RAI 208-8245, Question 03.08.03-6

The staff evaluated the applicant response and note the following:

1. The applicant response to part 1 is acceptable - Confirmatory Item

2. The applicant response to part 2 states, "The impulsive mode primarily acts to stress the wall, whereas the convective mode acts primarily to uplift the wall." The applicant is requested to clarify this statement. The convective mode also applies stresses on the IRWST and should be combined with the impulsive mode. The applicant is also requested to explain what is meant by the statement: “Therefore, considering the impulsive mode over the water level is more conservative than considering both impulsive and convective modes,” and why considering only the impulsive mode is more conservative.

3. The applicant response to part 3 is acceptable - resolved/closed.

4. The applicant response to part 4 is acceptable - resolved/closed.

KHNP INPUT

Response to Item 2:

2) As described in ACI 350.3-06 “Seismic Design of Liquid-Containing Concrete Structures and Commentary”, the impulsive mode primarily acts to induce stress to the wall, whereas the

convective mode acts primarily to induce uplift effect. In which, the terms “primarily” is not to be taken as the “only” effect that can occur to the walls. The sloshing effects can either increase or decrease the fluid pressure on the wall. In general, the sloshing is smaller than the impulsive effect. In addition, the impulsive and convective modes, depending on the depth, are considered to occur simultaneously but may not be acting in-phase with each other (Refer to ACI 350.3-06).

Regarding to the statement “Therefore, considering the impulsive mode over the water level is more conservative than considering both impulsive and convective modes”, refer to following example description.

Consider the height of water is H (i.e. H = H1 + H2) which consists of convective height (H1) and impulsive height (H2). As mentioned above, the pressures due to the height H1 and H2 acts in different phase with each other and the convective effect is smaller than the impulsive effect. The terms “considering the impulsive mode over the water level” means that the pressure of the height H (H1 + H2) is considered as the impulsive mode and not the pressure in the height H2 is only being considered as the impulsive mode. Therefore, the pressure considering the impulsive mode over the water level (H) is more conservative than considering both impulsive (H2) and convective (H1) modes.

Item to be discussed:

The staff review and feedback on the Item 2 response provided by KHNP is required.

27. RAI 208-8245, Question 03.08.03-7

The staff evaluated the applicant response and noted that if the concrete fill slab on top of the RCB basemat provides support to the containment internal structures and/or it interacts with the containment internal structures it should be considered as a structural member. Also, it appears that the concrete fill is included in the finite element model (FEM) with full connectivity with the RCB basemat and other containment internal structures, and thus should be considered as a structural member. Therefore, it should be designed for all applicable loads as if it were a structural member. In addition, since only the reinforcement of the SSW is connected to the basemat through the concrete fill slab, the applicant is requested to describe the evaluation performed to confirm that contact (i.e., no uplift) is maintained everywhere between the concrete fill and the basemat/liner.

KHNP INPUT

KHNP is reviewing the staff feedback provided by 05/26/2016 about this item, and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

28. RAI 227-8274, Question 03.08.04-4

The RAI responses are acceptable except the statement on the hydrostatic load (Lh): "This load is applied up to maximum elevation of groundwater specified in DCD Tier 2 Table 2.0-1 (0.61m (2 ft) below plant grade), and on the mark up sheet "The design water level (0.61m (2 ft) below plant grade) is considered in the calculation of hydrodynamic water pressure." The applicant needs to explain why the groundwater level can only reach the elevation 2 ft below the ground level and not the ground level.

KHNP INPUT

KHNP will provide the revised draft response to address the feedback provided on 5/26/2016 associated with this RAI to the staff for review by 06/15/2016.

Item to be discussed:

None

29. RAI 227-8274, Question 03.08.04-7

Question No.03.08.04-7 (b): The response stated that "The hydrodynamic load and dynamic soil pressure were included in the abnormal/extreme environmental loading condition with seismic load." The staff believes that the extreme environmental loading condition in Table 3.8-9A should also be included, because in the loading combinations that some of the loads, such as To and Ro, are included with the extreme environmental loading condition, but not with the abnormal/extreme environmental loading condition.

Question No.03.08.04-7 (b): Was the absolute sum of the hydrodynamic load and dynamic soil pressure used in the calculations? If not, provide justification.

Question No.03.08.04-7 (b): The response stated that "To consider

the effect of seismic direction, the lateral earth load (hydrodynamic load and dynamic soil pressure) was added to the seismic load using the SRSS method." Provide justification that the use of the SRSS method for these loading combinations is conservative.

Question No.03.08.04-7 (b): Explain why the markups for this response are given only for the Auxiliary Building, but not for all applicable buildings (e.g., EDG and Diesel Fuel Oil structure tank room).

KHNP INPUT

1) The differences of extreme and abnormal/extreme environmental loading condition come from locally applied loads, which do not significantly affect the global structural responses (displacements, member forces, etc.). Since these local loads are not considered in the global structural analysis both the extreme and abnormal/extreme environmental loading conditions have no difference in terms of the global structural responses (displacements, member forces, etc.). The self-weight of pipe, cable tray, and HVAC are included in the dead load.

   The local loads, such as To, Ro, Po, etc., are incorporated in the separate local structural analyses to find out the additional structural responses to be added the global structural responses, if needed.

2) The hydrodynamic load and dynamic soil pressure are added in the manner of the absolute summation.

3) The lateral earth loads were added to the SRSS-combined seismic load. The sentence in the response of RAI 227-8274 Question 03.08.04-7 will be revised as “Hydrodynamic load and dynamic soil pressure are added to the SRSS-combined seismic load”.

4) The same approaches as that of the Auxiliary Building regarding SSE loads, hydrodynamic loads, and dynamic soil pressure are applied to the global structural analysis of the EDG and Diesel Fuel Oil structure tank room.

Item to be discussed:

The staff review and feedback on Items 1 through 4 response provided by KHNP is required.

30. RAI 227-8274, Question 03.08.04-9

The RAI responses are acceptable except the last paragraph. The response in the last paragraph states that the COL applicant is required to provide appropriate testing and in-service inspection programs to examine the conditions of normally inaccessible below-grade concrete for signs of degradation and to conduct periodic site monitoring of ground water chemistry (COL 3.8(5)), which is acceptable. However, the write-up appears to exclude the need of performing in-service inspection for accessible portion of concrete structures, which is unacceptable. Therefore, the applicant needs to modify the write-up to indicate that the accessible portion of concrete structures also needs to perform in-service inspection.

KHNP INPUT

KHNP has submitted the final RAI response to the NRC on 04/19/2016.

Item to be discussed:

None

31. RAI 255-8285, Question 03.08.05-11

Notes 12/7/15: Discussed at public meeting

KHNP 1/29/16: Delayed due to performing the additional SSSI analysis as discussed in NRC meeting dated on Dec. 8th.

KHNP INPUT

KHNP will provide the final RAI response to the NRC by 06/10/2016.

Item to be discussed:

None

32. RAI 255-8285, Question 03.08.05-12

Notes 12/7/15: Discussed at public meeting

KHNP 1/29/16: Delayed due to performing the additional SSSI analysis and due to providing the justification of modal combination for basemat design as discussed in NRC meeting on Dec. 8th.

KHNP INPUT

KHNP will provide the final RAI response to the NRC by 06/10/2016.

Item to be discussed:

None

33. RAI 255-8285, Question 03.08.05-13

Notes 12/7/15: Discussed at public meeting

3/14/16: Based on the new information provided in the response, the items identified below should be addressed.

For Table 1:

a. Explain why the Severe Accident load combination that includes Ps (hydrogen generation loads) is not included in the basemat analysis and design.

b. Explain why the loads G (safety relief valve) and Ta (accident temperature) are not included in the basemat analysis and design.

c. For footnotes 7 & 8, explain why it states W and not 1.25 W is less critical than 0.25 X Pa, when comparing the specified load combination to the Abnormal load combination that is used in design of the basemat.

d. Similarly for footnotes 9 & 10, explain why it states W is less critical than 1.25 X Pa and not 1.5 X Pa.

For Table 2:

a. Explain why the Construction load combination is not included because such a load combination is needed in order to add these AB superstructure loads to the Service load category from the RCB. The footnotes provided do not address this issue; they only indicate which load combination gives higher loads.

b. For the Construction load combination, explain whether this includes evaluation of the structure during the stages of construction. From footnote 1 and 2, it appears such an evaluation is not performed.

c. Explain why the Severe Environmental load combination is not included because such a load combination is needed in order to add these AB superstructure loads to the Service load category from the RCB. The footnotes provided do not address this issue; they only indicate which load combination gives higher loads.

KHNP INPUT

For Table 1,

a) The severe accident load is not for basemat analysis and design. As mentioned in the response of RAI 129-8085, Question 03.08.01-1 Rev.1, the terminology of “Severe Accident” was changed to “Combustible Gas Control inside Containment”. This load combination is related to evaluation for structural integrity of containment under the pressure arising from the fuel cladding-water reaction. For the details of combustible gas control inside containment, refer to the response of RAI 199-8223, Question 03.08.01-8 Rev.1. This load combination is also addressed in RAI 129-8085, Question 03.08.01-1 of Bi-Weekly Seismic Call Agenda (2016-06-01).

   The severe accident load combination is not considered to determine structural member forces because this load combination is considered to

b) Refer the response of RAI 255-8285 Question 03.08.05-13, page 2.

c) For footnotes 7 & 8 in table 1, these are editorial error and will be incorporated correctly. The revised response will be provided before the next Bi-Weekly Meeting.

d) For footnotes 9 & 10 in table 1, these are editorial error and will be incorporated correctly. The revised response will be provided before the next Bi-Weekly Meeting.

For Table 2,

KHNP will provide the response by the 06/15/2016 seismic call meeting.

Item to be discussed:

The staff review and feedback regarding the response for Table 1 provided by KHNP is required.

34. RAI 255-8285, Question 03.08.05-14

Notes 12/7/15: Discussed at public meeting

3/15/16:

1) For consideration of the sliding interface between the lean concrete on soil or rock, the coefficient of friction (COF) is a function of the type of soil or rock foundation beneath. For lean concrete on rock, the use of 0.7 COF is acceptable, as indicated in the Naval Manual referenced in the RAI response. For sliding between the lean concrete on soil, the COF as indicated in the Naval Manual is below the 0.7 used for the APR1400 analysis. The COF may be much lower than 0.7 depending on the gradation of the gravel, sand, silt, and clay material that may be present. The response indicates that COL 3.8(13) requires the COL applicant to verify that the friction coefficient at the site is bounded by the DCD value of 0.7. Unless the foundation medium is made of rock, it does not appear that the COF value of 0.7 in COL 3.8(13) is appropriate and a lower value of COF should be considered in the DCD corresponding to (1) the type of soil gradations that would be reasonably expected at typical sites (see the soil interface materials identified in the Naval Manual, Table 1) and (2) consistent with the friction angle in the same table.

2) For consideration of the sliding interface between the concrete basemat and the lean concrete, the use of 0.7 for the COF as stated in the response is only valid if the surface of the concrete is placed against hardened concrete with surface intentionally roughened as specified in ACI 349 Section 11.7.9. The applicant is requested to identify where that is stated in the DCD or include this requirement in the DCD.

3) For consideration of sliding between any form of waterproofing and concrete and/or waterproofing to soil, the response indicates that waterproofing membranes are not used. Waterproofing of some form is an outstanding item under another RAI (RAI: 255-8285, Question: 03.08.05-4) and when resolved, may need to be considered when determining the lowest COF of any sliding interfaces.

4) Depending on the outcome of Items (1) and (3) above, the COL 3.8(13) markup will probably need to be revised because it currently states that “The COL applicant is to verify that the friction coefficient at the site is bounded by 0.7.” The COF value of 0.7 may need be revised based on the above items, and the COL does not identify the applicable interfaces (e.g., within the soil, lean concrete to soil, concrete to waterproofing, and waterproofing to soil) that need to be verified.

5) The response indicates that in calculating the resistant force,

the uplift effect of the vertical seismic component was not taken into account. It was assumed that 40% of the maximum vertical seismic force can be applied upward simultaneously with the maximum horizontal seismic force. As indicated in SRP Section 3.8.5 II.4.B, which addresses sliding evaluations, all three directional demand forces should be considered to act simultaneously, not just the two indicated in the RAI response. In addition, the SRP indicates that the resultant horizontal seismic demand force should be used for the sliding evaluation and resultant moment demand force should be used for overturning evaluation. In the case of sliding evaluation, if instead of using the resultant horizontal force with the vertical force, each pair of horizontal force and vertical force is evaluated separately, then the frictional resistance in the horizontal directions should be apportioned considering the existence of the two horizontal forces. The applicant should provide the basis for not considering this approach or implement the guidance presented in the SRP. Also, the applicant should provide the basis for using 40% vertical demand force acting upward with full one directional horizontal force demand, since the 100-40-40 method requires the use of three directional inputs, not two. Lastly, the applicant is requested to explain whether the same approach of using only 40% of vertical seismic demand acting upward was also utilized for the overturning stability evaluation, and if so, provide the basis for this approach or alternatively, follow the guidance in the SRP.

6) The DCD markup for Section 3.8.5.5.2 should be enhanced to provide more details on the analysis approach and to incorporate revisions to address the above items.

KHNP INPUT

KHNP needs to discuss whether this feedback is based on the staff’s review of KHNP’s final RAI response.

Item to be discussed:

See KHNP input.

35. RAI 255-8285, Question 03.08.05-17

Notes 12/7/15: Discussed at public meeting

3/15/16:

For the dynamic differential settlement due to seismic loading, the following items should be addressed:

1) The third paragraph of the RAI response states: “For the detailed evaluation of dynamic differential settlement, all of the displacement data corresponding to all time steps are checked. Table 1 summarizes the maximum displacement, the minimum displacement, and the differential settlement at the time when the differential settlements are maxima for each soil profile.” Clarify whether Table 1 summarizes the maximum displacement, the minimum displacement, and the differential settlement between every pair of adjacent nodes, or explain how the differential settlement was calculated.

2) For seismic loading, explain why is only the Z – input from SASSI considered and presented in Table 1, and not all three directions and the combined results from the three directions. The final calculation of differential displacements should consider all three directions of seismic input.

3) In Table 1, explain what does the heading “Distance” mean since it is a large dimension and not the distance between adjacent nodes.

4) The third paragraph of the RAI response states: “As a result, the maximum differential settlement in Table 1 is approximately 0.0075 ft. (0.09 in.), which is also less than 0.1 inch.” However, Table 1 indicates that 0.0075 ft corresponds to the difference between maximum and minimum displacements and the “Differential Settlement per 50 ft” is shown in a different column with a different value of 0.015 ft. Thus, explain the apparent inconsistency in the text and the table. Also, explain how the values in the Differential Settlement column are calculated from the other entries in the table and whether these represent the maximum differential displacements between every adjacent pairs of nodes.

5) Explain why the displacements for D + L, and the combined differential displacements for D + L + Es were not provided. If the displacements for Es are not done step by step throughout the time history (i.e., only maximum differential values are used) or the responses due to the three components of the earthquake input are combined by SRSS method (where the sign of the displacements are not known), then consideration of plus and minus for seismic displacements should be considered.

6) Explain why the response discusses the differential displacements are less than 0.1 inch when DCD Tier 1, Table 2.1-1 indicates the

"Maximum Differential Settlement inside Building" is "12.7 mm (0.5 in) per 15.24 m (50 ft) in any direction." In this case, also explain whether this criterion refers to only gravity loads (D+L) or the worst loading combination, and what that is. DCD Tier 1 should be updated to clarify under what loading the criterion applies.

Differential settlement between the NI common basemat and the TGB basemat, the following items should be addressed:

1) The paragraph following Table 1 states: "Technical report, APR1400-E-S-NR-14006-P, Rev. 1, "Stability Check for NI Common Basemat," Table 4-3 presents the maximum settlement values obtained from evaluating all nodes in the bottom of the NI common basemat and the TGB basemat for soil cases S1, S4, and S8." The title of Table 4-3 refers to "Static Loading Case." Confirm that the data in the table includes D+L+Es, in which case explain why the term "Static Loading Case" is used.

2) From the data in the table, it appears that the differential settlement is calculated by taking the difference between the total displacements of the NI basemat and the TGB basemat. While the D+L displacement is downward, the seismic displacements can be plus or minus. Therefore, explain why the differential displacement calculation does not consider the plus and minus values for the seismic displacements within each of the adjacent two structures (resulting in a pair of total displacements – max and min), and then the differential displacements between the two structures use the worst case difference of the pairs of displacements from the two structures (i.e., max of NI and min of TGB, and min of NI and max of TGB).

3) The response to the trending of results based on the soft to stiff soil cannot be judged until the differential settlements are updated to reflect the above items.

4) Similar to Item (6) above, DCD Tier 1, Table 2.1-1 indicates the "Maximum Differential Settlement between Buildings" is "12.7 mm (0.5 in)." Explain whether this criterion refers to only gravity loads (D+L) or the worst loading combination, and what that is. DCD Tier 1 should be updated to clarify under what loading the criterion applies.

KHNP INPUT

For the dynamic differential settlement due to seismic loading:

1) Based on SASSI analysis corresponding to soil cases, the displacement of all three directions (X, Y, and Z) was computed on check point shown in Figure 4-5 of the technical report, APR1400-E-S-NR-14006. Based on the calculated displacements, Table 1 is summarized according to following procedure.
   a) Choose the maximum and minimum displacement within check points (basemat SASSI nodes) and then calculate the differential settlement corresponding to each time step.
   b) Envelope the calculated differential settlement. (Column 4 of Table 1)
   c) Differential settlement summarized in Table 1 was calculated by following rule to evaluate differential settlement per 50ft. (Column 6 in Table1 1)

$$\frac{(A - B) \times 50}{\text{Distance}}$$

   Where, A is maximum displacement
   B is minimum displacement
   d) Repeat steps a) to c) corresponding to seismic excitation and soil profiles.

   According to procedure above, the results such as maximum and minimum displacement are summarized in Table 1 of response.

2) This response will be revised to incorporate the all three directions of seismic input. The revised response will be provided before the next Bi-Weekly Meeting.

3) The heading ‘Distance’ means the distance between the node for maximum displacement and the node for minimum displacement.

4) The detailed procedure how to check the differential settlement under seismic loading is discussed in above 1). As mentioned above, the differential settlement checked the difference between maximum and minimum displacement under same time. It is not calculated for every adjacent pairs of nodes.

5) This response will be added to incorporate the differential settlement for D+L+Es. The revised response will be provided before the next Bi-Weekly Meeting.

6) Differential settlement inside buildings described in DCD Table 2-1 is criterion under static loading cases (D+L). The value of 0.1in has no meaning, just expression of small differential settlement.

Differential settlement between the NI common basemat and TGB basemat:

1) The differential settlement between the NI common basemat and TGB basemat was checked under the static loading case (D+L). So, the table 4-3 in technical report, “APR1400-E-S-NR-14006-P, Rev.1” indicated the term “Static Loading Case”.
2) As above-mentioned, the differential settlement between the NI common basemat and TGB basemat was not checked under seismic loading cases. It was just considered under static loading cases.
3) The differential settlement between NI basemat and TGB basemat for seismic load could not be checked because seismic analysis for Turbine building is not performed. If it required, it will be added as COL information.
4) Refer to the response in item 6) above.

Item to be discussed:

The staff review and feedback on the KHNP response provided above is required.

36. RAI 255-8285, Question 03.08.05-4

Notes 12/7/15: Discussed at public meeting

3/14/16:

- DCD Tier 2, Section 3.4.1.2 states that “All below-grade exterior walls and basemats of seismic Category I structures are thickened by more than or equal to 0.6 m (2 ft) to protect against water seepage, as required in SRP Section 14.3.2.” This statement is consistent with SRP 14.3.2 which indicates the 0.6 m (2 ft) provides protection against water seepage, under the SRP section on flood, wind, tornado, rain and snow. While this thickness provides protection against water seepage for shorter time periods under a flood or rain condition, it is not clear that it provides waterproofing protection against degradation of reinforcement and concrete, and it does this under a continuous hydrostatic head and against potential aggressive

soil ground conditions for long periods of time (e.g., +60 year design life)

- Regarding the reference to COL 3.8(3), it’s not clear if it is appropriate in the DC phase to say no waterproofing membranes are used, and to delegate the determination of what concrete mix in design would be needed to prevent concrete degradation.

KHNP INPUT

KHNP needs to discuss whether this feedback is based on the staff’s review of KHNP’s final RAI response.

Item to be discussed:

See KHNP input.

37. RAI 255-8285, Question 03.08.05-8

Notes 12/7/15: Discussed at public meeting

KHNP 1/29/16: Delayed due to incorporating a racking evaluation and due to providing a justification for phasing consideration between structures and directional combination of seismic excitation as discussed in NRC meeting dated on Dec. 8th.

KHNP INPUT

KHNP will submit the final RAI response to the NRC by 06/15/2016 seismic call meeting.

Item to be discussed:

None

38. RAI 255-8285, Question 03.08.05-1

03.08.05-1
Notes 12/7/15: Discussed at public meeting

a. While some additional structural members were added, the following locations are still not included as critical sections and should be, unless otherwise justified. These sections are considered to be needed in view of their importance to safety, relatively large forces, representative of different

configurations or materials, and/or utilization of different or unique analysis/design procedures and/or codes:

1. Floor slab between the SSW and the containment

2. Containment steel liner plate/anchorage (this should be identified as a critical section and the description of the analysis approach, design procedure, criteria, and results should be expanded)

3. Concrete column or beam (see below)

4. Steel column or beam (see below)

   Regarding the statement in the response: “Practically, there is no concrete or steel column in the reactor containment building,” if there are any concrete or steel columns in any seismic Category I structures, then at least one highly loaded concrete column or beam and one highly loaded steel column or beam should be included as a critical sections, unless otherwise justified.

   Regarding the statement in the response: “steel beams are out of scope,” clarify why these are out of scope. If the design of steel beams is being deferred to the COLA, then that does not eliminate the need to include at least one of the steel columns or beams as a critical section based on the criteria described above in the staff’s question, or alternatively, a Combined License Information (COL) item should be considered.

b. Acceptable

c. Acceptable

KHNP INPUT

KHNP is reviewing the NRC feedback provided on 05/26/2016 regarding Question 03.08.05-1(a), and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

39. RAI 267-8301, Question 03.07.03-2

Notes Requested supplemental response to improve DCD markup.

KHNP INPUT

KHNP has submitted the final RAI response to the NRC on 05/26/2016.

Item to be discussed:

None

40. RAI 267-8301, Question 03.07.03-5

Notes 2/13/16: KHNP will be provide a supplemental response by 2/26/16

KHNP INPUT

KHNP has submitted the final RAI response to the NRC on 05/26/2016.

Item to be discussed:

None

41. RAI 249-8323, Question 03.08.01-15

Notes Original Due Date: 11/13/15

12/7/15: Discussed at public meeting

(2/22/2016)

The staff reviewed the applicant response and considered the response to be confirmatory, on the premise that the applicant includes Table 1, "Computer Programs for Seismic Category I Structures," in the DCD. Note: The adequacy of these analyses and designs of the structures; the confirmation of the V&V; and the implementation of the design approach to the various critical sections (in accordance with ASME Section III, Subsection CC, provisions) will be reviewed separately during the upcoming audit.

KHNP INPUT

KHNP will provide the revised draft response associated with this RAI including the markup of Table 1, “Computer Programs for Seismic Category I Structures”, to the staff by 06/03/2016.

Item to be discussed:

None

42. RAI 320-8383, Question 03.08.05-19

a. The staff will interface with Chapter 2 reviewers -- the staff's understanding is that the NRC 2.5.4 reviewers are normally the lead on this topic and the NRC structural staff provides support to this item. The staff would evaluate how the concrete fill was modeled in the seismic analysis and if the design information is acceptable to resist the demand forces in Section 3.7. Since the compressive strength, Poisson’s Ratio and unit weight is given in Table 5-2 of TR APR1400-E-S-NR-14003-P, and based on the response to Item b. below, the staff presume that the seismic reviewers are satisfied if it was accounted for properly in the seismic analysis. However, staff will confirm this with 3.7 reviewers.

   Regarding the design adequacy for resisting demand loads, the RAI question of “What is the design criteria for the lean concrete?” has not been provided, so this should be addressed. Also, the results of the design of the lean concrete to withstand the applicable loads should be provided.

b. Acceptable - check with 3.7

c. Acceptable

d. Acceptable

e. The staff's understanding is that lean concrete used to replace non competent soil and to provide a uniform and level layer of subsurface foundation material, does not need to be reinforced, unless the lean concrete alone is not sufficient to resist the applied loads. Therefore, this item should be addressed as part of Item a. above, i.e., what are the design criteria and results of design used for the lean concrete layer?

KHNP INPUT

KHNP is reviewing the staff feedback provided on 05/26/2016 about these items, and is requesting that these items be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

43. RAI 183-8197, Question 03.07.02-1

KHNP has provided the convergence criteria, which were to be used for the SSI analysis for inclusion of higher modes, at the April 06 bi-weekly seismic call. In these convergence criteria, it is stated that a supplementary study will be performed to confirm that the cumulated effect of modes higher than 16 is insignificant.

It was originally intended that the supplementary study be performed using the same procedure and analysis program (modified EPRI INCOH module and ACS SASSI) which were applied to the HRHF SSI analysis of APR1400 DC NI structures. Around April 06, KHNP was experiencing some difficulties to gain access and modify the source code of EPRI INCOH module to perform the supplementary study. KHNP decided to use ACS SASSI and ACS SASSI internal INCOH module because it was relatively easy to access the source code and follow up. Since that time, the EPRI INCOH module is secured and ready to be modified to support the application of the supplementary study.

Hence, KHNP would like to perform the supplementary study using the same procedure and programs (EPRI INCOH module and ACS SASSI) as it were originally used for APR1400 NI structures.

The modified convergence criteria will be provided to the staff for review.

Also see Attachment 2 for addition information.

44. RAI 227-8274, Question 03.08.04-5

The staff feedback:

Question No.03.08.04-5 (e): Is the stability load (s) in Table 3.8-9B and in your RAI response a value, or a number, for a shear wall or a moment frame, and how was it calculated? Provide justification for stating that there is no need to consider the overall stability

loads if the effects of wind or seismic loads on the structure are significant. How were the column stability loads (SC) and girder stability loads (SG) in your RAI response obtained or calculated, and what are their relationships to the shear wall or moment frame stability load (s)? How do you define "horizontal bracing" and "vertical bracing diagonals"? Explain the meaning of your statement "Additional load combinations shall be utilized as necessary to delete stability loads from the design of their structural elements, such as columns and anchor bolts." Explain why P-D analyses are not required for stability loads. The response and markup need to be completely rewritten.

KHNP INPUT

KHNP is reviewing the staff feedback provided on 05/26/2016 regarding Question No. 03.08.04-5 sub-part (e), and is requesting that this item be discussed during the 06/15/2016 bi-weekly seismic call.

Item to be discussed:

None

Outstanding Draft RAI Responses

RAI	Question	Draft Due Date	Draft Provided	Feedback Provided	Action With
182-8160	03.07.01-4	6/17/2016	4/6/2016	5/18/2016	KHNP; send
182-8160	03.07.01-1	6/30/2016	4/29/2016	5/18/2016	KHNP; need item 'c'
182-8160	03.07.01-2	N/A	4/29/2016	N	NRC
252-8299	03.07.02-7e	7/31/2016	N	N/A	KHNP
252-8299	03.07.02-7 item a.)i.)	6/16/2016	4/29/2016	04/29/2016	KHNP
252-8299	03.07.02-9	TBD	N	N/A	KHNP
252-8299	03.07.02-10	6/15/2016	N	4/20/2016	KHNP
252-8299	03.07.02-11	7/31/2016	N	N/A	KHNP
129-8085	03.08.01-1	N/A	5/17/2016	N	NRC
129-8085	03.08.01-2	N/A	4/29/2016	N	NRC
129-8085	03.08.01-4	N/A	4/20/2016	N	NRC
129-8085	03.08.01-5	N/A	4/29/2016	4/20/2016	KHNP
226-8235	03.07.02-5	N/A	4/27/2016	N	NRC
226-8235	03.07.02-6	8/12/2016	N	N/A	KHNP
183-8197	03.07.02-1	8/12/2016	N	N/A	KHNP
183-8197	03.07.02-4	6/10/2016	5/17/2016	4/6/2016	NRC
199-8223	03.08.01-8	6/3/2016	N	N/A	KHNP
199-8223	03.08.01-9	6/3/2016	N/A	5/18/2016	NRC
199-8223	03.08.01-10	N/A	4/28/2016	N	NRC
199-8223	03.08.01-13	N/A	4/28/2016	N	NRC
200-8225	03.08.02-2	6/30/2016	4/4/2016	4/29/2016	KHNP
227-8274	03.08.04-3	6/3/2016	5/3/2016	5/4/2016	KHNP
267-8301	03.07.03-1	6/9/2016	N	N/A	KHNP; send
208-8245	03.08.03-5	6/15/2016	N	4/29/2016	KHNP
255-8285	03.08.05-7	6/3/2016	N	4/29/2016	KHNP; send
255-8285	03.08.05-9	6/3/2016	N	4/29/2016	KHNP; send
255-8285	03.08.05-16	N/A	4/19/2016	N	NRC
255-8285	03.08.05-18	6/3/2016	3/21/2016	4/29/2016	KHNP; send
253-8300	03.07.01-5	6/3/2016	5/17/2016	5/18/2016	KHNP
253-8300	03.07.01-8	TBD	4/4/2016	5/4/2016	KHNP

Other RAI status

RAI	Question	Comment
227-8274	03.08.04-4	KHNP will provide revised draft by 06/15/2016
227-8274	03.08.04-7	Draft response is included in the agenda
227-8274	03.08.04-9	Final RAI response provided on 04/19/2016
208-8245	03.08.03-1	Need date for feedback response
208-8245	03.08.03-3	Need date for feedback response
208-8245	03.08.03-4	KHNP will provide revised draft by 06/15/2016
208-8245	03.08.03-6	Draft response is included in the agenda
208-8245	03.08.03-7	Need date for feedback response
208-8245	03.08.03-8	Need revised submittal date
248-8295	03.08.05-1	Need date for feedback response
267-8301	03.07.03-2	Final RAI response provided on 05/26/2016
267-8301	03.07.03-3	Feedback provided on 5/14/2016
267-8301	03.07.03-5	Final RAI response provided on 05/26/2016
199-8223	03.08.01-15	KHNP will provide revised draft by 06/03/2016
255-8285	03.08.05-1	Need date for feedback response
255-8285	03.08.05-4	Need staff clarification on this feedback
255-8285	03.08.05-8	KHNP will submit final response by 06/15/2016
255-8285	03.08.05-11	KHNP will submit final response by 06/10/2016
255-8285	03.08.05-12	KHNP will submit final response by 06/10/2016
255-8285	03.08.05-13	Draft response on Table 1 is included in the agenda Draft response on Table 2 will be provided by 06/15/2016
255-8285	03.08.05-14	Need staff clarification on this feedback
255-8285	03.08.05-17	Draft response is included in the agenda
320-8383	03.08.05-19	Need date for feedback response