

## **Bi-weekly Seismic Call Minutes**

**Date:** 2016-05-03

**NRC Attendance:** John Vera, Vaughn Thomas,

**KHNP Attendance:** Steven Mannon, Sunguk Kwon

**KEPCO E&C Attendance:** Jinwoo Lee, Jaewan Park, Changkyu Lee, Joohyung Kang, Donghyun Yoo, Kyeongin Jeong, Doyeon Kim, Daejoong Kim, Jinho Cho, Yeonghun Kim, Hoonin Cho, Bongrae Kim, Kwanghoon Koh, Seokhwan Hur

**Public Attendance:** None

### **Topics:**

1. RAI 199-8223, Question 03.08.01-11

KHNP has revised the draft response to include the information provided during the 2016-03-23 teleconference and provided the revised draft on 2016-04-19. Discussion regarding the revised response is to take place.

NRC accepted the draft response and requested that KHNP submit the formal response.

2. 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.

The following three items need to be included in the draft response to be reviewed in the next scheduled call:

a.) Add as an attachment, the English version of the current Attachment 2 that was sent to the NRC on April 19, 2016 and provide a discussion in the response section on the reason for the two versions.

b.) 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.

- c.) KHNP needs 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.

3. RAI 252-8299, Question 03.07.02-9

KHNP is still examining the cause of the abnormal ISRS for the S05 profile. KHNP anticipates the supplemental response can be produced by 2016-05-27. KHNP is to report any progress regarding determination of the cause of the EDGB & DFOT S5 behavior.

KHNP Input

KHNP has investigated whether numerical error exists in the EDGB and DFOT SSI analysis model for the S5 soil case, but no numerical error has been identified.

KHNP has performed the SSI analyses using separated superstructure models for the EDGB and DFOT, respectively, to find the cause of abnormal responses in the ISRS for the S5 soil case. The results of the separated SSI analysis using only the EDGB model are reasonable, but the results using only the DFOT model are still abnormal. Thus, KHNP has performed an additional SSI analysis using only the DFOT model with some modifications. These modifications include changing of backfill properties from structural fill granular to lean concrete and changing of the mesh configuration of the entire backfill from irregular to regular. The results of the additional SSI analyses using the modified DFOT model are found to be reasonable.

Since the EDGB and DFOT structures are adjacent to the NI structure and their embedment depths are different from each other, the backfill mesh configurations of the coupled EDGB and DFOT model are irregular and complex, while the backfill mesh configuration of the NI structure model is regular and simple. Therefore, KHNP assumed that mesh configuration and properties of the backfill model in the coupled model are the major causes of the abnormal ISRS.

(added for 2016-05-03)

To investigate the aforementioned assumption, KHNP has performed two SSI cases for the DFOT model (by itself) with partially changed backfill. One is a model using lean concrete as properties of EDGB side backfill. The other is a model using a modified mesh configuration for the backfill. The results of the analyses are lower than the original abnormal results, but these results are not enveloped by the ISRS. KHNP also performed an SSI analysis using a coupled EDGB and DFOT model which changed backfill properties of elements which are located between EDGB and DFOT from structural fill granular to lean concrete properties. The results of the analyses are shown in Attachment 1 to this agenda.

KHNP is continuing to perform SSI analyses to find out the main cause of the abnormal behavior by using a coupled EDGB and DFOT model which has modified mesh configurations.

The NRC wanted to know if the same mesh was used for all other cases. Overall the NRC wanted KHNP to provide more detail when the final conclusion has been reached and the evaluation has been completed; example, were the backfill and volumes used the same? The NRC does not recommend including lean concrete for backfill in the evaluation since that is not going to be used in the APR1400 and it is not evident how that would contribute to the intentions of the analysis. This issue will no longer be discussed until the conclusions are reached and a draft response can be provided.

4. 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).

KHNP INPUT

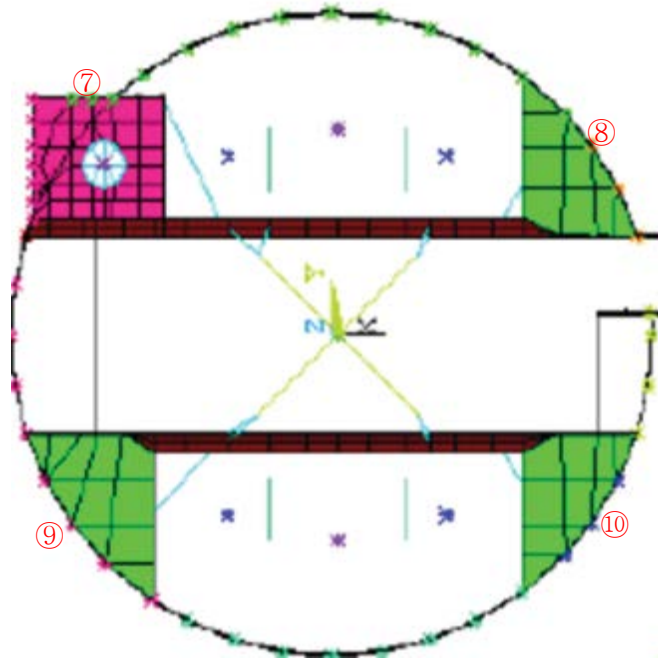
There are some small horizontal surfaces in the reactor containment building other than those horizontal surfaces between the secondary shield wall (SSW) and the containment shell. The small horizontal surfaces which are not between the SSW and the containment shell are modeled in the reactor containment building seismic analysis model. The following figure shows the horizontal surfaces modeled in the reactor containment building seismic analysis model compared to those those horizontal surfaces shown in DCD Tier 2, Figure 1.2-2, "General Arrangement Reactor Containment Building Section A-A"

on page 1.2-48, which was referred to by the NRC staff during the last bi-weekly seismic call.

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In addition to the six horizontal surfaces shown in the figure above, four horizontal surfaces also exist in the reactor containment building, as shown in the figure below.



Since the ten horizontal surfaces labeled above are relatively small, the seismic live loads of those surfaces were ignored in the last study for evaluation of seismic live load effect on seismic response of the reactor containment building.

Therefore, the revised ISRS comparisons, which show the effect of seismic live loads distributed on all horizontal surfaces as well as those horizontal surfaces between the SSW and the containment shell, are provided below. As shown in the figures below, the comparison results indicate that the variation of ISRS due to the consideration of the seismic live load in the RCB seismic analysis model is negligibly small. Therefore, it can be concluded that the effect of seismic live load on the RCB seismic response is insignificant.

The total weight of the seismic live load which is included in this evaluation is 1,650 kips, while the total weight of the reactor containment building internal structure is 183,000 kips.

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(a) Comparison of ISRS at SSW EL. 114'-0"

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(b) Comparison of ISRS at SSW EL. 136'-6"

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(c) Comparison of ISRS at SSW EL. 156'-0"



The NRC sent comments on the previous version of the draft response at the same time KHNP set a revised draft; therefore, KHNP needs to review the NRC comments and determine if the sent draft adequately incorporates the comments or if additional changes need to be made.

The NRC stated that RAIs 8299 and 8245 need to be responded to together since the subject matter is related.

The main issue that the NRC has is that the adequacy of the reactor containment walls is discussed, but the slab also needs to be addressed. Specifically whether the slab is considered flexible or rigid and if flexible, how is it determined that the mesh is adequate for the increased frequency response? How is out-of-plane behavior addressed in the modeled and non-modeled cases?

5. RAI 183-8197, Question 03.07.02-4

KHNP is to provide the revised response which includes the EDGB & DFOT.

KHNP INPUT

KHNP is experiencing technical challenges. An investigation of how previous applicants have resolved contact ratio issues is underway. KHNP anticipates being able to provide a draft due date during the next bi-weekly call on 2016-05-18.

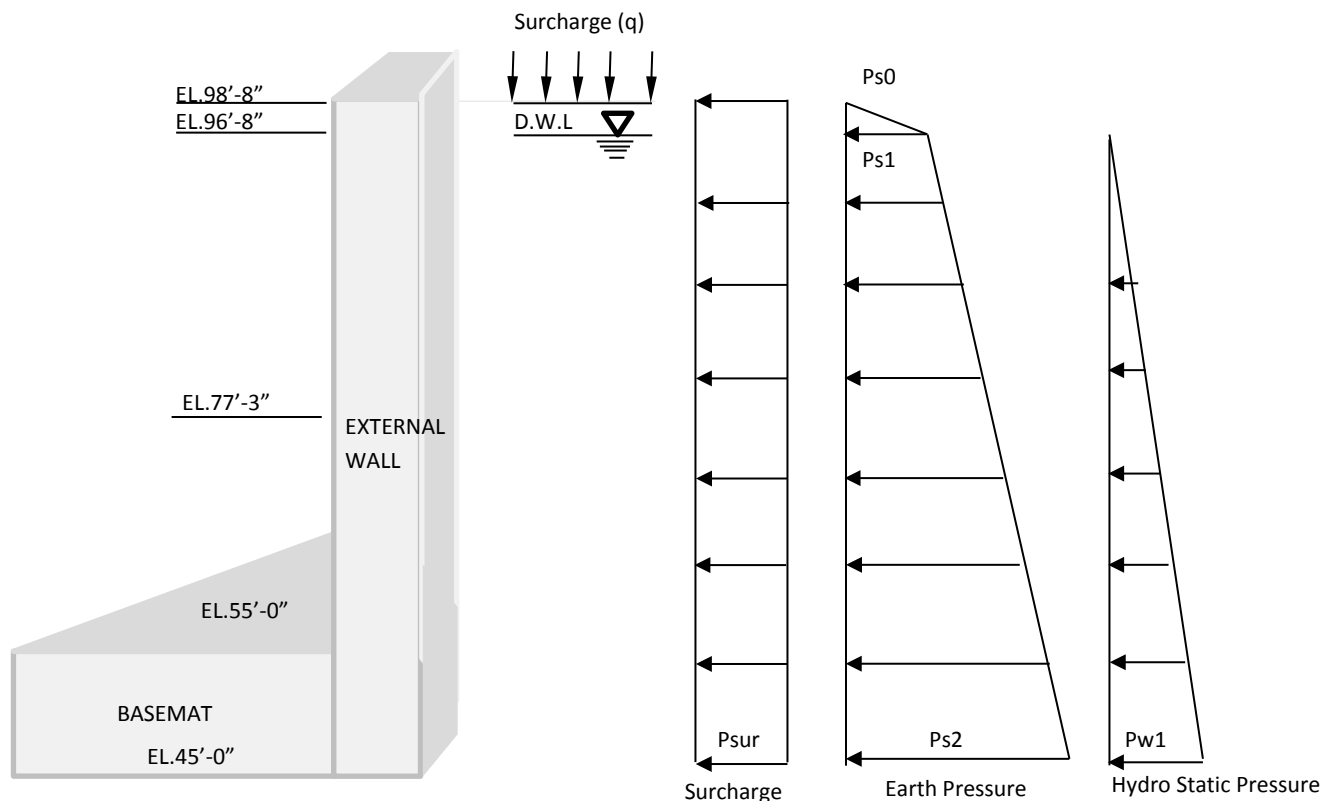
The staff reiterated that they agree with the methodology used for the nuclear island and expects that the same be used for the EDGB and DFOT. They understand that the technical challenges have been resolved and will look forward to reviewing the draft response soon.

6. RAI 227-8274, Q 03.08.04-4

KHNP is to explain why  $L_g$  is only applied up to two feet below grade.

KHNP Input

The soil and surcharge load ( $L_g$ ) include hydrostatic pressure, surcharge load, and earth pressure. The response in RAI 227-8274 Question 03.08.04-4 is focused on the description of the water pressure, so the response explains the height for the hydrostatic pressure. The hydrostatic pressure is applied up to two feet below grade. Earth pressures are applied up to the grade level, as shown in the figure below.



The provided response is acceptable and can be incorporated into a draft response. Revision 2 of the RAI response which will incorporate the above discussion also needs to delete the statement pertaining to the "maximum" level.

7. RAI 199-8223, Q 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.

Similar wording for inspection and testing that was added to 3.8.1 for the concrete needs to be added to Section 3.8.2 for the steel portions of containment. The NRC reviewers have passed this section on to the Chapter 6 reviewers and will provide any comments that they might have.

8. RAI 255-8285, Question 03.08.05-7

KHNP INPUT

KHNP would like to discuss the response approach for RAI 255-8285 Question 03.08.05-7 regarding the work scope of the evaluation of settlement due to construction sequences.

1. Under the site properties in DCD Table 3.7A-1, the construction sequence analysis will not affect the design of the basemat and superstructure. Because the settlement is dependent on the amount of applied load when considering sand characteristics, the settlement during construction will be smaller than the settlement under the as-built condition described in the technical report.
2. If the construction sequence is necessary to check item 1, KHNP plans to execute the construction sequence analysis based on the following assumptions. Confirmation that the NRC staff agrees that the assumptions are reasonable before work begins is desired.
  - 1) The site properties described in DCD 3.7A-1 are used in the construction sequence analysis.
  - 2) Based on assumption 1), the short-term settlement will be checked and considered.
  - 3) The analysis will use the construction sequence of Shin-Kori units 3,4 instead of the actual construction sequence which would be specified by a COLA.
  - 4) If the settlement for the construction sequence does not exceed the allowable settlement presented in DCD Table 2.0-1, the effects on the design for the seismic category I structures due to the construction sequence analysis will not be accounted for.

KHNP needs to review the NRC comments that were recently transmitted and incorporate any necessary changes into the response. NRC stated that RAI Questions 7, 9, and 18 need to be responded to concurrently since the material is related as they have provided comments together.

9. RAI 255-8285, Question 03.08.05-16

KHNP INPUT

KHNP has provided a draft revised response to address issues regarding the static elastic modulus, as discussed during the December 2015 meeting. KHNP would like to hear any feedback the NRC staff might have to offer.

NRC will review our responses that were recently provided and respond shortly.

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.

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 to move the final due date to 2016-06-03 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 better that schedule. An update on the preliminary results for the appropriateness of the time histories will be targeted for the next meeting.

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

Feedback regarding Questions 03.07.01-1 and 2 has been provided by the NRC staff. Discussion regarding the feedback is to take place.

KHNP INPUT

The response to feedback provided by the NRC is described in Attachment 2. The draft revised response has been provided to the NRC staff (2016-04-29).

For Question 1, the NRC reviewers had the following comments:

- a.) In the response to (a)(3), the paragraph states what is done if there is a close match between the time history response spectra and the CSDRS, but it also needs to address if there is not a close match. Similar language that is used in the last sentence of the added paragraph in the Attachment page 5 of 14 should be used in the response to this item also.
- b.) In comparing Figure 3.11 to 3.12 in the response to (b), it is stated in the response that it is very consistent with,

but slightly lower in amplitude which does not appear to be accurate. The staff agrees that it is close, but cannot state without further justification that it is conservative. Change (delete slightly lower or higher, conservative) the description with an appropriate word such as "closely matched."

- c.) KHNP needs to specify a revised date in the response to (c).
- d.) KHNP needs to review the equation specified in response to (d) since it appears that  $\text{in}^2/\text{sec}^4/\text{rps}$  should be divided by two times pi rather than multiplied.
- e.) In the mark-ups on page 1 of 14 the first added paragraph, the use of conservative is not accurate. In the second added paragraph the first sentence, it is not clear what "30 time histories of each of the CRDRS compatible..." is referring to. Also the second sentence is not a complete sentence.
- f.) The wording of the added paragraph on page 3 of 14 needs to correlate to the revised wording in the response.

For Question 2, the response provided appears to be appropriate, but the NRC requested that KHNP not finalize it until the NRC completes their confirmation.

#### 13. RAI 129-8085, Q 03.08.01-2 and 5

The NRC staff provided feedback regarding Questions 03.08.01-2 and 5. Discussion regarding the feedback is to take place.

#### KHNP INPUT

The response to the feedback provided by the NRC is described in Attachment 3 and the draft revised response has been provided to the NRC staff (2016-04-29).

KHNP needs to review the comments provided by the NRC and incorporate them into the recently provided response as necessary.

#### Outstanding Draft RAI Responses

RAI	Question	Draft Due Date	Draft Provided	Feedback Provided	Action With
182-8160	03.07.01-4	N/A	4/6/2016	N	NRC
182-8160	03.07.01-1	N/A	4/29/16	N	NRC
182-8160	03.07.01-2	N/A	4/29/16	N	NRC
252-8299	03.07.02-7	7/31/2016	N	N/A	KHNP
252-8299	03.07.02-7 item a.)i.)	N/A	4/29/2016	N	NRC
252-8299	03.07.02-9	5/27/2016	N	N/A	KHNP
252-8299	03.07.02-10	5/31/2016	N	4/20/2016	KHNP
252-8299	03.07.02-11	7/31/2016	N	N/A	KHNP

252-8299	03.07.02-12	N/A	3/22/2016	3/31/2016	KHNP (Est. 5/6/2016)
252-8299	03.07.02-14	TBD	N/A	4/21	KHNP
129-8085	03.08.01-1	N/A	2/19/2016	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	N	NRC
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	5/13/2016	N	4/6/2016	KHNP
199-8223	03.08.01-8	6/3/2016	N	N/A	KHNP
199-8223	03.08.01-9	N/A	4/19/2016	N	NRC
199-8223	03.08.01-10	N/A	4/28/2016	N	NRC
199-8223	03.08.01-11	N/A	4/19/2016	N	NRC
199-8223	03.08.01-13	N/A	4/28/2016	N	NRC
200-8225	03.08.02-2	N/A	4/4/2016	4/29/2016	NRC
227-8274	03.08.04-1	N/A	3/4/2016	4/6/2016	4/19/2016
227-8274	03.08.04-3	N/A	3/23/2016	N	NRC
227-8274	03.08.04-4	TBD	N	4/6/2016	4/19/2016
227-8274	03.08.04-9	N/A	3/4/2016	4/6/2016	4/19/2016
267-8301	03.07.03-1	N/A	5/4/2016	N/A	KHNP
267-8301	03.07.03-3	TBD	3/30/2016	4/28/2016	KHNP
208-8245	03.08.03-5	TBD		4/29/2016	KHNP
208-8245	03.08.03-9	TBD		4/29/2016	KHNP
255-8285	03.08.05-7	N/A	4/4/2016	4/29/2016	NRC
255-8285	03.08.05-16	N/A	4/19/2016	N	NRC
255-8285	03.08.05-18	N/A	3/21/2016	4/29/2016	NRC
253-8300	03.07.01-5	TBD	3/30/2016	4/28/2016	KHNP
253-8300	03.07.01-8	N/A	4/4/2016	N	NRC

One additional item that was discussed pertained to KHNP's response to Question 03.07.01-5. The low strain soil profiles were provided and the reviewers wanted to see the generic profiles. KHNP stated that these soil profiles would be provided by 5/11.