CCNPP3eRAIPEm Resource

From: Arora, Surinder
Sent: Tuesday, April 26, 2011 2:03 PM
To: 'Poche, Robert'; 'cc3project@constellation.com'
Cc: CCNPP3eRAIPEm Resource; Chakrabarti, Samir; Hawkins, Kimberly; Colaccino, Joseph; Miernicki, Michael; Wilson, Anthony; Vrahoretis, Susan
Subject: Draft RAI 304 SEB2 5717
Attachments: Draft RAI 304 SEB2 5717.doc

Rob,

Attached is Draft RAI No. 304 (eRAI No. 5717). You have until May 10, 2011 to review it and decide whether you need a clarification phone call to discuss any questions in the RAI before the final issuance. After the phone call or on May 10, 2011, the RAI will be finalized and sent to you for response. You will then have 30 days to provide a technically complete response or an expected response date for the RAI.

Thanks.

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Hearing Identifier: CalvertCliffs_Unit3Col_RAI
Email Number: 110

Mail Envelope Properties (B46615B367D1144982B324704E3BCEED6AD0498DFB)

Subject: Draft RAI 304 SEB2 5717
Sent Date: 4/26/2011 2:02:43 PM
Received Date: 4/26/2011 2:02:49 PM
From: Arora, Surinder

Created By: Surinder.Arora@nrc.gov

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Post Office: HQCLSTR01.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	643	4/26/2011 2:02:49 PM
Draft RAI 304 SEB2 5717.doc	46586	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Request for Additional Information No.304 (eRAI 5717)
DRAFT
4/26/2011

Calvert Cliffs Unit 3
UniStar
Docket No. 52-016
SRP Section: 03.07.02 - Seismic System Analysis
Application Section: FSAR 3.7.2

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)

03.07.02-54

Follow-Up Question to 03.07.02-42

In Question 03.07.02-42, the staff asked the applicant to demonstrate that the structural model was sufficiently detailed such that further refinement would have a negligible effect on the analysis results (see SRP 3.7.2, Acceptance Criteria 3.C.ii) and to demonstrate that the SSI modeling of the soil was sufficiently detailed such that the frequency range of interest of the earthquake time history input to the structure was not limited by the size of the finite elements used to model the soil (see SRP 3.7.1, Structural Acceptance Criteria 4.A.vii). In its response, the applicant provided a basis for the mesh size of the soil in the vertical direction. This was based on the lower bound soil properties of Table 3F-7 and a requirement to capture the earthquake input up to a frequency of 50 Hz. However, any limitations or requirements for the mesh sizes in the horizontal direction which are shown in Figure 3.7.2-27 were not described nor was the vertical mesh size defined for elevations below elevation -27.5 feet. In addition, on page 12 of Enclosure 2 it states the mesh size in the vertical direction is 1.6 feet, not the 1.5 feet provided in the applicant's response. Because the information provided only addresses the mesh size in the vertical direction above elevation -27.5 feet, and does not address whether the structural model is sufficiently detailed, the applicant is requested to provide the following additional information in order for the staff to conclude that the structure and the soil models are sufficiently refined and meet the SRP criteria mentioned above:

1. Provide for the horizontal directions the soil model mesh size for elevations both above and below elevation -27.5 feet and their technical basis.
2. Provide the basis for the mesh size in the vertical direction below elevation -27.5 feet.
3. Resolve the discrepancy between the mesh size of 1.5 feet and 1.6 feet.
4. Demonstrate, as originally requested, whether the dynamic structural model is sufficiently detailed such that further refinement will have a negligible effect on the solution results.

03.07.02-55

Follow-Up Question to 03.07.02-43

Because the amount of concrete cracking under combined earthquake and other loads can affect the seismic response of a structure and therefore the building design, the staff in Question 03.07.02-43 asked the applicant to provide the results of an analysis which verifies the applicant's statement that only the east and west forebay walls will crack and that the other walls and slabs remain uncracked under the applicable loading conditions which include earthquake loads. The methodology for determining the stiffness of the structure and the amount of cracked vs. un-cracked sections outlined in the applicant's response is acceptable. However, to enable the staff to understand the details and results of the analyses that are presented, the applicant is requested to provide the following additional information:

1. The response states that in Figures 1-4 cracked elements are magenta and un-cracked elements are blue. The key in the upper left hand corner of each figure is not clear, and could be interpreted to imply just the opposite. The applicant is requested to clarify which elements are cracked and which are un-cracked by providing a key which clearly identifies which is which.
2. Provide the criteria that were used to determine that a section was cracked, and the loads and loading combinations that were used for this determination.

03.07.02-56

Follow-Up Question to 03.07.02-44

In Question 03.07.02-44, the applicant was requested to provide an analysis using the methods of ACI 350.3-06 to determine the convective seismic loads on the CBIS and to demonstrate that these loads are insignificant and have no effect on the structure's design. In its response, the applicant stated that both impulsive and convective loads are determined as part of the building response. In reviewing the revised write-up in FSAR Section 3.7.2.3.2 on page 13 of Enclosure 2 which describes the analysis for the hydrodynamic effect of water contained within the CBIS, it is not clear if the entire impulsive water mass calculated for the x, y, and z directions is included in the model for each direction of earthquake motion, or if only the impulsive water mass calculated for the x direction is included for an x-direction earthquake. As the mass of the water may not be trivial when compared to the mass of the structure, including the entire impulsive mass of the water (impulsive mass calculated for x, y, and z directions) for each direction of earthquake excitation could have an effect on the calculated response of the structure as the water mass may be overestimated by a factor of approximately three for each direction of the earthquake motion. Therefore, in order for the staff to conclude that the hydrodynamic effects of water is appropriately considered for design of the CBIS, the applicant is requested to provide additional information on the water mass that was determined for each direction of earthquake excitation and include the following information in its response:

1. Page 13 of Enclosure 2, Unistar letter UN#10-285 dated November 16, 2010, states that hydrodynamic loads are included for walls both in the forebay and the basement of the UHS Makeup Water Intake Structure. Identify whether there are other walls subject to hydrodynamic loads and whether the dynamic effect of the water contained within these walls been included in the SSI analysis. If there are other walls, please identify these and provide a technical justification if hydrodynamic effects were not considered.
2. If the total impulsive mass of water (x-direction, y-direction, and z direction) was included in the model for each direction of excitation, provide the technical justification as to why this is acceptable and what effect this has on the dynamic response of the structure.

3. Describe how the effects of the vertical earthquake were considered in determining the hydrostatic pressures acting on the walls. If they were not considered, provide suitable justification for this omission.
4. Explain why it was considered adequate to lump the entire water mass at the basemat nodes for vertical direction earthquake, and why amplification of vertical excitation of the water column need not be considered.
5. Acceptance Criteria 14 of SRP 3.7.3 cites TID 7024 as providing acceptable methods for determining the impulsive and convective modes of tank structures under earthquake loads. Please provide a comparison of the methods used in ACI 350.3-06 to those of TID 7024 explaining any differences between the two methods and the expected effect on the hydrodynamic response.
6. On page 13 of Enclosure 2, it states that the minimum height of water during a hurricane is used to determine the height of the water contained within the CBIS. Provide additional description as to why this is an appropriate design height for the water contained within the structure and how this water height is determined.
7. Provide the minimum and maximum depths of water in the forebay and state if the corresponding freeboards are sufficient to contain the sloshing of water during the SSE. If not, state the amount and consequences of water loss due to sloshing effects. Describe how the height of sloshing and subsequent water loss, if applicable, was determined.
8. Provide a figure depicting how the convective water mass is connected to the walls of the SASSI finite element model of the structure and describe, including equations, how this mass and spring constant was determined for each direction of motion.
9. Describe if soil structure interaction analysis of the CBIS considered the maximum and the minimum water levels expected during life of the plant. If not considered, provide justification for not doing so.

03.07.02-57

Follow-Up Question to 03.07.02-47

In Question 03.07.02-47, the applicant was requested to address why non-symmetry was ignored in the model development of the UHS EB and what affect the modeling assumptions had on the building's seismic response and the computed torsional loads for which the structure must be designed. The staff had requested this information to enable it to determine whether or not the response of the structure to a seismic event had been under-predicted by the assumption of building symmetry in which case it might not meet the requirements of General Design Criteria 2. In its response, the applicant stated that the UHS MWIS has been modified to include the electrical equipment, eliminating the need for a separate Electrical Building. The applicant's response addressed the modeling of the Common Basemat Intake Structure (CBIS), which now includes the equipment formerly contained in the USH EB; provided justification for assuming symmetry about a North-South plane, which bisects the structure; and, the use of a half model to determine the structure's seismic behavior. After reviewing the applicant's response, the staff requests that the applicant provide the following additional information so that it can determine the technical adequacy of using a half model for calculating the building's seismic loads:

1. Identify the basis for selecting the two points in the model for comparing responses of the half models with those of the complete structure. Discuss whether other points would show similar results.
2. Looking at Figure 12, the western half of the CBIS model under-predicts the response at 40 Hz by a significant amount. This does not appear to support the decision to use

the western half of the model for SSI analysis of the CBIS. The applicant should provide further justification for its decision to use the western half of the model as opposed to using the full finite element model.

3. The labeling of the vertical axis in Figure 12 of the response appears to be in error. The applicant needs to correct this.
4. As they directly affect the design of the structure, the applicant should provide a comparison of the ZPA values for each model at each elevation for each direction of excitation.
5. On page 14 of Enclosure 2, Unistar letter UN#10-285 dated November 16, 2010, it states that the earthquake excitation along the North-South and vertical directions cause symmetric loading on the structure, whereas the earthquake excitation along the East-West direction causes anti-symmetric and anti-symmetric loading on the structure. Given that the comparison of the half model results to the full model results demonstrate that the response of the structure is not symmetric, the applicant should revise the page 14 write-up.

03.07.02-58

Follow-Up Question to 03.07.02-53

In Question 03.07.02-53, the staff asked how the results of the SASSI analysis are used to determine forces and moments within the static model for building design. The response provided by the applicant only states that absolute accelerations are used. This description does not provide information in sufficient detail for the staff to understand how results of the SASSI analysis including hydrodynamic effects were used in the static model and conclude that the structure will meet the requirements of General Design Criteria 2 for earthquake loads. The applicant is requested to describe each step used to calculate the seismic moments and forces needed for the design of the structure starting with the structural accelerations due to each direction of earthquake excitation as determined from the SSI seismic analysis.

03.07.02-59

The last paragraph on page 11 of Enclosure 2, UniStar letter UN#10-285 dated November 16, 2010, includes two sentences which state, “The skimmer walls, at the entrance of the UHS Makeup Water Intake Structure and Circulating Water Makeup Intake Structure into the Forebay Structure, have an inclination of approximately 10 degrees with the vertical, which is neglected in the finite element model. This simplification has an insignificant effect on the global mass and stiffness distribution, and is conservative for the local response of structural panels.” This appears to be redundant to information provided in the last paragraph on page 12 of Enclosure 2. If this is an error, the applicant is requested to provide the corrected text.

03.07.02-60

On page 11 of Enclosure 2, UniStar letter UN#10-285 dated November 16, 2010, it states that the a 3D finite element model of the CBIS is developed in STAAD Pro, Version 8i and that this model is used to generate the finite element model for seismic SSI analysis using RIZZO computer code SASSI, Version 1.3a. As the STAAD model serves as the basis for the SASSI model, the applicant is requested to describe the process that was used to generate the SASSI model and to demonstrate that the two models (STAAD model and SASSI model) are dynamically equivalent by providing ISRS for the two models using a rigid base comparison. The staff needs this information to conclude that an adequate dynamic model was used in the seismic analysis of the CBIS and that this structure will meet the requirements of General Design Criteria 2.

03.07.02-61

Beginning on page 26 of Enclosure 2, UniStar letter UN#10-285 dated November 16, 2010, the stability analysis of the CBIS is described. It appears that the applicant has performed a dynamic stability evaluation by computing stability factors at each point in time as the ratio of the restoring stresses and the seismically induced stresses. In order for the staff to conclude that the dynamic stability evaluation of the structure has appropriately considered the overall seismic demand and the restoring forces, the applicant is requested to provide the following additional information:

1. Identify the coefficient of friction between the structure and the sub-grade. Provide the basis for how this value was determined.
2. The stabilizing forces for the CBIS are described as the self-weight of the intake structure and static earth pressure. Describe the static earth pressures considered and how they are determined.
3. On page 26 of Enclosure 2, it states that the seismic normal and shear stresses at the bottom of the basemat are computed by using the response time histories of reaction stresses at selected basemat locations. Describe the basis for determining stresses only at selected locations, how these locations are determined and provide a quantitative comparison of the method used to one which calculates the stresses across the entire basemat.
4. Describe how the overturning calculation and corresponding factor of safety is performed for this structure.
5. Describe each program used in the stability analysis and its function including how correspondence between the PLAXIS 3D model and the SSI model was established.
6. On page 27 of Enclosure 2, it states that the results of the dynamic stability analysis are reported in Appendix 3E. The results were not found in Appendix 3E. The applicant is requested to provide the appropriate load combinations and calculation results for the CBIS stability analysis.