CCNPP3COLA PEmails

From: Arora, Surinder
Sent: Wednesday, June 16, 2010 7:37 AM
To: 'Poche, Robert'; 'cc3project@constellation.com'
Cc: CCNPP3COL Resource; Hawkins, Kimberly; Chakrabarti, Samir; Colaccino, Joseph; Biggins, James; Vrahoretis, Susan; Miernicki, Michael; Chazell, Russell
Subject: DRAFT RAI 253 SEB2 4788
Attachments: DRAFT RAI 253 SEB2 4788.doc

Rob,

Attached is DRAFT RAI No. 253 (eRAI No. 4788). You have until June 30, 2010, to review this RAI and decide whether you need a conference call to discuss the question in this RAI before the final issuance. After the phone call or on June 30, 2010, 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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Request for Additional Information No. 253 (eRAI 4788)
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6/16/2010

Calvert Cliffs Unit 3
UniStar
Docket No. 52-016
SRP Section: 03.07.02 - Seismic System Analysis
Application Section: FSAR 3.7

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

03.07.02-42

Follow Up to Question 03.07.02-5

The response provided by the applicant to address SRP 3.7.2, Acceptance Criteria 3.C.ii regarding whether a structural model is sufficiently detailed such that further refinement will have a negligible response on the solution results, does not provide a basis for concluding that the mesh size is suitably refined to accurately capture the global and local dynamic response. The applicant is requested to demonstrate that the mesh size used in the SASSI finite element model of the Common Basemat Intake Structures (CBIS) is sufficiently detailed such that further refinement will not significantly change the response of the structure or the analysis results.

In addition, per SRP 3.7.1, Structural Acceptance Criteria 4.A.vii, the SSI model for the CBIS needs to be evaluated to confirm that the dynamic model is of sufficient refinement to capture the response of the structure throughout the frequency range of interest including the high frequency responses. For soft soil case(s), the transmission characteristics are limited by the transmission capability of the site soils, which have a much lower stiffness than the concrete structural elements. As a result, insufficient modeling of the soil layers may limit the frequency content of the earthquake time history input to the structural model. The applicant is requested to present the results of any sensitivity studies that were performed to assure that the seismic models meet the above SRP criterion, and include this information in the FSAR. If sensitivity studies were not performed, the applicant is requested to provide the technical basis for how it meets the criterion of the SRP, or justify an alternative.

The information requested above is needed for the staff to conclude that the seismic models are providing the complete response of the structure to the seismic input and that an under-prediction of seismic results has not occurred due to the assumptions of mesh size used in the analysis.

The last sentence in the first paragraph of page 3-38 refers to Figure 3.7.2.3-1 as providing the finite element mesh for the half model of the CBIS. It appears the figure number should be 3.7-26. The applicant is requested to identify the correct figure number and change the reference in the FSAR.

03.07.02-43

Follow Up to Question 03.07.02-8

In FSAR Section 3.7.2.3.2, the applicant states that the only walls that will crack are the east and west forebay walls. As the assumption of whether walls or slabs are cracked can affect the seismic response of the structure and change the frequency response characteristics of in-structure response spectra (ISRS), the applicant is requested to provide the results of an analysis that demonstrates that only the east and west forebay walls will crack and that the other walls and slabs remain uncracked under the applicable loading conditions. The staff requests this information to enable it to conclude that the calculated design loads used for the structure and the ISRS used for the design of supported equipment and suspended systems are conservative and accurately reflect the building response to the seismic input. The applicant is requested to provide this information for both the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) and the UHS Electrical Building (EB).

03.07.02-44

Follow Up to Updated Response to Question 03.07.02-11

Regarding the calculation of the convective water mass, the applicant stated that the methodology of ACI 350.3-06 (Seismic Design of Liquid Containing Concrete Structures and Commentary) has been used. However, the applicant stated that because the convective frequencies are very low, it has concluded that the corresponding accelerations are insignificant and therefore the convective loads are ignored in the analysis of the structure. The applicant is requested to provide an analysis using the methods of ACI 350.3-06 to determine the convective seismic loads on the structure and demonstrate that these loads are insignificant and have no effect on the structure's design.

03.07.02-45

Follow-Up to Question 03.07.02-17

In the background portion of its response, the applicant stated that certain SSCs within the fire protection/suppression systems (including the Fire Water Storage Tanks and Fire Protection Building) do not fall into the category of SSCs that have the potential to interact with their proximate Seismic Category I SSCs, and thus these SSCs comply with SRP 3.7.2 Acceptance Criteria 8A. Criterion 8A states that "The collapse of the non-Category I structure will not cause the non-Category I structure to strike a Category I structure." However, both the Fire Water Storage Tanks and Fire Protection Building are designated as Seismic Category II-SSE (SC II-SSE) and are designed to remain elastic under SSE excitation. Therefore they are designed not to collapse and as such meet Acceptance Criterion 8C of SRP 3.7.2. The applicant is requested to clarify its response in this regard.

In the first paragraph under the first bullet of the **Response** section, the applicant states that, "Both Cat II and Cat II-SSE SSCs will be designed to remain elastic at the SSE excitation." However, it also states that the design will be based on codes and standards such as ASCE 4-98, ACI 349 as appropriate. The staff finds this part of the the applicant's response to be too general, and it does not provide the staff with the information needed to determine if the approach used by the applicant will result in the SC II-SSE structures remaining elastic under an SSE excitation. The seismic design requirements for the SC II-SSE structures are similar to seismic category I structures, and they are required to remain functional after an SSE. Therefore, in order for the staff to conclude that these structures will remain functional after an SSE, the applicant is requested to provide details of the seismic analysis of these structures (seismic models, method of analysis, modeling of fluid-structure interaction for the Fire Water Storage Tanks, etc.), following the guidance provided in SRP 3.7.2 and 3.7.3, and include this information in the FSAR.

In the second paragraph under the first bullet of the **Response** section, the applicant states that Cat II-SSE SSCs which include mechanical/electrical equipment and piping will be qualified as if they are Seismic Category I SSCs. The applicant is requested to describe in detail how the in-structure response spectra, if required, are developed to support this qualification.

In the third paragraph under the first bullet of the **Response** section**,** there is a discussion of seismic margin as it pertains to reactor core damage. The applicant is requested to clarify why this discussion has been introduced into the response and its relevance to the design of the SC II and SC II-SSE portions of the Fire Protection System.

In the fourth paragraph under the first bullet of the **Response** section, the applicant states that Cat II-SSE SSCs and those Cat II SSCs that are in the proximity of Cat I SSCs will be designed using the site SSE spectrum. It then states that in light of their potential for interaction with the U.S. EPR standard plant SSCs, the rest of the Cat II and Cat II-SSE SSCs will be designed using the Certified Seismic Design Response Spectrum (CSDRS) to assure equivalent margin as that for the standard plant SSCs. Because it is not clear from the response, the applicant is requested to provide in a tabular format the Cat II-SSE SSCs and Cat II SSCs referred to and the design ground motion spectrum to be used for each. For the CSDRS, the applicant is requested to clarify to which CSDRS it is referring (soft, medium or hard soil case) and to describe the implications of the fact that the CSDRS at low frequencies fails to envelope the site SSE. The information provided in this response should be included in the FSAR.

In the first paragraph under the second bullet of the **Response** section, the applicant states that the methods of analysis and acceptance criteria for the above ground portions of the fire protection system that are SC II-SSE are provided in U.S. EPR FSAR Section 3.9.2.2.2 (which references the AREVA Piping Topical Report) and in U.S. EPR FSAR Section 3.12. For buried segments the applicant states these requirements are provided in U.S EPR FSAR Section 3.12.3.8 (which also references the AREVA Piping Topical Report). The AREVA topical report presents the U.S. EPR Design Certification code requirements, acceptance criteria, analysis methods and modeling techniques for ASME Class 1, 2 and 3 piping and pipe supports while Section 3.12 addresses ASME Code Class 1, 2, and 3 piping systems, piping components, and their associated supports. In neither case are the requirements or acceptance criteria for fire protection piping identified. In Table 3.2-1 for Fire Suppression Systems of the UHS MWIS, UHS EB, and Fire Protection Building and for standpipes and hose stations of the UHS MWIS and UHS EB, under the “Comments/Commercial Code” column, the ANSI/ASME B31.1 piping code is listed as being applicable. The applicant is requested to provide additional information which specifically describes the methods of analysis (seismic models, seismic input, damping values,etc.), design allowable stresses, and the piping design codes that will be used for SC II and SC II-SSE Fire Protection Systems and include this information in the FSAR.

The staff requests this information to assist in understanding the seismic methods and acceptance criteria used for fire-protection structures systems and components (SSCs) and how the design of those fire protection SSCs classified as SC II-SSE ensures they remain functional following a design basis earthquake event.

03.07.02-46

Follow Up to Question 03.07.02-19

The applicant in its response stated that the Switchgear Building (SB) will be analyzed using the same methodology as the Turbine Building (TB) which is described in the response to U.S. EPR FSAR NRC **RAI 248, Question 03.07.02-56**. In this methodology buildings are designed in such a way that the deformation, collapse, or partial collapse due to SSE loads are controlled by introducing an eccentrically braced frame in steel structures and a "crumple zone" in concrete structures. AREVA stated that this meets Acceptance Criteria 8A of SRP 3.7.2. The staff is still reviewing the AREVA response and has asked a follow-up question requesting additional information. With respect to the applicant's response to use the methodology proposed by AREVA, the applicant is requested to provide the following additional information for the TB and SB. As the Access Building (AB) is also the design responsibility of the applicant, and as it is situated adjacent to Category I buildings, the requested information also applies to this structure:

1. Describe the design process that will be applied to these structures and describe in detail how they will be analyzed for SSE load conditions;
2. For each building (TB, SB, and AB), describe the building design including the eccentrically braced frame in steel structures and the "crumple zone" in concrete structures and how the design prevents seismic interaction with a Category I structure;
3. Describe the collapse sequence and how the collapse will be controlled under an SSE event such that failure occurs in a direction away from a Category I structure; and,
4. Describe how the displacement of the TB and AB will be determined to verify that the separation distance to Category I structures are adequate during an SSE event.

The applicant needs to add the AB to Table 3.7-14 and revise Table 3.2-1 to reflect the fact that the Access Building is now classified by AREVA as a Seismic Category II structure.

Regarding the Circulating Water System (CWS) Makeup Water Intake Structure (MWIS), the applicant in its response states that the embedded portion of the CWS MWIS will be designed as a Seismic Category I structure. Therefore, the design methodology for embedded concrete structure will meet Acceptance Criteria 8.C of SRP 3.7.2. However, it is not clear from the applicant's response whether the operating deck of the CWS MWIS will be designed as a Seismic Category I structure. As failure of this portion of the CWS MWIS could compromise the structural integrity of the embedded walls and the

Seismic Category I Common Basemat Intake Structure (CBIS) slab, the applicant is requested to provide a description of the design requirements for the operating deck slab, and if not designed to Seismic Category I requirements, to provide the technical justification and consequences for not doing so.

Also, FSAR Section 3.7.2.3.2 states, in part, that a portion of the pump house enclosure is partially supported on the operating deck slab of the CWS MWIS, and that the masses corresponding to the applicable dead loads and snow loads for the pump house enclosure are appropriately included in the finite element model. The pump house enclosure is supported partially on the operating deck of the CWS MWIS and partially on its own slab. It is not clear from the response if a portion of the dead loads and snow loads associated with the pump house enclosure are included in the CWS MWIS model, or if the entire dead load and snow load is used. Since this can affect the analysis results, the applicant is requested to explain what was done and include this explanation in the FSAR.

Since the pump house enclosure is not designed for seismic loads, the applicant is requested to address what will happen to the operating deck of the CWS MWIS if the enclosure collapses and what will be the effect of this collapse on the seismic response of the CBIS.

If the pump house does not collapse, the response of the CBIS will be influenced by the mass and structural stiffness of the pump house enclosure and the pump house enclosure slab. The applicant is requested to discuss and quantify the effect of the pump house enclosure and slab on the CBIS seismic response and in-structure response spectra (ISRS).

This information will assist in determining whether or not adjacent or near-by Seismic Category I structures will be capable of meeting their intended safety functions under a design basis earthquake event.

03.07.02-47

Follow Up to Question 03.07.02-21

The seismic model of the UHS EB assumes that the building is symmetric along the North South plane of the structure. However, the internal walls are not symmetric about this plane (See Figure 3E.4-5 in Revision 6 of the FSAR). For a seismic excitation in the North-South direction, there will be a torsional response of the structure which the existing model locks out due to the assumed boundary conditions. The applicant is requested to address why this non symmetry was ignored in the model development and what affect the modeling assumptions have on the building's seismic response and the computed torsional loads for which the structure must be designed. The staff requests this information to enable it to determine whether or not the response of the structure to a seismic event and the loads used in structure's design have been under-predicted by the assumption of building symmetry.

03.07.02-48

Follow Up to Question 03.07.02-25

In its response to Question 03.07.02-25 which requested that the applicant confirm that only the guidance provided in RG 1.122 was used for peak broadening of in-structure response spectra (ISRS), the applicant responded by incorporating by reference Section 3.7.2.9 of US EPR FSAR. Section 3.7.2.9 of the U.S. EPR FSAR does not provide the Regulatory Guide used for peak broadening of ISRS. That basis is provided in U.S. EPR FSAR Section 3.7.2.5 which references RG 1.122. The applicant is requested to revise the CCNPP FSAR to indicate the basis for the peak broadening of ISRS by providing the appropriate reference.

03.07.02-49

Follow Up to Question 03.07.02-26

The applicant is requested to provide the following additional information regarding the determination of factors of safety against overturning and sliding:

- The applicant stated that the results of the SASSI analysis are used for the overturning and sliding calculations of the EPGB, ESWB, CBIS, and UHS EB. The applicant is requested to describe whether or not during the seismic response of these structures there exists a vertical tensile force between the bottom of the basemat and the supporting subgrade. Since this would indicate an uplift of the mat where such a force is indicated, the applicant is requested to describe the effect this has on the results of the overturning and sliding analysis and whether the results of these analyses can be considered as valid if such an effect exists.
- The load combination for determining the factor of safety against overturning and sliding as provided in RG 3.8.5, Acceptance Criteria 3 is the sum of the dead load, lateral earth pressure loads and the seismic load. FSAR Table 3E.4-1 agrees with the SRP load combination. However, in FSAR Section 3.7.2.14, it states that in addition to the self weight of the structure, weight of the permanent equipment and contained water during normal operation, 25 percent of the design live load and 75 percent of the design snow load is also included to determine the restoring moments. The applicant is requested to explain this inconsistency between the different sections of the FSAR, and provide justification for including these loads for determination of sliding and overturning factors of safety.
- It is not clear how static and dynamic lateral earth pressures were determined in the analysis and how they contribute to the overturning and sliding factors of safety for the structures. The applicant is requested to provide a description of how lateral earth pressures were determined and if tensile soil forces are indicated between the building sidewalls and the soil to describe how these were treated in the overturning and sliding analyses.

The staff requests this information to assist in understanding the applicant's methodology and to enable the staff to conclude whether or not the structure meets the minimum factors of safety for sliding and overturning stability. The applicant is requested to include in its response an appropriate update to the FSAR.

03.07.02-50

Follow Up to RAI 03.07.02-30, Part 3

In its response, the applicant states that interior walls carry impulsive pressure on both sides of the wall as shown in Figure 2 included in the response. In evaluating the net pressure distribution on an interior wall, for a given direction of earthquake excitation, the hydrodynamic pressure increases on one side of a wall and decreases on the other side by the impulsive force that is generated within each chamber. Thus there is a net increase on the hydrodynamic load acting on any given wall. The applicant is requested to confirm that this effect is considered in the wall design and include its description in the FSAR. In addition the applicant states on page 3-38 that the entire water mass is lumped at the basemat when determining the seismic response in the vertical direction. The hydrodynamic pressure of the water mass acting on the sides of the wall needs to be increased to reflect its acceleration in the vertical direction. The applicant is requested to revise the FSAR to state that this effect is also considered in the wall design. The information requested will assist the staff's analysis to conclude that the effects of fluid-structure interaction have been properly accounted for in the seismic design of the building.

03.07.02-51

Follow Up to Question 03.07.02-33

Section 3.7.2.3.2 (page 3-38) indicates that the thick shell element formulation (SHL17) is used in the SASSI SSI calculations for the Common Basemat Intake Structure to account for transverse shear deformation effects as well as in-plane and out-of-plane effects. Given the thickness of the walls and slabs of the structure relative to the spans, it appears that the use of a thick shell element is appropriate. However, the applicant's response indicates that the GTSTRUDL static model made use of a thin shell element (SBHQ6), which does not consider transverse shear effects. The applicant is requested to provide an evaluation of the differences in calculated forces and moments which occur between using the SBHQ6 element vs. using an element that includes shear deformation effects. The use of the SBHQ6 element may produce non-conservative results when determining the distribution of forces and moments within the structure with the result that the structure may be under-designed for Safe Shutdown Earthquake loads.

03.07.02-52

Follow-Up to RAI 03.07.02-35

In its response to Question 03.07.02-35, the applicant stated that the analysis and design results for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) will be updated in a future submittal of FSAR Sections 3.8.4, 3.8.5, and Appendix 3E. In order for the staff to be able evaluate the design basis and the design loads used for this structure and to be able to conclude that the structure meets the requirements of General Design Criteria 2, the applicant is requested to provide the analysis and design results for the UHS MWIS including updated FSAR Sections for staff review. In addition, the applicant is also requested to respond to the issues raised in Question 03.07.02-35, as appropriate, in the revised Table 3E.4-2.

03.07.02-53

Follow Up Question to 03.07.02-40

In its response to RAI No. 65, Question 03.07.02-15, the applicant described a systematic method for using the accelerations determined in the dynamic analysis of the UHS MWIS and applying these to a static model of the building to obtain forces and moments for structural design. This method involved the use of a weighted average of accelerations which were obtained from the building dynamic analysis. In Question 03.07.02-40, the applicant was requested to clarify if the absolute or signed acceleration values were used in the weighted average calculation. If the signed acceleration values were used, the applicant was requested to explain why it was acceptable to apply this methodology to out-of-plane slab accelerations caused by a building rotation about a horizontal axis. The applicant's response to Question 03.07.02-40 states that the time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4. This does not provide a response to the follow-up question, and Section 3.7.2.4 does not describe how the results of the SASSI analysis are used to determine forces and moments for building design. If the weighted average method is used to determine the forces and moments for building design then Question 03.07.02-40 is still applicable and the applicant is requested to provide a response. If this method is not used, the applicant should describe the methods used to determine the design forces and moments in the static models of the UHS MWIS and UHS EB using the analysis results from the SASSI seismic model. This information will assist in assessing how the three directions of earthquake motion were considered in the design and whether the method used to convert seismic accelerations into design loads was done in a conservative manner.