APR1400
Feedback on Advanced Copy Response to RAI 255-8285, Question 03.08.05-12
Prepared July 21, 2016

The following is the feedback for Parts a through c of the response:

(a) The staff notes that the response refers to RAI Question 03.08.05-11 for comparison between the SSI analysis and equivalent static analysis methods. This part of the response is acceptable. However, when applying reaction forces, obtained from the separate analyses of the three superstructures, onto the NI common basemat model, there are several issues that arise, which would not be a concern if one model and one seismic analysis is performed for the entire NI model containing all three structures. These issues are related to how the reaction forces from the separate superstructure analyses should be combined (i.e., phasing and combination of the reaction forces when applied to the NI common basemat analysis). Therefore, the applicant is requested to explain the items identified below.

1. Combination of three seismic input directions within a given structure:
Table 3-3 of KHNP technical report APR1400-E-S-NR-14006-P, Rev. 1, identifies the use of the 100-40-40 method for combining the reaction forces due to the X, Y, and Z direction earthquake components for each of the three structures. The applicant is requested to explain whether the terms Fx, Fy, and Fz, refers to total reaction forces across the entire base of the superstructure or the individual forces at all finite elements. The question of why it is appropriate to only consider translational forces and not moments may be addressed in the response to RAI Question 03.08.05-11.

Table 3-3 of the technical report presents three combinations (permutations) for combining the three input directions for each structure. The staff notes that the 100-40-40 method is supposed to consider all possible combinations of the three input components, including variations in sign (plus and minus). This leads to a total of 24 combinations which is evident from the formulations given in ASCE 4-98 and which is explained in greater detail in Table 2 of the ASME 2010 PVP conference paper entitled, “On the Correct Application of the 100-40-40 Rule for Combining Responses due to Three Directions of Earthquake Loading,” July 18-22, 2010. Therefore, unless all combinations are considered, provide the technical basis for only using the three combinations given in Table 3-3 of the KHNP technical report.

2. Proper application of the 100-40-40 method:
Normally, the application of the 100-40-40 method, as well as the SRSS method, is applied to a given response of interest for an individual member (i.e., force or stress) or

individual node location (i.e., displacement/velocity/acceleration). Thus, after applying a given input, e.g., X direction seismic input to the entire model containing all three structures, the force or stress in a specific direction for an individual finite element is determined. Then, the same is performed for the Y direction, followed by the Z direction. Then, the total force or stress in the specific finite element in a specific direction is determined by the 100-40-40 method or SRSS method. In the case of the NI common basemat model, it appears the the 100-40-40 method was not applied in this manner. Therefore, provide the technical basis for this alternative approach utilized.

3. Phasing of reaction forces for the three structures:
Table 3-4 of KHNP technical report APR1400-E-S-NR-14006-P, Rev. 1, presents eight seismic load combinations for the NI common basemat model. These load combinations identify how the reaction forces from the three structures are combined with the various signs (plus or minus). The staff notes that for the RCB shell and dome and the RCB internal structures, the response spectrum analysis method was utilized. The signs of the reaction forces at the base of the superstructures are lost in a response spectrum analysis. Thus, the staff believes that both plus and minus values should be used in such seismic analysis of structures, unless it is clearly evident that one sign (plus or minus) is governing.

Similarly, for the AB, an equivalent static analysis was utilized. In this case both plus and minus reaction forces from the finite elements at the base of the AB should be used in combination with the varying signs of the RCB shell and dome and the internal structures. However, the staff notes that Table 3-4 indicates for each load case for a given direction, all forces from the three structures have the same sign (all plus or all minus). The technical basis for this approach should be provided.

(b) The applicant is requested to confirm whether the basemat soil bearing pressure calculation, which is described in Section 4.1.3 of KHNP technical report APR1400-E-S-NR-14006-P, Rev. 1, was used to obtain the maximum seismic soil bearing pressure demands for the NI basemat. If so, provide a comparison of the governing value of 29.6 ksf shown in Table 4-4 of the technical report (for soil case 8) with the maximum soil bearing pressure obtained directly from the SASSI results for the same soil case.

(c) The first paragraph of the response indicates that, for other analyses computed for member forces in the RCB shell & dome and RCB internal structural analysis, the SRSS method was used to combine modal responses. The applicant is requested to confirm whether the use of the modal combination method of SRSS for all modes for the structural evaluations was performed in accordance with NRC Regulatory Guide, Rev. 3 because this regulatory guide has very specific limitations on its use. For example, in

the “periodic response range” of amplified spectra, the SRSS method is only valid when the frequencies of the modes are all sufficiently separated by the specified criteria in the regulatory guide. Also, in the spectral range beyond the periodic response range, other methods are identified in the regulatory guide.

For the second paragraph of the response, confirm that for the NI common basemat analysis, which utilizes the response spectrum analysis of the RCB shell and dome and the internal structures, new analyses based on the CQC modal combination method are used. Confirm this applies to all analyses associated with the NI common basemat evaluations which consist of the design of the basemat sections and soil bearing pressure. Confirm that the stability evaluations (sliding and overturning) and settlement analysis do not rely on the NI common basemat model analysis. Also, for uplift, the basis for meeting the uplift criteria is demonstrated based on the separate SASSI analysis. Lastly, for lateral soil pressure loads on embedded walls, the NI common basemat is not utilized; but instead, confirm that the governing wall pressures from the ASCE 4-98 method and SASSI wall pressures are utilized.