Draft

Request for Additional Information No. 108 (1345, 1463), Revision 0

10/20/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.03.01 - Wind Loading
SRP Section: 03.07.03 - Seismic Subsystem Analysis
Application Section: FSAR Ch. 3

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

03.03.01-2

(1) In SRP 3.3.1 Acceptance Criteria, it states that design wind loads are acceptable if they are in accordance with Sections 6.5.12, 6.5.13, 6.5.14 and 6.5.15 of ASCE/SEI Standard 7-05. In FSAR Section 3.3.1.2, it states that effective pressure loads on structural elements and members are determined according to the applicable requirements of Sections 6.5.12 and 6.5.13 of the Standard. However, no mention is made of the use of Sections 6.5.14 and 6.5.15. If applicable, the application of these sections should be described and included in the FSAR.

(2) In FSAR Section 3.3.1.2, it states that the shape coefficients for distribution of wind pressures around the circumference of the Reactor Shield Building (RSB) and the vent stack are taken from ASCE paper No. 3269. The acceptance criteria of SRP 3.3.1 do not include this reference.

a. What are the shape coefficients that are used on these two structures?

b. Are the shape coefficients for distribution of wind pressures around the circumference of the Reactor Shield Building (RSB) and the vent stack used equivalent to, or more conservative than those of ASCE/SEI Standard 7-05? If not, provide the technical justification for using the shape coefficients taken from ASCE paper No. 3269.

03.07.03-1

RG 1.122 provides the requirements for the development of amplified response spectra and peak broadening for use in subsystem seismic analysis. However, in FSAR Section 3.7.3.1.1 (pg 3.7-293), in addition to a peak broadening method, a peak shifting method is described using as a basis ASCE Standard 4-98. This standard has not been accepted as providing NRC guidance for methods of seismic analysis.

a. On page 3.7-294, it states that where three different ISRS curves are used to define the response of the structure, the peak shifting method is applied in each direction. Confirm that this is in reference to three orthogonal directions of motion for a single set of ISRS representing the combined results from the different soil cases used in the SSI analysis referenced in FSAR Section 3.7.2. If this is not the case, describe the basis for the three different ISRS curves. Provide examples of where three different ISRS curves would not be used.

b. It also states, the final results are obtained by enveloping the results of the separate analyses. Describe using examples how this enveloping process is accomplished including how the results account for seismic input in three orthogonal directions.

c. Provide justification for using this method of analysis including a comparison of margins-of-safety with the peak broadening method.

03.07.03-2

In FSAR Section 3.7.3.1.2 (pg 3.7-294), it states that the cutoff frequency is determined so that the number of modes calculated does not produce dynamic analysis results within 10 percent of the same results combined with the next higher mode. Should this be changed to state that the number of modes calculated produces dynamic results that are within 10 percent of the same results when combined with the next higher mode? If this is the actual intent of the statement, what is the basis for this criterion?

03.07.03-3

In FSAR Section 3.7.3.1.2 (pg 3.7-295) under the description for the time history method, it states that to account for uncertainties in the structural analysis one of two methods may be used. One of the methods described is to use a method similar to the peak shifting method used in response spectrum analysis.

a. Describe how this method meets the intent of the requirements in RG 1.122 to account for uncertainties in the structural seismic analysis.
b. Provide the basis for considering only three separate input time histories and describe how the time steps are modified so as to achieve an equivalent +/- 15 percent peak shifting used in the response spectrum method.
c. Provide justification for using this method of analysis including a comparison of margins-of-safety with the peak broadening method.
d. It is not clear from the discussion what the second method is that is used to account for uncertainties or how it is applied. A discussion of the second method should be provided for review.

03.07.03-4

In FSAR Section 3.7.3.1.2, (pg 3.7-295), the third paragraph states that "The time step is to be no larger than one-tenth of the cut-off frequency period, without justification." While for most of the commonly used integration methods, the maximum time step is limited to one-tenth of the smallest period of interest, which is generally the reciprocal of the cutoff frequency, industry practice also requires that (Section 3.2.2.1(c) of ASCE 4-98) the time step (Δt) used shall be small enough such that the use of one-half of Δt does not change the response by more than 10 percent. Provide the technical justification for not considering common industry practice in determining the maximum time step when time history integration methods are used.

03.07.03-5

FSAR Section 3.7.3.1.4 (pg 3.7-295) describes an equivalent static method of analysis for subsystems where the mass of the subsystem components are considered as lumped masses at their center of gravity locations. It states that the seismic response forces from these masses are determined by multiplying the contributing mass by an appropriate seismic acceleration coefficient at each location.

a. How is the seismic acceleration coefficient determined?

b. Is the acceleration that is applied to each contributing mass the same value?

c. How does this method compare to the response spectrum method in terms of resultant seismic loads?

d. Describe the methods that will be used to justify the use of the equivalent static method over the use of other methods.

e. Describe how the methods meet the requirements of SRP 3.7.2-SAC-1.B for the equivalent static load method including how this method meets the requirements for accounting for the relative motion between points of support.

Further down in Section 3.7.3.1.4 (pg 3.7-295), a seismic acceleration equal to the peak acceleration multiplied by 1.5 is discussed as being appropriate for many subsystems to account for multi-modal participation. This is normally conservative for only simple systems and may not be conservative in which the maximum response results are derived from more than one direction. Under what situations and for what systems will the use of an equivalent static method be considered? It also states that the results from three directions of seismic input motions are combined by the SRSS method. Since the method is static, how are out-of-plane responses obtained from this analysis?

03.07.03-6

In FSAR Section 3.7.3.3 (pg 3.7-298), it states that in general three dimensional models are used for seismic analysis and six degrees-of-freedom exist for mass points. It then states that in most structures some of the dynamic degrees-of-freedom can be neglected or can be uncoupled from each other so that separate analyses can be performed for different types of motions. Provide the technical basis and criteria used for neglecting dynamic degrees-of-freedom and for uncoupling degrees-of-freedom such that a separate analysis can be performed for different types of motions.

03.07.03-7

In FSAR Section 3.7.3.3 (pg 3.7-297), it states that it is sufficient to include degrees-of-freedom equal to twice the number of modes with frequencies below the ZPA frequency. This criterion does not meet the acceptance criteria for modeling described in SRP 3.7.2-SAC-1.A.iv. In addition, the stated criterion for establishing the cutoff frequency does not appear to satisfy the current Interim Staff Guidance (COL/DC-ISD-01) which requires that models used for dynamic analysis capture frequencies up to at least 50 Hz. Describe how the models developed for subsystem analysis meet the requirements of SRP 3.7.2 acceptance criteria and the Interim Staff Guidance or provide justification if they do not.

03.07.03-8

In FSAR Section 3.7.3.3 (pg 3.7-297), it states that when developing dynamic models of structural elements that support the system under consideration, masses equal to 25 percent of the floor live load or 75 percent of the roof snow load are included in the model. This amount of mass considered in the substructure model is not consistent with the acceptance criteria specified in SRP 3.7.2–SAC-3.D which specifies an additional 243 kg/m^2 (50 psf) be included to account for miscellaneous dead loads. Provide confirmation that the structural elements that support subsystems have included miscellaneous dead loads of 243 kg/m^2 (50 psf) or justify why they have not included this additional dead load.

03.07.03-9

In FSAR Section 3.7.3.3 (pg 3.7-298), it states that it is sufficient to include only the mass of the subsystem at the support point when the subsystem is rigid in comparison to the supporting system and is rigidly connected. Describe the criteria that are used to make this determination. Similarly for subsystems supported by flexible connections it states that the subsystem may be excluded from the primary model. Provide the criteria for making this determination. Is this true even when R_m is greater than .1? (See pg 3.7-298)

03.07.03-10

In FSAR Section 3.7.3.3 (pg 3.7-298), it states "Seismic input for the subsystem and component design are the peak-broadened ISRS envelopes described in Section 3.7.2.5 or the floor acceleration time histories described in Section 3.7.2.4." However, Section 3.7.2.4 does not provide a single set of floor time histories that envelope the peak-broadened ISRS. How does the applicant propose to use the various floor time histories generated from SSI analysis, which used a variety of soil conditions, in the subsystem analysis?

03.07.03-11

In FSAR Section 3.7.3.6 (pg 3.7-302) under "Time History Method," it states that analyses of subsystems may be performed separately for each of the three components of earthquake motion, or one analysis may be performed by applying all three components simultaneously. The FSAR then refers to free-field time histories that are used as input to the overall structural analysis models including SSI models. Given that the SSI analyses produces a separate time history motions for each direction and soil case evaluated, it is not clear from the FSAR discussion how time history analyses of subsystems are performed if time histories produced by the SSI analyses are to be used. Additionally, a description of how the time histories, which vary node by node, will be selected or applied to the model of the subsystem is not provided. If it is intended that an alternative approach to time history analyses which uses time histories developed to envelope the smoothed and broadened in-structure response spectra, the criteria used to develop these time histories should be specified. The staff is therefore requesting that additional information be provided on the source of the time histories, how they were developed, and how many sets of time histories are used in the analysis. If they are time histories that envelope the ISRS, provide the enveloping criteria, and if they are applied simultaneously, state whether or not they are statistically independent.

03.07.03-12

In FSAR Section 3.7.3.7.1 (pg 3.7-304), it states the approved methods of RG 1.92 are used to obtain more accurate modal response for closely spaced modes. How does the combination of modal responses address each of the methods specified in Section C of RG 1.92, Rev. 2? In FSAR Section 3.7.3.7.1 (pg 3.7-304), it states that closely spaced modes are combined using the methods of RG 1.92, Revision 1 as well as the less conservative methods of RG 1.92, Revision 2. This revision was issued by the NRC after research in the U.S. resulted in improved methods for combining modal responses that provide a more accurate estimate of SSC seismic response while reducing unnecessary conservatism. The statement in the FSAR should be revised to more accurately reflect the basis for the methods in Revision 2 of the RG.

03.07.03-13

In FSAR Section 3.7.3.7.2 (pg 3.7-304) at the bottom of the page, should the the mass point displacement vector {r} be identified as an acceleration vector?

03.07.03-14

In FSAR Section 3.7.3.8 (pg 3.7-306), it states that for non-seismic subsystems attached to seismic systems, the dynamic effects of the non-seismic subsystem are accounted for in the modeling of the seismic subsystem. It states that the non-seismic subsystem is precluded from causing failure of the seismic subsystem. What are the methods and design criteria that are used to assure that such failures do not occur and how do the methods in this FSAR section meet the acceptance criteria of SRP 3.7.3-SAC-8 which addresses the interaction of non-seismic systems with Seismic Category I systems?

03.07.03-15

In FSAR Section 3.7.3.8.2 (pg 3.7-306), it states that safety-related subsystems or components which may be impacted by a non-seismic SSC are identified as interaction targets and are evaluated to establish that there is no loss of ability to perform their safety-related functions. In SRP 3.7.3-SAC-8, there are no acceptance criteria for the described situation. Provide justification as to why non-seismic SSCs which could interact with seismic Category I SSCs are not analyzed and designed to the same criteria as seismic Category I SSCs so that an interaction does not occur.

03.07.03-16

FSAR Section 3.7.3.9 (pg 3.7.3-307) addresses distribution subsystems supported at multiple locations within a structure or at multiple locations in different structures. The acceptance criteria of SRP 3.7.3-SAC-9 states that the relative displacements of support points should be considered in the analysis of these systems. Describe how the methods of analysis account for these displacements and how the methods include the effects of the application of three orthogonal seismic inputs.

03.07.03-17

FSAR Section 3.7.3.14 (pg 3.7-309) which describes the methods of analysis for above ground tanks needs to address each of the acceptance criteria requirements of SRP 3.7.3-SAC-14 for the seismic analysis of above ground tanks and how these requirements will be met for the U.S. EPR design. These requirements include the seismic modeling of the tank, the basis for the assumption of a rigid tank, sloshing effects, and the effects of seismic loads from connected piping.

03.07.03-18

In FSAR Section 3.7.3.9.2 (pg 3.7-307), it states that independent support motion (ISM) may be used when distribution subsystems are supported by multiple support structures or at multiple support levels within a structure. When this approach is used, are the guidance and criteria given in NUREG 1061 related to ISM followed ?

03.07.03-19

FSAR Section 3.7.3.2 (pg 3.7-296) describes various methods to account for seismic induced fatigue. To qualify electrical and mechanical equipment, the FSAR states that consideration of low level seismic effects is required by IEEE Standard 344-2004 with the equivalent of five OBE events followed by one SSE event (with 10 maximum stress cycles per event). It further states that this consideration includes the seismic qualification process based on the approach outlined in SRP 3.10-SAC-3.C. The FSAR states that earthquake cycles included in the fatigue analysis are composed of five one-third SSE events followed by one full SSE event. However, SRP 3.10-SAC-3.C states electrical equipment should be qualified with five one-half SSE events followed by one full SSE event. Provide justification for using a different method of analysis than that described in the SRP.

In referencing the IEEE Standard 344, the FSAR states that the 2004 version is being used while the SRP acceptance criteria reference the 1987 version of the Standard. The FSAR further states in a footnote on the bottom of page 3.7-296 that justification for use of the latest version of the IEEE Standards is provided in FSAR Section 3.11. A comparison of the two revisions of IEEE 344 for fatigue evaluation could not be found in FSAR Section 3.11. As a result, the staff is asking for reconciliation between the two versions of the Standard as it applies to fatigue evaluation.