## ArevaEPRDCPEm Resource

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**Sent:** Thursday, March 25, 2010 2:00 PM
**To:** 'usepr@areva.com'
**Cc:** Chakravorty, Manas; Hawkins, Kimberly; Miernicki, Michael; Patel, Jay; Colaccino, Joseph; ArevaEPRDCPEm Resource
**Subject:** U.S. EPR Design Certification Application RAI No. 370 (4292,4272,4275), FSAR Ch. 3
**Attachments:** RAI_370_SEB2_4292_4272_4275.doc

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on February 18, 2010, and on March 24, 2010, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
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Request for Additional Information No. 370(4292, 4272, 4275), Revision 0

3/25/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.07.01 - Seismic Design Parameters
SRP Section: 03.07.02 - Seismic System Analysis
SRP Section: 03.07.03 - Seismic Subsystem Analysis

Application Section: 03.07

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

03.07.01-27

**Follow Up to RAI 248, Question 03.07.01-25**

In NUREG/CR6919 "Recommendations for Revision of Seismic Damping Values in Regulatory Guide 1.61" it states on page 6 "If significant stresses due to load combinations that include SSE are less than 80 percent of the applicable code stress limits, then using SSE damping values may under-predict the structure's response to seismic loads. In this case structural evaluation and development of in-structure response spectra should be based on a seismic analysis utilizing the OBE damping values specified in Table 2." The OBE damping value in Table 2 recommended for reinforced concrete is 4 percent. In the tables provided in the applicant's response there are only 14 instances where one of the load components results in a stress that exceeds 80 percent of the allowable stress. In addition the locations in the table are at critical sections of the NI common basemat structures. Other locations may have stress levels lower than those presented in the applicant's response. Thus the staff believes it does not have sufficient information to justify the use of SSE damping for the generation of ISRS. The staff is requesting that the applicant provide additional information on the state of stress within the NI common basemat structures (such as stress contours from the GT STRUDL model) to support its position on the use of SSE structural damping values. Justification for the use of SSE damping values for the generation of ISRS should also be provided in the FSAR.

03.07.02-64

**Follow Up to RAI 248, Question 03.07.02-53:**

The applicant has proposed utilizing a lateral-force resisting system (LFRS) with a controlled collapse zone as the design basis for the NAB under an SSE event. In order for the staff to evaluate the acceptability of this design feature and whether it meets Acceptance Criteria 8 of SRP 3.7.2, the staff is requesting the following additional information:

1. The design codes applicable to the LFRS and the controlled collapse zone.
2. A detailed description of the LRFS and the controlled collapse zone.
3. Figures that depict the physical dimensions of the LFRS and the collapse zone of the NAB.

4. A description of the loads and the loading combinations applicable to each portion of the building.
5. A description of the methods used to control the collapse of the non-seismic portion of the NAB in such a way that the collapse zone does not impact a Category I structure or reduce the structural integrity of the LFRS.
6. A description of the seismic analysis method including assumptions, description of the model, description and point of application of the seismic input, and a description of how the seismic loads are determined and applied to the NAB structure.
7. A description of the method used to calculate the seismic displacement of the NAB from which it is concluded that the gap between the NAB and Safeguard building (SB4) and the gap between the NAB and Fuel Building is sufficient to prevent an interaction with these adjacent Category I structures.
8. The results of an analysis that demonstrates that the NAB does not slide or overturn into adjacent Category I structures.
9. The interaction between the LFRS and the controlled collapse zone including the collapse or impact loads that are expected to be applied to the LFRS by the collapse zone.
10. The interaction between the NAB and the RWB including a detailed description of how the NAB prevents an indirect transfer of load from the RWB to Seismic Category I structures. Include in your response a description of the loads that will be transmitted to the NAB by a failure of the RWB and describe how these loads will be accounted for in the design of the LFRS.
11. Examples of a LFRS and collapse zone design concept used in the seismic design of structures that have been built especially structures at nuclear power plants.

03.07.02-65

**Follow Up to RAI 248, Question 03.07.02-56:**

a. The markup of the U.S. EPR FSAR states on page 3.7-81 that "Category II structures are to be seismically analyzed and supported to prevent transfer of unanalyzed loads to a Category I structure." This implies that an analyzed load could be transferred to a Category I structure from a Seismic Category II structure and is at odds with the applicant's response which states that their collapse does not cause them to strike adjacent Seismic Category I structures. In addition the markup of Table 3.7.2-29 states in column 5 that there is no interaction potential for the TB and AB structures. The applicant is requested to revise the FSAR to resolve this conflict in design requirements for these structures as it relates to their interaction with a Seismic Category I structure.

b. The markup of the U.S.EPR FSAR in describing the interaction of Category I and non-Category I structures states on page 3.7-95 that "The non-Category I structure will be analyzed and designed such that the margin of safety is equivalent to that of a Category I structure." In light of the applicant's proposal to allow the collapse or partial collapse of the NAB, TB and AB, the applicant is requested to explain how the non-Category I structure with potential of seismic interaction has a margin of safety that is equivalent to that of a Category I structure.

c. The markup of Table 1.8-2, COL item 3.7-7 does not require the applicant to verify the separation gap adequacy as reported in the applicant's response. The applicant is requested to correct the wording in item 3.7-7 to include this requirement. In addition,

since sliding and overturning could be potential modes of failure that could cause an interaction with a Category I structure, the COL applicant should also be required to verify the sliding and overturning stability of these structures. The applicant is requested to add this requirement to Table 1.8-2.

d. Even if the AB and the TB are the design responsibility of the COL applicant, without additional information, the staff cannot conclude that the design concepts proposed by the applicant are acceptable, i.e. these buildings are designed in such a way that the deformation, collapse, or partial collapse due to SSE loads is controlled by introducing an eccentrically braced frame in steel structures and a "crumple zone" in concrete structures. Specific to the design of the TB and AB, the applicant is requested to provide the following additional information:

<u>For the AB:</u>

1. Describe the design process including the method of analysis that will be applied to this structure and how it will be analyzed for SSE load conditions.
2. Describe whether the whole structure will collapse or only a portion of the 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.
4. Describe the design features of the AB that ensures collapse of the structure will occur in a controlled manner.
5. Provide figures that depict the failure of the AB under an SSE load including the controlled collapse zone.
6. The markup of the U.S. EPR FSAR on page 3.7-97 states that evaluation to SSE load confirms that separation gaps between the AB and SB 3 or SB 4 are sufficient to preclude interaction in accordance with SRP 3.7.2 criteria SAC-8A. Describe the evaluation that was done and how this conclusion was reached.
7. The U.S. EPR FSAR on page 3.7-97 states that crossover passageways between the SBs and the AB are designed to accommodate differential displacements without importing unacceptable loads to the supporting structure. As a portion of the AB may collapse under an SSE event the applicant needs to describe how the loads transmitted to the SBs as a result of this event are determined.

<u>For the TB:</u>

1. Describe the design process including the method of analysis that will be applied to this structure and how it will be analyzed to SSE load conditions.
2. Describe whether the whole structure will collapse or only a portion of the structure.
3. Provide a figure of the eccentrically braced frame used to control collapse of the TB in a favorable direction and describe how this design will meet its intended function under an SSE event.
4. Describe the other design features of the structure that will ensure collapse of the structure will occur in a controlled manner.
5. The markup of the U.S. EPR FSAR on page 3.7-97 states that evaluation to SSE loads confirms that the separation gap between the TB and SB 2 and SB 3 is sufficient to preclude interaction and is, thus, in accordance with SRP 3.7.2 acceptance criterion. Describe the evaluation that was done and how this conclusion was reached.

03.07.03-38

**Follow Up to RAI 215, Question 03.07.03-32:**

In its markup of the FSAR the applicant has identified two approaches for non seismic SSC that could impact a Seismic Category I SSC. In the first approach, if the non seismic SSC can impact a Seismic Category I SSC, an evaluation is performed to determine if the target has significant structural integrity to withstand impact without loss of ability to perform its safety-related function. Since there is a risk that the Seismic Category I SSC may not be able to perform its safety-related function due to the impact of a non seismic SSC, the applicant is requested to provide an example of how such an interaction evaluation will be performed and include this information in the FSAR. In addition, the ability of an SSC to perform its safety related function goes beyond maintaining its structural integrity. If the SSC performs a control function, that function could be impaired by the impact of the non-seismic SSC which could cause an unacceptable acceleration or vibration of the safety-related SSC. The applicant needs to address this condition of interaction and describe how it will be evaluated.

In the second approach, if an unacceptable interaction can occur between a Seismic Category I SSC and non seismic SSC, the non seismic SSC is classified as Seismic Category II. These are then "analyzed and supported so that an SSE event does not cause an unacceptable interaction with the Seismic Category I item, in accordance with the provisions of SRP 3.7.2-SAC II-8." In this approach the applicant in its response states that the full SSE load is applied to the Seismic Category II SSC. However this is not stated in the FSAR. As it appears that it is acceptable for some type of interaction to occur under this approach, the applicant needs to describe under what types of situations this might be used and give examples of its application. The applicant should include in the FSAR and in its response the following information:

1. How the SSE load acting on the non-seismic SSC is determined.
2. How the impact load is calculated on the Seismic Category I SSC.
3. How it is determined that the Seismic Category I SSC maintains its safety function and that the seismic qualification of the component or piece of equipment is not invalidated.
4. How it is assured that after impact that the non-seismic SSC doesn't collapse or fall on the Seismic Category I SSC.
5. The code and code allowables that apply to Seismic Category II SSCs subjected to the SSE loads.

03.07.03-39

**Follow Up to RAI 291, Question 03.07.03-36**

A. In its response to **Question 03.07.03-36**, the applicant provided a markup to page 3.7-309 of the U.S. EPR FSAR. The first bullet of the markup states "If the first seismic restraint beyond the Seismic Category I subsystem boundary is an anchor restraining the Category I subsystem in all six degrees of freedom, the analysis model includes only the Category I subsystem up to the anchor, which is designed to accept loads from both the Category I subsystem and the non-seismic subsystem." The applicant is requested to provide further clarification as follows:

1. If the Category I system terminates prior to the anchor, the applicant is requested to amend the first bullet to state that the analysis model includes the Category I system and any extended portion of the system which is Category II up to the anchor defining the analysis boundary and provide the design requirements imposed on the included Category II portion of the seismic subsystem model. If not designed to Seismic Category I requirements the applicant is requested to provide the requirements that do apply and provide their technical justification. These should be included in the FSAR.

2. The applicant states that the anchor is designed to accept subsystem loads from the side containing the Category I subsystem as well as the loads on the other side of the anchor from the non-seismic subsystem. The applicant should provide and include in the FSAR the method for determining the loads from the non seismic side caused by a seismic event.

B. The second bullet of the markup to page 3.7-309 states "If the first seismic restraint cannot be an anchor the non-seismic subsystem and supports beyond this location that affect the seismic Category I subsystem dynamic analysis are classified Seismic Category II, included in the model and designed to the same requirements as Seismic Category I *supports.*" Additional clarifications are needed in this regard as follows:

1. The last part of the criteria needs to be explained as it is not clear how the included Seismic Category II portion of the seismic subsystem model is designed to the requirements of Seismic Category I supports.

2. The applicant is requested to provide in the FSAR the design requirements for the Seismic Category II portion of the model and if not designed to Seismic Category I requirements the applicant should provide a technical justification for not doing so.