ArevaEPRDCPEm Resource

From: Tesfaye, Getachew
Sent: Friday, June 12, 2009 10:23 AM
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Cc: Ma, John; Xu, Jim; Clark, Theresa; Phan, Hanh; Fuller, Edward; Mrowca, Lynn; Chowdhury, Prosanta; Rycyna, John; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 234 (2861), FSAR Ch. 19
Attachments: RAI_234_SEB2_2861.doc

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on May 19, 2009, and discussed with your staff on June 11, 2009. Draft RAI Question 19-305 was modified as a result of that discussion. 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,
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Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 563

Mail Envelope Properties (C56E360E9D804F4B95BC673F886381E71FBAC4A0BE)

Subject: U.S. EPR Design Certification Application RAI No. 234 (2861), FSAR Ch. 19
Sent Date: 6/12/2009 10:23:26 AM
Received Date: 6/12/2009 10:23:28 AM
From: Tesfaye, Getachew

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Files	**Size**	**Date & Time**
MESSAGE	758	6/12/2009 10:23:28 AM
RAI_234_SEB2_2861.doc	41466	

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

Request for Additional Information No. 234 (2861), Revision 0

6/12/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation
Application Section: 19

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

19-304

In the response to RAI 19.01-1 and 19.01-2, AREVA used the NUREG/CR-0098 median spectral shapes anchored to the average peak spectral acceleration (PSA) in 2 to 10 Hz frequency range to define the seismic margin earthquake (SME). This resulted in 1.17g average spectral acceleration for rock sites and 1.45g for the envelope of the soil sites. Comparisons of the NUREG/CR-0098 spectra with CSDRS raised by a factor of 1.76 for pga showed that the NUREG/CR-0098 spectra anchoring to the average PSA practically envelopes 1.67 times CSDRS for soil sites while for rock sites, it resulted in the spectral exceedance in the frequency range of 8 – 30 Hz. This means that the use of NUREG/CR-0098 spectral shape anchoring to the average PSA between 2 and 10 Hz results in a seismic margin less than 1.67 times CSDRS in the respective frequency range. Please also note that in the PRA-based seismic margin method, only the SME will be used for quantifying the sequence-level HCLPFs; the term: Review Level Earthquake or RLE is associated with the capacity screening of as-built and as-designed structures, systems, and components - a condition that is not available for design certifications and therefore, would not be applicable to the design certification application.

AREVA is requested to identify those SSCs on the seismic accident sequences with fundamental frequencies falling within 8 – 30 Hz, and to demonstrate that these SSCs possess adequate seismic margins to meet 1.67 times CSDRS based on the spectral acceleration. Alternatively, AREVA can use the 1.67 times CSDRS as the SME to reconstitute the sequence level HCLPFs for the US EPR design.

AREVA is requested to demonstrate the seismic margin of 1.67 time CSDRS for the Nuclear Island against the seismic induced sliding and overturning.

The staff also requests that AREVA provide a COLA Action Item for meeting Part 52.79(a)(46) to update the system model (seismic accident sequences) developed in DCD to incorporate site-specific capacity reductions due to site-specific effects (soil liquefaction, slope failure etc.) and site-specific structures (safety related site-specific intake structure, intake tunnel heat sink), if any appears on the seismic accident sequences used for the PRA-based HCLPF assessments of the DC, and demonstrate the seismic margins of the applicable site-specific SSCs; the HCLPFs for respective site-specific SSCs will be estimated based on the site-specific GMRS.

Further, Since DCD uses 1.67 x CSDRS as SME and COLA will use 1.67 x GMRS as SME for margin assessment, AREVA is requested that the HCLPFs be provided in terms of PGA for consistency.

19-305

Follow-up to RAI Question 19.01-8

The response to 19.01-8 is inadequate with respect to equating the ASME Service Level C/Factored load capacity to the ultimate capacity as defined in Section 3.8.1.4.11 of the U.S. EPR FSAR, rev. 0, which appears to be a fragility value. The ASME Service Level C analysis is a deterministic design process with allowable stress and strain limits specified in the ASME B&PV Code Section III. Furthermore, the response did not address the containment structural performance when subjected to internal pressurization by hydrogen released assuming 100% fuel clad-fuel reaction followed by hydrogen burning as required by Part 50.44(c)(5) for new reactor designs (a guidance is provided by RG 1.7, rev. 3). Instead, the response introduced the AICC assumption and associated pressure and temperature, but provided no discussion of how the AICC represents the accident scenario assuming 100% fuel clad-fuel reaction followed by hydrogen burning.

To facilitate the staff's review and evaluation of the U.S. EPR containment structural performance to meet Part 50.44(c)(5), AREVA is requested to provide the following information:

1. An analysis which estimates the containment internal pressure load time history due to the hydrogen released by assuming 100% fuel clad-fuel reaction followed by hydrogen burning;

2. A structural analysis of the containment subject to the pressure load as determined in step 1 plus the dead load (a guidance is provided in RG 1.7, rev. 3); the Code specified minimum material properties at the temperature should be used in the analysis (however, the temperature load should not be included).

3. Demonstrate that the containment response in terms of the liner strain determined from the step 2 analysis remains below the ASME Service Level C limit.

19-306

Follow-up to RAI Question 19.01-9

To address the SECY-93-087 containment deterministic structural performance expectation, the applicant stated in the RAI response that "Relevant scenarios in the U.S. EPR are defined as those having a Core Damage Frequency (CDF) greater than 1.0E-8/yr. In AREVA's scenario identification analysis, this 1.0E-8/yr threshold captured categories of events covering over 95% of the CDF." Since accident sequences which comprise 95% of the CDF should encompass the events most likely to challenge the containment structural integrity, the staff accepts the more likely accident scenarios defined in this manner for the containment deterministic structural performance evaluation. However, the applicant did not provide the controlling containment pressure and temperature load time histories for the identified accident events, nor was the containment Service Level C capacity correctly addressed for reasons stated in the 19.01-8 supplement.

To facilitate the staff's review and evaluation of the U.S. EPR containment deterministic structural performance evaluation, AREVA is requested to provide the following information:

1) Provide the controlling containment pressure demand in terms of pressure time history and the corresponding temperature time history derived from the more likely accident scenarios.

2) A structural analysis of the containment subject to the pressure load as determined in step 1 plus the dead load; the Code specified minimum material properties at the temperature should be used in the analysis (however, the temperature load should not be included in the containment structural analysis).

3) Demonstrate that for the initial 24 hours following the onset of core damage, the containment response in terms of the stresses or strains for containment structural elements as determined from the step 2 analysis remains below the ASME Service Level C (or Factored Load) limit.

4) For the period following 24 hours after the core damage, either demonstrate that the pressure and temperature time histories are not greater than those during the initial 24-hour period, or perform additional nonlinear containment structural analysis to demonstrate that the containment still provides a barrier against the uncontrolled release of fission products.

19-307

Follow-up to RAI Question 19.01-10

In the response to RAI 19.01-10, the applicant stated that the composite fragility was calculated based on six containment failure modes. Based on the equation provided for determining failure probability, any additional failure modes identified for the containment would increase the containment failure probability. The applicant did not provide any justification for excluding other possible failure modes.

The applicant set the failure criterion for the tendons at 3% strain; however, the applicant did not explain what it means in the context of probability for developing the containment fragility nor did it define what the failure means for other structural components. The manner in which the information is presented in Table RAI 19.1-10-1 and Table RAI 19.1-10-2 was very confusing. Aside from that, the modeling uncertainty was not even mentioned.

To facilitate the staff's review and evaluation of the U.S. EPR containment pressure fragility evaluation, AREVA is requested to provide the following information:

a) The containment pressure fragility should be determined based on analyses which utilize appropriate material constitutive relations, and an assessment of uncertainties within a probabilistic framework. The uncertainties in the analysis results should be associated with the modeling and analysis approach (epistemic uncertainty), the material properties (aleatoric uncertainty) of the structure at the time of the accident, failure criteria or limit states used in establishing the pressure capacity, and the loading conditions that lead to pressurization of the containment.

b) Failure criteria are defined to establish limit states on the structural response where the internal pressure is no longer contained by the structure. Uncertainty in defining these failure criteria should be addressed; one could use median and 95% confidence values to evaluate the effect of the uncertainty on the analysis results.

c) Accident conditions leading to over-pressurization will also include elevated temperatures. Because of thermal induced stresses and material property degradation at elevated temperatures, the fragility for over-pressurization is also a function of temperature. Thus, the fragility analyses should be conducted for three different thermal conditions, 1) steady state normal operating temperatures (referred to as ambient conditions), 2) steady state conditions representing long-term accident conditions, and 3) transient thermal conditions such as a temperature spike representative of direct containment heating conditions.

Uncertainty associated with the modeling used in the analyses for determining the failure pressures should be addressed. This uncertainty concerns the finite element mesh discretization, the type of element formulations used, the robustness of the constitutive models, the equilibrium iteration algorithms and convergence tolerances, geometric imperfections, fabrication and construction exactness, rebar placement locations, and the like. This modeling uncertainty should be quantified as part of the fragility calculation.