ArevaEPRDCPEm Resource

From: Getachew Tesfaye
Sent: Friday, June 05, 2009 4:10 PM
To: 'usepr@areva.com'
Cc: Hernando Candra; Samir Chakrabarti; Jim Xu; Ching Ng; Jennifer Dixon-Herrity; Michael Miernicki; Jay Patel; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 222 (2746, 2699, 2720), FSAR Ch. 3
Attachments: RAI_222_SEB2_2746_EMB2_2699_SEB2_2720.doc

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on May 11, 2009, and discussed with your staff on May 29, 2009. Draft RAI Questions 03.06.02-20 and 03.06.02-31 were 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,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 545

Mail Envelope Properties (C56E360E9D804F4B95BC673F886381E71FB9740D9E)

Subject: U.S. EPR Design Certification Application RAI No. 222 (2746, 2699, 2720), FSAR Ch. 3
Sent Date: 6/5/2009 4:10:16 PM
Received Date: 6/5/2009 4:10:21 PM
From: Getachew Tesfaye

Created By: Getachew.Tesfaye@nrc.gov

Recipients:
"Hernando Candra" <Hernando.Candra@nrc.gov>
Tracking Status: None
"Samir Chakrabarti" <Samir.Chakrabarti@nrc.gov>
Tracking Status: None
"Jim Xu" <Jim.Xu@nrc.gov>
Tracking Status: None
"Ching Ng" <Ching.Ng@nrc.gov>
Tracking Status: None
"Jennifer Dixon-Herrity" <Jennifer.Dixon-Herrity@nrc.gov>
Tracking Status: None
"Michael Miernicki" <Michael.Miernicki@nrc.gov>
Tracking Status: None
"Jay Patel" <Jay.Patel@nrc.gov>
Tracking Status: None
"Joseph Colaccino" <Joseph.Colaccino@nrc.gov>
Tracking Status: None
"ArevaEPRDCPEm Resource" <ArevaEPRDCPEm.Resource@nrc.gov>
Tracking Status: None
"'usepr@areva.com'" <usepr@areva.com>
Tracking Status: None

Post Office: HQCLSTR02.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	780	6/5/2009 4:10:21 PM
RAI_222_SEB2_2746_EMB2_2699_SEB2_2720.doc		66554

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

Request for Additional Information No. 222 (2746, 2699, 2720), Revision 0

6/05/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.04.02 - Analysis Procedures
SRP Section: 03.06.02 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping
SRP Section: 03.08.03 - Concrete and Steel Internal Structures of Steel or Concrete Containments
Application Section: FSAR Ch. 3

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)
QUESTIONS for Engineering Mechanics Branch 2 (ESBWR/ABWR Projects) (EMB2)

03.04.02-8

Supplemental to RAI 03.04.02-1

In its response the applicant has noted a number of soil parameters that are used for the calculation of lateral loads on walls and in determining sliding stability of structures. As these values have an impact on the design and stability of Seismic Category I structures and are a function of the soil conditions found at a site, the applicant is requested to add the soil parameter coefficients assumed in the design as well as the values for the coefficients of friction to Table 2.1-1 "U.S. EPR Site Design Envelope". The applicant is also requested to comment on the applicability of the Boussinesq method for determining lateral pressures against a rigid surface (embedded structural wall), when the theory was developed to calculate stress distribution in an elastic half space due to a point load.

03.04.02-9

Supplemental RAI 03.04.02-3

In its response to Question 3.4.2-3, the applicant stated that the protective measures for PMF or ground water are provided in Tier 2, FSAR Section 3.4.2. However this Section does not address specifically the seismic Category I items addressed in the question. The applicant is requested to address each of those items individually and describe how they are protected.

03.06.02-19

This is the supplemental RAI S01 for RAI 107, 03.06.02-1

The staff reviewed the response to RAI Letter No. 107, RAI #03.06.02-01 and found that AREVA has not addressed the issue. BTP 3-4, Part B, item A(iv) suggests that the designer should identify and include all complex system piping containing headers and parallel piping running between headers in each high energy piping run. It is not clear from AREVA response that U.S. EPR piping design would not have any such high energy piping arrangement subject to postulated pipe breaks. FSAR Section 3.6.2.1.1.2, as referenced in the response does not define a piping run or its layout. The staff requests the applicant to identify all complex system such as those containing arrangement of headers and parallel pipe running between headers and clarify that the criterion BTP 3-4 Part B, item A (iv) is applicable or not.

03.06.02-20

This is the supplemental RAI S01 for RAI 107, 03.06.02-2

The response from AREVA concerning RAI #03.06.02-2 is not adequate. Specifically for inside containment, BTP 3-4, Part B, item A(i) states that the effects of postulated piping breaks at any location should be isolated or physically remote from essential systems and components. It does allow an evaluation of each postulated rupture location for its effects on essential systems and components, as identified in the second bullet of the response. However, using the idea of separation and redundancy for the essential systems and components to eliminate the need for detailed evaluation and protection of a ruptured pipe's essential target may not be acceptable. The applicant's effort may include analyses demonstrating that the essential systems and components affected by a rupture in a nearby piping break would be able to perform their intended functions (see BTP 3-3, item B.3 for outside containment) or providing appropriate protection devices. The staff requests the applicant to address the concerns discussed in the original RAI and to clarify the third bullet of the RAI response. The applicant is requested to discuss in detail how its plant design and the separation and redundancy method can be used to mitigate the effect of pipe rupture.

03.06.02-21

This is the supplemental RAI S01 for RAI 107, 03.06.02-6

In the response of RAI #03.06.02-06, AREVA has not provided information to substantiate the validity of the methods of ANS 58.2 for dynamic jet force analysis. The CRAFT2 program is not applicable to dynamic jet impingement analysis, and AREVA has not provided a validated alternative to ANS 58.2. AREVA has also not provided criteria to determine when simplified modeling is acceptable and when more detailed modeling is needed. AREVA is therefore encouraged to review again the ACRS concerns regarding the validity of the methods in ANS 58.2, and requested to provide the information requested in the original RAI.

03.06.02-22

This is the supplemental RAI S01 for RAI 107, 03.06.02-7

In its RAI response, AREVA explained that they continue to apply the methodology in ANS 58.2 to their jet impingement analyses. AREVA should be advised that ANS 58.2 methodologies may not be conservative, per the ACRS concerns described in the preamble to the original RAI. AREVA also stated that analyses of the structural responses to the jet loads are conducted statically, and multiplied by a dynamic load factor of 2.0 to account for the effects of a nearly instantaneous jet load. AREVA ignored the fact that when jet loads are dynamic, they can induce significantly higher vibrations and stresses in structures, particularly when the structural resonance frequencies are close to the jet excitation frequencies. It should be noted that dynamic effects beyond those due to the initial transient assumed in ANS 58.2 (0.1 millisecond ramp time) may need to be considered in the US EPR FSAR. AREVA is encouraged to review the criticisms raised by Wallis (Wallis, G., "The ANSI/ANS Standard 58.2-1988: Two-Phase Jet Model," ADAMS ML050830344, 15 Sep 2004) and Ransom (Ransom, V., "COMMENTS ON GSI-191 MODELS FOR DEBRIS GENERATION," ADAMS ML050830341, 15 Sep 2004).

AREVA is requested to provide a conservative methodology that addresses these criticisms.

AREVA also states that the only postulated breaks that need to be assessed are those with pure steam conditions at the break plane. It should be noted that all jets have to be characterized for the forces that they might impart on surrounding structures and safety related systems. For example, sub cooled water, at high pressure, would typically flash to steam upon break, transforming to a supersonic jet.

AREVA is requested to provide an updated list of high energy breaks based on the comments above.

In addition, AREVA claims that several pipes and nozzles are qualified using Leak Before Break (LBB) methodology, eliminating several potential postulated breaks, including those at the main steam line piping from the steam generators to the first anchor point location at the containment building penetration. This LBB issue is still being reviewed by NRC staff in Section 3.6.3, we therefore, leave this aspect of the RAI open until the LBB issue is resolved.

03.06.02-23

This is the supplemental RAI S01 for RAI 107, 03.06.02-8.

(a) In the response of RAI # 03.06.02-8, AREVA ignored blast waves in open cavities. However, based on ACRS concerns, and the information in the Knowledge Base for Emergency Core Cooling System Recirculation Reliability, February 1996, Issued by the NEA/CSNI, http://www.nea.fr/html/nsd/docs/1995/csni-r1995-11.pdf, all high pressure and temperature pipes should be considered as sources of blast waves with initial energy and mass roughly equal to the exposed volume from a hypothesized break. The subsequent damage from such waves has been well documented and is not properly accounted for by the isolated analysis of a pure spherically expanding wave. It should be noted that loads due to blast waves depend on the energy source of the blast, the ambient conditions, and the interaction of the subsequent waves with the surrounding structures. These interactions will result in reflections and likely local focusing of the waves. In addition, blast wave load analyses should be based on three dimensional (or asymmetric) unsteady analysis of the flow field, with appropriate representation of the surrounding structures, subsequent to the initial blast. It does not appear from the description in US EPR FSAR Tier 2, Appendix C, that the analysis methods used resolve the unsteady flow physics that govern blast wave loads, whether asymmetric or three-dimensional.

AREVA is requested to provide a rigorous and thorough explanation of their procedures for estimating the effects of blast waves on nearby SSCs.

(b) AREVA claimed that blast wave effects are accounted for using an analysis approach documented in NUREG-0609. However, NUREG-0609 does not support the physics of blast waves. The methods described would be most incorrect in the initial few milliseconds of a hypothetical blast transient when wave physics dominate the flow.

AREVA is requested to submit an assessment approach which conservatively bounds blast wave effects.

03.06.02-24

This is the supplemental RAI S01 for RAI 107, 03.06.02-9

(a) In the answer of this portion of RAI #03.06.02-9, AREVA referenced their response to question 3.6.2-7. However, that response did not substantiate the use of ANS 58.2 for jet path and loading analyses. AREVA is therefore requested to respond to the original RAI 3.6.2-9(a).

(b), AREVA updated their submission to state that components that are within a distance of ten pipe diameters from a two-phase jet emanating from a pipe break are assumed to fail. AREVA also rejected the evidence in NEA/CSNI/R (95) 11 that jets can cause significant damage at distances up to 25 diameters from pipe breaks, stating that those data are only relevant to insulation damage. However, it should be noted that although the focus of NEA/CSNI/R (95) 11 is on insulation damage, the findings in the report that jets can cause significant loads on neighboring structures at distances up to 25 diameters from a pipe break is relevant to the jet impingement loading issue. AREVA is requested to explain what assessments will be performed of jet loading outside the 10 diameter range. If none, AREVA is requested to substantiate this assumption in light of the findings in NEA/CSNI/R (95) 11.

03.06.02-25

This is the supplemental RAI S01 for RAI 107, 03.06.02-10

(a) In the response of RAI# 03.06.02-10, AREVA explained that they did not use the pressure distribution models from Appendix D of ANS 58.2 in their jet force calculations. Instead, the worst case static pressure at the pipe break location was used to compute the jet force, which is then applied to the target area. AREVA cited data in NUREG/CR-2913 as proof this approach is conservative. For static jet forces, AREVA's approach is conservative. However, for unsteady jets with internal pressure oscillations, the approach is not necessarily conservative. AREVA is requested to either prove that their current approach bounds all possible unsteady jet loads in their plant, or submit a revised approach that conservatively addresses those possible unsteady jet loads.

(b) AREVA has not provided the requested information. As described in the introduction to the original RAIs 3.6.2-8 through 13, the ACRS has called into question the conservatism of the models used in ANS 58.2 Standard. It should be noted that the information requested in the original RAI 3.6.2-10 (b) is required to assess whether the ACRS concerns are applicable to the EPR design. AREVA is therefore requested to provide the information as requested in the original RAI.

03.06.02-26

This is the supplemental RAI S01 for RAI 107, 03.06.02-11

(a) AREVA referenced their response to 3.6.2-7. However, its response to RAI 3.6.2-7 did not address the RAI. AREVA is requested to provide information that establishes that their interpretation of the jet impingement force as static is conservative.

(b) AREVA acknowledged that there are pipe break scenarios with the break locations within 10 diameters of a neighboring SSC or barrier. However, AREVA stated that jet feedback and resonance issues are 'a lesser problem with two-phased jets'. The staff does not understand this assertion. AREVA also stated that the equivalent static analysis (with dynamic load factor) is acceptable as long as the resonance frequencies of the impinged upon structure are 20 percent from the frequencies of peak loads in the jet. AREVA will design all structures near jets to ensure this frequency separation. The dynamics example cited by AREVA is true only for single degree of freedom systems. Since reactor structures have many resonances, and since the jet oscillation frequencies will vary over time as mass flow of the jet changes, there is no way to ensure that a structure will have no resonances near the jet peak loading frequencies. AREVA is requested to submit a realistic analysis and/or design approach to address the jet feedback/resonance phenomenon as requested in the original RAI.

(c) AREVA cited their response to RAI 3.6.2-7, and their response to part (b). However, neither of these responses addressed the RAI. Since real structures will have resonance frequencies in the vicinity of peak jet loading frequencies, the dynamic analysis approach proposed by AREVA is likely not relevant. AREVA is requested to provide information to prove that their analysis approach is conservative, or provide an alternative approach which is conservative and addresses the dynamic nature of the jet loads and structural response.

03.06.02-27

This is the supplemental RAI S01 for RAI 107, 03.06.02-12

In its RAI response AREVA stated that they ignored jet reflections due to energy losses, and that reflected jet amplitudes are negligible compared to other loads, like safe shutdown earthquake and pipe break loads. AREVA is likely basing this assessment on the ANS 58.2 standard, which the staff does not consider to be universally applicable. AREVA is requested to submit analyses confirming their assertion that reflected jet loads are negligible compared to other design loads, keeping in mind the concerns raised by the staff in RAIs 3.6.2-8 through 11 (i.e., confirmatory analyses using ANS 58.2 will not be acceptable). Should AREVA reconsider their assertion that jet reflection loads are negligible, they are requested to summarize their quantitative approach for modeling them.

03.06.02-28

This is the supplemental RAI S01 for RAI 107, 03.06.02-13

In its response to RAI 03.06.02-13, AREVA explained that they plan to use ANS 58.2 to design barriers, shields, and enclosures around high energy lines. An equivalent static analysis with DLF of 2 will be used. AREVA did not address the possibility of dynamic jet resonant loading in their response. AREVA is advised that the ANS 58.2 standard is no longer universally acceptable for specifying jet loads over barriers, shields, and enclosures in nuclear power plants, and that dynamic effects beyond those due to the initial transient assumed in ANS 58.2

may need to be considered in the US EPR design. AREVA is requested to consider realistic jet loads which include dynamic effects and possible resonant amplification in their response to this RAI.

03.06.02-29

This is the supplemental RAI S01 for RAI 107, 03.06.02-14

In U.S. EPR FSAR Section 3.6.2.4.2, AREVA provides criteria for significant dynamic loads and displacements in essential system piping attached to the broken pipe. A factor in the definition of such a dynamic problem is the existence and location of check valves in the remaining unbroken piping. With closing check valves, the faster the closing time for the valve the higher the dynamic loading in the remaining piping. In the response of the RAI 03.06.02-14, AREVA elaborated the methodology for accurate prediction of check valve closing transients that are used in the analyses of piping systems. However, no details are provided how these analyses are performed. The staff request AREVA to explain step by step how it will perform the analysis of essential system piping due to a break in attached piping and should address the following:

1. How the existence and location of check valves in the remaining unbroken piping define the dynamic loads and displacements (excluding jet discharge effect) in essential system piping attached to the broken pipe?

2. Discussion of the analysis that will be performed to demonstrate that the remaining essential piping systems will remain functional after the postulated pipe break.

3. Operability of in-line components in the essential piping.

03.06.02-30

This is the supplemental RAI S01 for RAI 107, 03.06.02-15

AREVA stated, in FSAR Section 3.6.2.5.1.2, that the pipe whip restraints are designed for the extreme one-time loads associated with postulated pipe breaks and typically, are classified as miscellaneous steel structures. In the response of the RAI 3.6-15, AREVA also stated that the dead load (if applicable) and the pipe break loads are the only loads combined, However, the staff has a concern about whether the pipe whip restraints should also be designed for the seismic load. The applicant is requested to explain why the seismic load is excluded in its piping restrain design.

03.06.02-31

This is the supplemental RAI S01 for RAI 107, 03.06.02-17

AREVA did not address the original RAI adequately. For Part (a), the applicant referred to their response to RAI No. 80, Question 03.06.01-2. The applicant proposed a system based ITAAC in Tier 1 Table 2.1.1-7 of the Nuclear Island for pipe break evaluation. It should be noted that system based ITAAC includes only ASME Class 1, 2, and 3 piping but not non-safety class piping that is within the scope of SRP 3.6.2. The applicant is requested to address how the system based ITAAC as proposed will include all the piping systems within the scope of SRP 3.6.2. Furthermore, the RAI response did not address staff's concern relating to ITAAC item including both design aspect and as-built reconciliation of the pipe break hazards analysis report as described in the original RAI. The applicant is requested to include both design aspect and as-built reconciliation in the ITAAC table for the pipe break hazards analysis report.

The applicant also did not adequately address Parts (b) and (c) of the original RAI. The applicant should note that there are three areas involved in the pipe break hazards analysis. These three areas are the methodology or the criteria for evaluating the effects of postulated pipe failures, the design aspect of the pipe break hazards analysis report performed in accordance with the methodology, and then the as-built reconciliation to ensure the plant is built in according to the design and meets the applicable regulation. Since the applicant indicated that the design aspect of the pipe break hazards analysis will be performed by the COL applicant, AREVA should include a description in FSAR Tier 2 Section 3.6.2 that clearly outlines the information that will be included in the as-designed pipe break hazards analysis report. This is to ensure that the design aspect of the pipe break hazards analysis report will contain sufficient information for the staff's review to ensure that the design is performed in according to the FSAR methodology and meet the applicable regulation. Moreover, the applicant did not address the closure milestone of the as-designed pipe break hazards analysis report. FSAR should include a description to address the point that the process will allow the coordination with staff's review, such that it will make the final as-designed pipe break hazards analysis report available for NRC review. The applicant is requested to address the above staff's concerns as requested in the original RAI.

03.08.03-18

During a telephone conference held on April 8, the NRC and AREVA NP agreed upon the specific data subset that would be provided to support the NRC confirmatory analysis. Accordingly, the NRC staff is requesting that AREVA NP provide the data and supporting information described below:

a) One or more DVDs containing the ANSYS (.db) and the input (.txt) files to create the ANSYS (.db) file for RBIS truncated model, including all boundary condition files. This model corresponds to the FEM model described in US EPR FSAR Section 3.8.3.4.1 and shown in Figures 3.8-32 through 3.8-37.

b) Load files for the applicable N-S or E-W direction earthquake (E and Ecommon load files) that corresponds to the soil case with the highest ZPAs (or the case with the highest shear/overturning forces) but lowest ZPA Modification Factor. AREVA will determine this and provide an explanation for the choice. A description of these files will be provided to explain their meaning and how they were developed.

c) Some of the loadings (other than the concrete elements) are represented as (a) uniform pressures (e.g., certain dead loads, percentage of live load, fluid loads, etc.) and (b) concentrated forces (e.g., for equipment). These loadings must also be accelerated by the response spectra. Consequently, these loadings must be converted to equivalent lumped masses or material densities. AREVA will either make this conversion or provide sufficient information to enable the NRC to make this conversion.

d) Accelerations in the input loading file (Item (b) above) will include the equivalent static accelerations in the selected direction with seismic modification factors included, or if separate, will so indicate. AREVA NP will explain how the equivalent static accelerations were obtained including where they were obtained. The SASSI model may not contain the same node locations as the refined static NI model with the RBIS, thus AREVA NP will explain how the seismic acceleration values from SASSI analysis are applied to the truncated RBIS model. AREVA NP will verify that these acceleration factors are the same as those used in the full NI FEM for design.

e) Seismic floor response spectra (translation and rotation) in the selected governing direction (e.g., N-S and associated rotation about E-W) at the base of the RBIS model at 7 percent damping, for the soil case identified in Item (b) above. AREVA NP will indicate whether spectra correspond to the specific location at the base (bottom) of the RBIS. If not, AREVA NP will provide the spectra at the closest node beneath the base of the RBIS and the closest node above the base of the RBIS. If responses of the two spectra are not similar (i.e., within 10%) throughout the frequency range of interest, AREVA NP will interpolate between them to obtain the expected spectra at the base of the RBIS. AREVA NP will verify that floor response spectra are taken from the lumped mass stick model shown on FSAR Figure 3.7.2-3. If this is the case, AREVA NP will also provide the spectra in the reactor building containment and shield building closest to the RBIS haunch elevation. This will enable the NRC to determine the extent of any amplification from the base to the top of the haunch that may affect the overall response of the RBIS. AREVA NP will provide spectra in graphical and electronic form (e.g., Excel or text format).

f) In addition to the requested floor response spectra, AREVA NP will provide acceleration (or displacement) time histories for translation and rotation corresponding to spectra determined from Item (e) above. AREVA NP will verify that these time histories are obtained directly from the SASSI analysis building response for the soil case identified in Item (b) above.

g) RBIS responses (displacements, member forces) for representative nodal locations and structural elements covering the different elevations (top to bottom) and locations (e.g., compartments and platforms) within each elevation. These responses are expected to correspond to those obtained from the full ANSYS NI FEM that allows uplift as used in the design analysis presented in the U.S. EPR FSAR. AREVA NP will verify that these responses are the forces and displacements only from analysis of the horizontal direction selected in (b) above. Displacements will be made at more flexible locations, while member forces will be made at more rigid locations. Presentation will be created and provided in EXCEL format. Explanation will be provided for choice of locations.

h) To address potential differences in the results of the confirmatory analysis and the design basis results discussed in (g) above, AREVA NP will re-run the RBIS model provided to the NRC using the same FEM model (fixed base boundary conditions) and equivalent static loadings discussed in Items (a) and (b) above and will provide the complete set of responses (displacements, member forces) for the RBIS using the default set of such responses available in ANSYS. This will be provided in electronic form.

i) Validation of re-run analysis results using the fixed base RBIS model discussed in (h) above with the results obtained from the full NI model containing the RBIS discussed in (g) above. This will be achieved by creating additional Excel tables that compare RBIS responses from Item (h) above for the same representative locations discussed in Item (g) above. If comparison of the results of (g) and (h) show significant differences, then (g) will be performed using the full ANSYS NI FEM with fixed base conditions. In demonstration, AREVA NP will provide a representative subset of results from the full ANSYS NI FEM that allows uplift.

j) AREVA NP will state the version of ANSYS used and describe in technical terms the platform used to execute ANSYS (e.g., IBM PC Windows, bit size, and type(s) of processors) for the original design basis evaluation in the FSAR (Item (g) above) and for the re-run performed for item (h) above.

k) Information needed to understand the FEM model, loading, analytical method, and interpretation of results that is otherwise not provided in the RBIS model description currently presented in U.S. EPR FSAR Section 3.8.3.4.1 and shown in Figure 3.8-32. The description will be in sufficient detail to minimize the need for further discussion.