ArevaEPRDCPEm Resource

From: Getachew Tesfaye
Sent: Tuesday, April 07, 2009 2:17 PM
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Cc: David Jeng; Jim Xu; Abdul Sheikh; Kaihwa Hsu; Anthony Hsia; Michael Miernicki; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: Draft - U.S. EPR Design Certification Application RAI No. 211 (2435, 2437, 2438, 2439, 2462, 2442, 2376), FSAR Ch. 3
Attachments: Draft RAI_211_SEB2_2435_2437_2438_2439_2462_EMB1_2442_2376.doc

Attached please find draft RAI No. 211 regarding your application for standard design certification of the U.S. EPR. If you have any question or need clarifications regarding this RAI, please let me know as soon as possible, I will have our technical Staff available to discuss them with you.

Please also review the RAI to ensure that we have not inadvertently included proprietary information. If there are any proprietary information, please let me know within the next ten days. If I do not hear from you within the next ten days, I will assume there are none and will make the draft RAI publicly available.

Thanks,
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Request for Additional Information No. 211(2435), Revision 0

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U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.03.01 - Wind Loading
SRP Section: 03.03.02 - Tornado Loads
SRP Section: 03.04.02 - Analysis Procedures
SRP Section: 03.05.03 - Barrier Design Procedures
SRP Section: 03.08.01 - Concrete Containment
SRP Section: 03.09.03 - ASME Code Class 1, 2, and 3 Components
SRP Section: 03.12 - ASME Code Class 1, 2, and 3 Piping Systems and Piping Components and Their Associated Supports

Application Section: FSAR Ch. 3

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)
QUESTIONS for Engineering Mechanics Branch 1 (AP1000/EPR Projects) (EMB1)

03.03.01-3

The staff in RAI 94, Question 03.03.01-1(b), asked that since AREVA had used the value of K_d from Table 6-4 of ASCE/SEI Standard 7-05, did it also use the load combinations which include wind load from Sections 2.3 and 2.4. The Standard requires these load combinations be used if the value of K_d is based on Table 6-4. In its written response AREVA did not state whether the load combinations in the Standard were the basis of load combinations containing wind load in the FSAR. Section 2.3 and 2.4 of the Standard contain the following load combinations which are to be used when the wind load has been calculated using the values of K_d from Table 6-4.

For strength design (Section 2.3):

1.2D + 1.6W + L + 0.5(Lr or S or R)
0.9D + 1.6W + 1.6H
1.2D + 1.6(Lr or S or R) + (L or .8W)

Where: Lr=roof load
S=snow load
R=rain load
D=dead load
W=wind load
E=earthquake load
L=live load
H=lateral earth pressure load

For allowable stress design (Section 2.4):

D + H + F + (W or 0.7E)
D + H + F + 0.75(W or 0.7E) + 0.75L +0.75(Lr or S or R)
0.6D + W + H

The load combinations in ACI 349-06 for strength design which contain wind load are:

1.2(D + F +Ro) + 1.6(L + H + W)
0.9D + 1.6L + 1.6W

Where: Ro=normal pipe reaction loads
F=fluid loads

These load combinations are very similar to those in the ASCE Standard with the factor on the wind load the same in both sets of load combinations. The ACI code also allows alternate load combinations which are the same as those found in the FSAR Section 3.8.4.3.2. For concrete structures what has been provided in the FSAR for load combinations containing wind load is therefore acceptable. AREVA is requested to perform a similar review of the FSAR load combinations that apply to steel structures and demonstrate they meet the requirements of the ASCE/SEI Standard when wind load is included or, alternatively, provide justification for the load combinations that are used.

03.03.02-3

a. In Question 03.03.02-1(2) of RAI 126, the staff had asked what methods were used to qualify the Nuclear Auxiliary Building (NAB) for tornado loading. AREVA in its written response stated that the methodology of ASCE 43 and Limit State A would be utilized to ensure that the NAB does not collapse under tornado loads and affect adjacent Seismic Category I Nuclear Island Common Basemat structures. The staff has concluded that the response needs additional information in order to be acceptable. The concern of the staff is that ASCE 43-05 provides seismic design criteria for SSCs in nuclear facilities and has not been accepted by the staff for general use. The limit states and other criteria in ASCE 43-05 were developed for seismic loads not wind loads. Limit states define levels of acceptable damage with structures designed to Limit State A expected to have significant damage. AREVA also stated that the NAB is evaluated for tornado loadings per RG 1.143 due to its classification as RW-IIa per RG 1.143. RG 1.143 provides design tornado wind loads that are 3/5ths of the tornado wind load of RG 1.76. These design loads are appropriate for a stand-alone facility, but in this instance the NAB is adjacent to Category I structures. SRP Section 3.7.2, subsection 3.7.2 II.8 C, which addresses the interaction of a non Category I structure with a Category I structure states that a non-Category I structure analyzed and designed to prevent its failure under SSE conditions, should have a margin of safety that is equivalent to that of a Category I structure. The same design approach is applicable to the design of non Category I structures for tornado loads as the tornado wind represents an extreme environmental load and the level of protection provided the Category I structure should be no less than that provided under a seismic load. AREVA should provide and discuss the design tornado wind velocity, tornado loads, loading combinations, and design code used in the design and analysis of the NAB structure. If its design under tornado loading conditions will not provide a margin of safety that is equivalent to that of a Category I structure, AREVA should provide the methods of

analysis, acceptance criteria, expected damage, critical sections and calculated displacements of the NAB for staff review.

b. In FSAR Section 3.3.2.3 (Effect of Failure of Structures or Components not Designed for Tornado Loads), it states that for the ACB and the TB 'one of the above methods' will be utilized to ensure that due to tornado loading, the adjacent Nuclear Island Basemat Structure is protected from the failure of either the ACB or TB. In Question 03.03.02-1(3) of RAI 126, the staff had asked for additional information as it was not clear what methods were being referenced and how they were to be used to ensure that adjacent Nuclear Island Basemat Structures were protected from failure of the ACB or TB due to tornado loading. In its written response, AREVA stated that the methods referred to are the three bulleted items in U.S. EPR FSAR Tier 2, Section 3.3.2.3. Specifically, the three methods referred to are:

• The adjacent non-Seismic Category I structure is designed to resist applicable tornado loadings.
• The integrity of a Seismic Category I structure is evaluated for failure of an adjacent non-Seismic Category I structure during a design basis tornado to verify the functionality and continued operation of the Seismic Category I structure during and after the tornado.
• A structural barrier(s) is provided to protect the Seismic Category I structure from failure of the adjacent non-Seismic Category I as a result of a tornado.

AREVA stated that U.S. EPR FSAR Tier 2, Section 3.3.2.3, will be updated to state: "The ACB is a reinforced concrete or steel frame building. One of the methodologies identified in the preceding three bullets will be utilized to provide reasonable assurance that the ACB will not collapse under tornado loads and affect Seismic Category I Nuclear Island Common Basemat structures." U.S. EPR FSAR Tier 2, Section 3.3.2.3, will be updated to state: "The TB is a steel frame building. One of the methodologies identified in the preceding three bullets will be utilized to provide reasonable assurance that the TB will not collapse under tornado loads and affect Seismic Category I Nuclear Island Common Basemat structures." U.S. EPR FSAR Tier 2, Section 3.3.2.3, 3rd bullet will be updated to state: "A structural barrier(s) is provided to protect the Seismic Category I structure from failure of the adjacent non-Seismic Category I structure as a result of a tornado."

The staff has concluded that the above response is not acceptable. For both the ACB and the TB the applicant states that the FSAR will be changed to state that one of the methodologies identified in the three bullets will be utilized to provide reasonable assurance that the ACB (or TB) will not collapse under tornado loads and affect Seismic Category I structures. However, only the first bullet deals with designing the structure to resist applicable tornado loads. The second and third bullet assume the structure will collapse and other measures will be implemented to assure the collapse does not affect the functionality and continued operation of adjacent seismic Category I structures. To provide assurance that the design method used on the non-Seismic Category I structure is adequate to resist applicable tornado loads, an acceptable method is to implement the guidance provided in SRP Section 3.7.2, subsection 3.7.2 II.8, i.e. the structure should be designed with the same margin of safety as that of a Category I structure. If the margin of safety is not equivalent to that of the Category I structure, AREVA should provide and discuss the detailed methods of analysis, acceptance criteria, expected damage, critical sections and calculated displacements for the staff's review. If the second bullet is to be implemented, AREVA should provide and discuss the methods by which this will be accomplished including the methods of analysis, mode of failure, impact loads and impact analysis of adjacent Category I structures

or a similar description if a structural barrier identified in the third bullet is used. Also include the design basis adopted for the barrier as well as design codes and acceptance criteria used in evaluating barrier response under the impact load of the failed structure.

c. Acceptance Criteria 3 A. Concrete Structures of SRP Section 3.8.3 Loads and Load Combinations states that all loads and load combinations are to be in accordance with ACI 349 and RG 1.142. The reduction to 25% live load with tornado load as stated in FSAR Sections 3.3.2 (Tornado Loading) and 3.8.4.3.2 (Loading Combinations) contradict the requirements of ACI 349 and RG 1.143 Table 3 which use full live load instead of the 25% live load noted above. In Question 03.03.02-1(5) of RAI 126, the staff had asked for the bases of this live load reduction in combination with tornado load and for AREVA to justify this deviation from pertinent provisions of the SRP 3.8.3. AREVA in its response stated that one hundred percent of the live load is used for structural design activities and that U.S. EPR FSAR Tier 2, Section 3.3.2, will be updated to state: "One hundred percent of the design live load is considered with tornado load combinations." The staff finds this to be acceptable. The reference to use twenty-five percent of the live load in U.S. EPR FSAR Tier 2, Sections 3.8.1.3.2, 3.8.4.4.1, and 3.8.5.4.1 will be updated to state: "Twenty-five percent of the design live load is considered during static analysis with seismic load combinations. The full potential live load is used for local analysis of structural members." The staff has concluded that this part of the response needs additional clarification in order to be acceptable. The meaning of the first sentence in this revised statement is not clear and does not agree with the load combinations in U.S. EPR FSAR Tier 2, Sections 3.8.1.3.2 or 3.8.4.3.2 in which the load combinations that contain either tornado load or seismic load also include the full live load. Also, the first sentence of the statement seems to contradict the second sentence which states that the full potential live load is used for local analysis of structural members, although it is not clear what is meant by local analysis of structural members. The applicant is requested to clarify the meaning of the revised statements and update the text in U.S. EPR FSAR Sections 3.8.1.3.2, 3.8.4.4.1, and 3.8.5.4.1 to be consistent with the relevant load combinations which include the full live load in combination with tornado loads and seismic loads.

03.04.02-7

In the U.S. EPR FSAR it isn't apparent that the depth of embedment defined by the distance between the finished grade and the bottom of the foundation mat is explicitly defined for each of the structures. This dimension is important as it could impact earth pressure loads as well as a structure's seismic analysis if a different embedment depth is used by the COL applicant. AREVA is requested to provide this information in a table or figure of the FSAR for each in-scope U.S. EPR structure and include a COL requirement in the FSAR for the applicant to verify the depths of embedment for U.S. EPR structures, i.e. the foundation depth from finished grade to the bottom of each foundation mat, so that it meets the design basis of the U.S. EPR standard design.

03.05.03-10

In FSAR Section 3.5.2 on page 3.5-11 it states that missile protection for openings and penetrations in structures is provided by enclosures, missile-resistant doors and covers, labyrinth structures or physical protection features. For the U.S. EPR Category I structures, AREVA is requested to provide specific examples of each of these protective features, including

the method of analysis used for the missile barrier and the external missile for which the barrier is being designed.

03.08.01-31

FSAR Section 3.8.1.7.2 does not provide sufficient information which demonstrates that the inservice inspection (ISI) of the prestressed concrete containment is performed in accordance with RG 1.90. For example, there is no explanation whether the EPR containment falls within the definition of a “reference containment” type as defined in Section B of the RG. Based on the dimensions of the EPR containment, it appears that it does not, and so it is not clear whether the ISI program for this containment meets the guidelines in Appendix A to the RG 1.90. FSAR Section 3.8.1.7.2 does not identify whether Alternative A or B is being used to monitor the performance of the containment as defined in the RG. If monitoring deformation under pressure (Alternative B) is selected, then where does the FSAR state that the design of the containment structure meets additional criteria such as maintaining compression of the containment under the peak pressure during the ISI tests and limiting the maximum stress in the tensile reinforcing steel to one half of the yield strength. The FSAR also does not describe the locations for monitoring the displacement of the containment which demonstrates that these locations satisfy the guidelines presented in RG 1.90. Based on the above, AREVA is requested to provide more detailed information which demonstrates how the ISI program satisfies the guidelines presented in RG 1.90.

03.09.03-21

In response to RAI 03-09.03-6, AREVA stated that the combined license (COL) information item in the U.S. EPR FSAR Tier 2, Section 3.9.3 addresses the information that NRC requests of the COL applicant in Part C.III of RG 1.206, Section CI.3.9.3.1 which requires a summary of the maximum total stress, deformation, and cumulative usage factor values for each of the component conditions for all ASME Code Class I components.

Part C.III of RG 1.206, Section CI.3.9.3.1 also requires that applicant should include all ASME Code Class 2 and 3 components required to shut down the reactor or mitigate consequences of a postulated piping failure without offsite power, a summary of the maximum total stress and deformation values for each of the component operating conditions (with identifications of those values that differ from allowable limits by less than 10 percent).

The staff requests AREVA to confirm that the the existing COL item for ASME Class 1 components will be revised to include Class 2 and 3 components which are required to shutdown the reactor or mitigate consequences of a postulated piping failure without offsite power.

03.12-12

The staff reviewed RAI 161(questions 3.12-1 thru 3.12-5) and determined that the response is not adequate to address the concern on the following bases.

SRP 1.0 states that a table of information demonstrating how COL action items were addressed, or appropriate FSAR section references as to where this information is provided, is reviewed. However, FSAR Table 1.8-2 does not identify this activity as COL information item and subsection 3.12.5.9 also does not identify this activity as COL information item.

According to the response which quotes COL IBR, there is no need to identify COL information item in DC at all since all activities were stated in DC FSAR. This concept does not meet the intent of SRP 1.0. The staff does not consider this response acceptable.

The staff also noted that these are monitoring activities during first cycle to verify that operating conditions have been considered in the design analysis. The applicant's response indicated initial test programs which are not intended for these specific monitoring activities for thermal cycling/stratification.

Therefore, the staff requests that the applicant readdress these RAIs.

03.12-13

The staff reviewed the response to Question 3.12-9 of RAI 161 and requests the applicant to further clarify its response as per below:

a) The applicant's response (Bullet 4) stated that for any un-isolable piping attached to the RCS with the first vertical-to-horizontal elbow L/Di greater than 20, thermal stratification does not occur in the branch line considered. However, TR-1011955 (referencing EPRI report MRP-132) stated that the swirl penetration distance is a function of the line diameter with greater penetration in larger diameter lines. Thermal stratification is dependent on the swirl penetration distance which is not a constant of L/Di=20. Clarify the difference.

b) The applicant's response (Bullet 5) stated that piping oriented downward from the RCS followed by a horizontal section is not susceptible to thermal stratification due to valve leakage, based on operating plant experience presented in the EPRI guidelines Appendix B.

The piping oriented downward from the RCS followed by a horizontal section has been identified as DH piping branch configuration in TR-1011955. The staff noted that EPRI guideline TR-1011955 stated that valve in-leakage is not required for thermal cycling to occur in DH line configurations. Clarify the response (Bullet 5) statement related to DH not susceptible to thermal stratification due to valve leakage.

c) The applicant also stated that the U.S. EPR design incorporates lessons learned from operating experience in that the injection line (SIS/RHRS) continually rises in elevation from the check valve; therefore, it is not susceptible to valve leakage-induced cyclic thermal stratification. However, FSAR Section 3.12.5.9 stated that RHR/SIS/EBS injection piping is subject to thermal stratification. Clarify the inconsistency.

03.12-14

GDC 2 and 10 CFR 50 require load combinations for components/piping/piping supports necessary to withstand the effects of earthquakes combined with the effect of normal or accident conditions.

In FSAR subsection 3.9.3 and Topical Report ANP-10264NP, the applicant stated that SSE and high energy line break (loss-of-coolant-accident (LOCA) and secondary side pipe rupture) loads are always combined using the SRSS method. The staff is requesting the applicant to provide justification for the load combination of SRSS method for SSE and secondary side pipe rupture.

03.12-15

In November 20, 2007, the applicant's response to an RAI on Topical Report ANP-10264(N) stated that AREVA will identify three (3) representative calculations from the analyses currently being completed for the U.S. EPR design certification to be used in the benchmark program. The staff requests the applicant to submit these representative calculations to ensure that the computer programs are benchmarked with the appropriate NRC benchmarks as described in SRP 3.12.

03.12-16

The staff reviewed the applicant's response (question 3.12-10 of RAI 161) for building settlement cases. The response did not address piping supports loading combination for building settlement cases. Table 3-2 and 3-4 in ANP-10264NP-A address only stress criteria, not loading combination for pipe supports. Clarify the loading combination for piping supports for building settlement cases.