ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Friday, October 16, 2009 5:38 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); WELLS Russell D (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 265, FSARCh. 3
Attachments: RAI 265 Response US EPR DC.pdf

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 265 Response US EPR DC.pdf" provides a technically correct and complete response to 1 of the 7 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 265 Question 03.06.03-24.

The following table indicates the respective page in the response document, "RAI 265 Response US EPR DC.pdf," that contains AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 265 — 03.06.03-20	2	2
RAI 265 — 03.06.03-21	3	3
RAI 265 — 03.06.03-22	4	4
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A complete answer is not provided for 6 of the 7 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 265 — 03.06.03-20	December 18, 2009
RAI 265 — 03.06.03-21	December 18, 2009
RAI 265 — 03.06.03-22	December 18, 2009
RAI 265 — 03.06.03-23	December 18, 2009
RAI 265 — 03.06.03-25	December 18, 2009
RAI 265 — 03.06.03-26	December 18, 2009

Sincerely,

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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Wednesday, September 16, 2009 1:52 PM
To: ZZ-DL-A-USEPR-DL
Cc: Reichelt, Eric; Miernicki, Michael; Patel, Jay; Terao, David; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 265 (3358), FSARCh. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on August 3, 2009, and discussed with your staff on August 17, 2009. Draft RAI Questions 03.06.03-21 and 03.06.03-22d 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: 884

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Subject: Response to U.S. EPR Design Certification Application RAI No. 265, FSARCh. 3
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Response to

Request for Additional Information No. 265 (3358), Revision 0

9/16/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.06.03 - Leak-Before-Break Evaluation Procedures
Application Section: 03.06.03

QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

Question 03.06.03-20:

Follow-up to RAI Question 03.06.03-3

During the 6/09/2009, audit, the staff reviewed information related to Dynamic Strain Aging (DSA) and recommendations regarding metallurgical and heat treatment specifications as well as improvements to production welding procedures for ferritic base metals that would minimize the concern for dynamic strain aging. AREVA is requested to formally submit this material so the staff can review the recommendations and AREVA's approach.

Response to Question 03.06.03-20:

A response to this question will be provided by December 18, 2009.

Question 03.06.03-21:

Follow-up to RAI Question 03.06.03-6

RAI Question 03.06.03-6 requested AREVA to provide details for the J-R curves used for ALL the calculations as none were provided in the original FSAR. AREVA provided the requested information during an audit conducted on June 26, 2008. The information presented to the staff during the audit indicated that for SST pipe and welds the toughness was reduced by 30% to account for thermal aging. In the formal response to RAI Question 03.06.03-6, dated 9/18/2008, AREVA indicated that the reduction in toughness was to account for heat to heat variations. The staff requests AREVA to provide the justification and the basis for the 30% reduction.

Response to Question 03.06.03-21:

A response to this question will be provided by December 18, 2009.

Question 03.06.03-22:

Follow-up to RAI Question 03.06.03-10

In RAI 03.06.03-10 AREVA was requested to justify the use of the crack morphology parameters used in the leakage calculations. During the 06/09/2009 audit, AREVA provided a comparison of the data between KRACKFLO (AREVA) and SQUIRT (NRC) sorfware.

1. AREVA stated in order to get similar results with SQUIRT, they use a penalty factor of 26 in KRACKFLO (and an improved crack morphology option with SQUIRT). Please provide the basis for using these criteria.

2. Additionally, the following factors need to be accounted for by AREVA that could affect the ALL diagram:
   a. Compare crack length for the leakage limits between KRACKFLO and SQUIRT with and without the improved COD-dependant crack morphology.
   b. Examine and validate the effect of tensile stress-strain curve on crack-driving force J-applied to assess, leak versus moment curves as well as J applied for flaw stability analysis.
   c. Effect of J-R material property data being too low. While using a low J-R curve is conservative, the values to fit the J-R curve seemed to result in an unusually low curve and may need to be confirmed.
   d. As was discussed in the audit of June 9, 2009, air fatigue morphology is the least conservative assumption for leak-rate calculations. If an SCC or corrosion morphology is assumed in the calculations (as a lower bound conservative case) each of the ALL diagrams will change. AREVA is requested to provide justification for using air fatigue or provide an analysis using a corrosion fatigue and SCC for comparison. AREVA may want to include in their discussion that SCC can be eliminated for the leak-rate analysis if AREVA's recommended welding procedures (when implemented) **will** produce compressive residual stresses on the ID surface.

Response to Question 03.06.03-22:

1. See the Response to Question 03.06.03-25.

2a. A response to this question will be provided by December 18, 2009.

2b. A response to this question will be provided by December 18, 2009.

2c. A response to this question will be provided by December 18, 2009.

2d. A response to this question will be provided by December 18, 2009.

Question 03.06.03-23:

Follow-up to RAI Question 03.06.03-13

In response to RAI 03.06.03-13, AREVA referenced EPRI Report 1009801, "Materials Reliability Program (MRP), Resistance to Primary Water Stress Corrosion Cracking of Alloys 690, 152, 52 in Pressurized Water Reactors (MRP-111), Electric Power Research Institute, March 2004, which contained controls for welding dilution effects and chromium content. Please provide the data contained in the EPRI Report for review and clarification of dilution effects and chromium content in nickel based welds.

Response to Question 03.06.03-23:

A response to this question will be provided by December 18, 2009.

Question 03.06.03-24:

Follow-up to RAI Question 03.06.03-14

In response to RAI 03.06.03-14, AREVA stated that a safety factor of 1.7 is the highest attainable safety factor that can be used to qualify the MSL piping for LBB for the U.S. EPR design. AREVA is requested to check the Ramberg-Osgood fit of the stress-strain data for the MSL to verify that the J driving force is modeled correctly, and then again address the safety factor of 1.7.

Response to Question 03.06.03-24:

The safety factor of 1.7 in U.S. EPR FSAR Tier 2, Section 3.6.3.6.3.1 on dynamic loadings for leak-before-break (LBB) of the main steam line (MSL) was based on seismic analysis using modal combination methods per RG 1.92, Revision 1 using the AREVA NP structural analysis code BWSPAN (See U.S. EPR FSAR Tier 2, Section 3.9.1.2). U.S. EPR FSAR Tier 2, Section 3.6.3.6.3.1, Table 3.6.3-26, and Figure 3.6.3-23 will be revised to change the safety factor from 1.7 to 2.0 on dynamic loadings for LBB of the MSL piping. This change is due to a decrease in seismic loads based on the application of more accurate, but still conservative, methods of modal combinations as described in RG 1.92, Revision 2.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.6.3.6.3.1, Table 3.6.3-26, and Figure 3.6.3-23 will be revised as described in the response and indicated on the enclosed markup.

Question 03.06.03-25:

During the NRC/AREVA audit on 06/09/2009, there was much discussion between AREVA and the NRC staff concerning the comparison data between KRACKFLO(AREVA) and SQUIRT(NRC). AREVA stated that in order to get similar results with SQUIRT, it uses a "penalty factor" of 26 for KRACKFLO and an improved crack morphology option for SQUIRT. AREVA is requested to provide the basis for their penalty factor of 26 in KRACKFLO to compare their results to SQUIRT results using the improved crack morphology option. Please identify what variable/variables are modified by the penalty factor in their leak rate analysis.

Response to Question 03.06.03-25:

A response to this question will be provided by December 18, 2009.

Question 03.06.03-26:

During the audit on 06/09/2009 between the NRC and AREVA, AREVA stated that the material properties of ASME SA-106 was being used to obtain the moment vs. crack length curves for the surge line in the EPR design. However, the material that is to be used for construction is identified as ASME SA-508. In the staff's confirmatory analysis, the stress-strain curves for ASME SA-508 were higher, which would result in a greater amount of constraint of the plasticity. This was confirmed by the staff's Finite Element analysis. AREVA is requested to:

a. Verify that ASME SA-508 is the material to be used in construction for the nozzles and specify which grade or class of SA-508.

b. Provide a confirmatory analysis on ASME SA-508 and justify that ASME SA-106 is more conservative.

c. Perform a Finite Element analysis between the two materials much like what the staff has performed and discussed during the 06/09/2009 audit.

Response to Question 03.06.03-26:

A response to this question will be provided by December 18, 2009.

U.S. EPR Final Safety Analysis Report Markups

Comparison of Base and Weld Metal ALL in Main Steam Line Piping. These results demonstrate that the base metal is the most limiting material for the MSL piping. The results of the flaw stability analysis, considering the limiting base metal properties and all the required safety margins for LBB, are shown in Figure 3.6.3-22—ALL for Main Steam Line Piping with Safety Factor of 2 on Flaw Size (Base Metal).

The explanations for the interpretation of the ALL diagram are provided in Figure 3.6.3-22. As long as the maximum applicable moment (normal operating plus SSE loading) load for the applicable location is within the "ALL LBB Zone," LBB is justified for that location. The maximum moment loads are derived considering various coincident axial loading conditions (100 kips, 200 kips, 300 kips, 451 kips, and 600 kips). The maximum axial loading (external applied) that is applicable for the location, is used as the maximum moment curve for the location. These maximum moment curves already include the end cap load due to pressure at 100 percent power operating condition. The "ALL LBB Zone" region is reduced as the axial loading is increased from 100 kips to 600 kips. The corresponding tabulated values for the ALL diagrams in Figure 3.6.3-22 are provided in Table 3.6.3-25—ALL for the Main Steam Line Piping with Safety Factor of 2 on Flaw Size (Base Metal).

03.06.03-24

~~In the event that the final applied loading data for the MSL piping are not within the "ALL LBB Zone" region, an additional ALL diagram is provided considering a safety factor of 1.7 on flaw size. That ALL diagram is shown in Figure 3.6.3-23—Figure DeletedALL for Main Steam Line Piping with Safety Factor of 1.7 on Flaw Size (Base Metal with the corresponding tabulated values given in Table 3.6.3-26—Table DeletedALL for the MSL Piping with Safety Factor of 1.7 on Flaw Size (Base Metal). In previous LBB evaluations, the NRC has concluded that margins of slightly less than two on the critical-leakage flaw size are acceptable provided that a full margin of 10 is maintained on the leakage uncertainty (Reference 27). As noted in Section 3.6.3.6.1, a margin of 10 on the predicted leakage rate is applied to the MSL.~~

3.6.3.6.3.2 Circumferential Through-Wall Extrados Crack in an Elbow

A sample problem is evaluated to demonstrate that this cracked geometry is bounded by the results of the circumferential through-wall crack in the adjoining straight pipe at a given location. As previously noted in Section 3.6.3.5.4.3, the J-solutions for this cracked geometry are only available for crack half-angles of 45° and 90°. The results of the evaluation of the circumferential crack at the extrados of the elbow are illustrated in Figure 3.6.3-22 which also depicts the results of the circumferential through-wall crack in a straight pipe. As shown in this figure, the results for the circumferential crack at the extrados of the elbow are comparable to the results of the circumferential through-wall crack in a straight pipe.

Table 3.6.3-25—ALL for the Main Steam Line Piping with Safety Factor of 2 on Flaw Size (Base Metal)

Minimum Moment (in-kips)	Maximum Allowable Moment with Moment Plus Axial Load					
	0 kip (in-kips)	100 kips (in-kips)	200 kips (in-kips)	300 kips (in-kips)	451 kips (in-kips)	600 kips (in-kips)
2402	25,153	24,495	23,892	23,214	22,047	20,720
4815	29,053	28,321	27,664	27,084	26,085	24,955
7270	32,379	31,626	30,859	30,241	29,339	28,320
9618	34,845	34,116	33,377	32,634	31,799	30,856
12,122	37,002	36,288	35,569	34,833	33,926	33,041
14,661	38,858	38,159	37,453	36,734	35,746	34,904
17,169	40,352	39,722	39,026	38,318	37,259	36,449
19,805	41,751	41,186	40,496	39,798	38,707	37,887
22,550	43,016	42,509	41,825	41,134	40,058	39,181
25,628	44,285	43,837	43,158	42,473	41,411	40,474
28,822	45,466	45,056	44,398	43,718	42,667	41,673

Table 3.6.3-26—Table Deleted~~ALL for the MSL Piping with Safety Factor of 1.7 on Flaw Size (Base Metal)~~

~~Minimum Moment (in-kips)~~	~~Maximum Allowable Moment with Moment Plus Axial Load~~					
	~~0 kip (in-kips)~~	~~100 kips (in-kips)~~	~~200 kips (in-kips)~~	~~300 kips (in-kips)~~	~~451 kips (in-kips)~~	~~600 kips (in-kips)~~
~~2402~~	~~29,705~~	~~28,972~~	~~28,282~~	~~27,714~~	~~26,738~~	~~25,633~~
~~4815~~	~~33,591~~	~~32,851~~	~~32,099~~	~~31,420~~	~~30,552~~	~~29,572~~
~~7270~~	~~36,493~~	~~35,776~~	~~35,053~~	~~34,311~~	~~33,426~~	~~32,528~~
~~9618~~	~~38,758~~	~~38,054~~	~~37,348~~	~~36,627~~	~~35,644~~	~~34,800~~
~~12,122~~	~~40,655~~	~~40,039~~	~~39,344~~	~~38,639~~	~~37,564~~	~~36,761~~
~~14,661~~	~~42,286~~	~~41,745~~	~~41,058~~	~~40,363~~	~~39,279~~	~~38,435~~
~~17,169~~	~~43,646~~	~~43,169~~	~~42,487~~	~~41,799~~	~~40,730~~	~~39,824~~
~~19,805~~	~~44,917~~	~~44,499~~	~~43,822~~	~~43,140~~	~~42,083~~	~~41,116~~
~~22,550~~	~~46,454~~	~~46,069~~	~~45,382~~	~~44,627~~	~~43,490~~	~~42,399~~
~~25,628~~	~~47,395~~	~~47,006~~	~~46,406~~	~~45,696~~	~~44,617~~	~~43,522~~
~~28,822~~	~~48,284~~	~~47,891~~	~~47,353~~	~~46,683~~	~~45,656~~	~~44,605~~

03.06.03-24

Next File

Figure 3.6.3-23—Figure Deleted~~ALL for Main Steam Line Piping with Safety Factor of 1.7 on Flaw Size (Base Metal~~

Next File

03.06.03-24