ArevaEPRDCPEm Resource

From: WELLS Russell D (AREVA NP INC) [Russell.Wells@areva.com]
Sent: Friday, February 27, 2009 6:20 AM
To: Getachew Tesfaye
Cc: Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 162, FSAR Ch 3
Attachments: RAI 162 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 162 Response US EPR DC.pdf" provides technically correct and complete responses to 6 of the 15 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 Question 03.05.03-7.

The following table indicates the respective pages in the response document, "RAI 162 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 162 — 03.04.02-1	2	3
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A complete answer is not provided for 9 of the 15 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 162 — 03.04.02-2	April 30, 2009
RAI 162 — 03.04.02-4	April 30, 2009
RAI 162 — 03.04.02-6	April 22, 2009
RAI 162 — 03.05.03-1	April 22, 2009
RAI 162 — 03.05.03-2	April 30, 2009
RAI 162 — 03.05.03-3	April 22, 2009
RAI 162 — 03.05.03-4	April 22, 2009
RAI 162 — 03.05.03-6	April 30, 2009
RAI 162 — 03.05.03-8	April 30, 2009

Sincerely,

(Russ Wells on behalf of)
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New Plants Deployment
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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, January 27, 2009 5:55 PM
To: ZZ-DL-A-USEPR-DL
Cc: Hernando Candra; Sujit Samaddar; John Budzynski; Shanlai Lu; Joseph Donoghue; Michael Miernicki; Joseph Colaccino; Meena Khanna; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 162 (914, 938,1845), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on December 23, 2008, and discussed with your staff on January 21, 2009. Draft RAI Question 03.05.03-5 was deleted and Draft RAI Question 03.06.02-18 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,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 261

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Subject: Response to U.S. EPR Design Certification Application RAI No. 162, FSAR Ch 3
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Response to

Request for Additional Information No. 162 (914, 938, 1845), Revision 0

01/27/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.04.02 - Analysis Procedures
SRP Section: 03.05.03 - Barrier Design Procedures
SRP Section: 03.06.02 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping

Application FSAR Ch. 3

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)
QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

Question 03.04.02-1:

SRP 3.4.2 Acceptance criteria 2 and 3 states that unless the hydrostatic head associated with the highest flood and groundwater levels is relieved by utilizing a drainage or a pumping system around the foundations of structures, hydrostatic pressure has to be considered as a structural load on basement walls and the foundation slab of a structure. In consideration of any uplifting or floating of a structure, the total buoyancy force may be based on the highest flood level or the highest groundwater level excluding wave action. However, the dynamic loads of wave action should be included in the calculation for lateral and overturning movements of a structure if the flood level is above the proposed plant grade.

In FSAR Section 3.4.2 (External Flood Protection) it states that Seismic Category I SSCs can withstand the effects of ground water pressure and external flooding. There is no discussion in the FASR of how the PMF is utilized in the calculation of loads on basement walls and foundations, or in a stability check. Therefore, the staff requests additional discussion of the following:

a. How has the buoyancy force resulting from PMF has been used in the calculation of uplift?
b. With respect to the load combination required in SRP 3.8.4, what is the maximum hydrostatic pressure being used and how are lateral loads calculated on buried walls and foundations of a structure?
c. If soil friction is used in the calculation of stability, provide the value used for this parameter, and describe the method and basis used in computing the above value including the effects of maximum water table.

Response to Question 03.04.02-1:

a. Probable maximum flood (PMF) is 1 ft below grade, which corresponds to a head of 40.36 ft at the bottom of the basemat. The buoyancy force is therefore applied as an upward pressure of 17.49 psi on the bottom surface of the basemat.

b. The maximum hydrostatic pressure is 17.9 psi. This value is conservatively based on a flood level at grade. Hydrostatic pressure is calculated as $h*\gamma$, where h is the height of the column above and γ is the unit weight. Static lateral soil loads are calculated as $K_o*h*\gamma$, where K_o is the at rest lateral soil coefficient. Lateral loads due to surcharge are calculated according to the Boussinesq method. Seismic lateral loads are calculated—in accordance with Section 3.5.3.2, item 2 of ASCE 4-98—using the John H. Wood method.

c. The stability calculation is carried out for a coefficient of friction (μ) of 0.7 and 0.5. The value 0.7 is the static coefficient of friction between concrete and soil based on a slip plane occurring in the soil and is calculated as tan φ, where $\varphi = 35^o$ is the angle of internal friction. See U.S. EPR FSAR Tier 2, Section 2.5.4.2 for further details. To check the upper limit of sliding and uplift (including the effects of maximum water table and dynamic versus static coefficient), the angle of internal friction is reduced to 27^o, which corresponds to a coefficient of friction of 0.5.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 03.04.02-2:

EPR FSAR Section 3.4.2 states that portions of Seismic Category I structures located below grade elevation are protected from external flooding by water-stops and water-proofing and below grade exterior construction joints having water-stops to prevent in-leakage. Provide the specified design life for waterproofing, water stops and water seals. If this is less than the operating life of the plant, describe how continued protection will be provided.

Response to Question 03.04.02-2:

A response to this question will be provided by April 30, 2009.

Question 03.04.02-3:

Identify if there are Seismic Category I buried structures, pipes, conduits and duct banks within the scope of the EPR design certification, and located below the PMF or ground water elevations. If yes, list those items and describe measures taken to protect them from the effects of ground water or PMF.

Response to Question 03.04.02-3:

A list of Seismic Category I Systems, Structures, Components (SSC) for the U.S. EPR, including buried items, is provided in U.S. EPR FSAR Tier 2, Table 3.2.2-1.

Protection measures/criteria are listed in U.S. EPR FSAR Tier 2, Section 3.4.2

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 03.04.02-4:

In FSAR Section 3.4.2, it states that no access openings or tunnels penetrate the exterior walls of the Nuclear Island below grade. Protection for other safety-related structures must also be described. Are there access openings or tunnels for other safety-related structures not located on the Nuclear Island? If so, how are these openings protected from the PMF or maximum ground water level?

Response to Question 03.04.02-4:

A response to this question will be provided by April 30, 2009.

Question 03.04.02-5:

SRP 3.4.3 Acceptance Criteria 3 states that “Where the flood level is above the proposed plant grade, the dynamic loads of wave action should be considered”. In FSAR Section 3.4.2, it states that flood protection measures described in nine bullet items provide protection against flooding from postulated failure of onsite storage tanks. There is no discussion in the FSAR how those nine flood protection measures can provide assurance that the sudden failure of onsite storage tanks may not cause a surge of water above yard grade that could cause temporary flooding and wave action to nearby structures. Therefore, the staff requests the basis be provided for not including the effects of flood or wave action from sudden failure of onsite tanks and to also address the impact on adjacent structures.

Response to Question 03.04.02-5:

Finish floor is the lowest elevation of the Nuclear Island (NI) with an opening through which water could freely flow into the building. Finish floor elevation is defined as zero elevation. Finish grade is set at -1.0 ft elevation. Large volume fluid storage tanks are located on the site but not in close proximity to safety-related structures. U.S. EPR FSAR Tier 2, Section 3.4.2, states that the site has a positive grade causing fluids at the site to flow away from safety-related structures. Distance, hydraulic energy dissipation, and site grading mitigates effects of a postulated tank rupture and its ability to generate wave action or hydraulic pressure due to an external flood that is greater than the values considered in the barrier design of safety-related structures.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 03.04.02-6:

The staff is requesting that the following changes be made to the EPR FSAR: FSAR Section 3.4.2 entitled “External Flood Protection” is not consistent with the title of SRP 3.4.2 “Analysis Procedures”. Also FSAR Section 3.4.3 entitled “Analysis of Flooding Event” does not correspond to an SRP section. Those portions of FSAR Section 3.4.3 which relate to internal flooding should be included in FSAR Section 3.4.1 and meet the acceptance criteria of SRP 3.4.1. Those portions of FSAR Section 3.4.3 that relate to external flooding should be included under FSAR Section 3.4.2 and meet the acceptance criteria of SRP 3.4.2. In addition, COL items 3.4-1 to 3.4-3 listed in Table 1.8-2, should be revised to reference FSAR Section 3.4.2.

Response to Question 03.04.02-6:

A response to this question will be provided by April 22, 2009.

Question 03.05.03-1:

The last paragraph of FSAR Section 3.5.3.1.1 (Concrete Barrier Analysis) states that “Table 3.5-2 (Minimum Concrete Barrier Thickness Requirements for Local Damage Prediction Against Tornado Generated Missiles) shows minimum concrete barrier thicknesses requirement for local damage prediction against tornado generated missiles, which are based on the Region I guidelines in NUREG-0800”. FSAR Sections 3.5.3.1.1.1 through 3.5.3.1.1.3 also provide equations endorsed by SRP 3.5.3. Table 3.5-2 is acceptable because it is consistent with SRP 3.5.3 Table 1 and the SRP acceptance criteria. However, SRP 3.5.3 Acceptance Criteria 1.A also states that these equations should be used to determine the required barrier thicknesses. Thicknesses resulting from such calculations should not be less than those listed in SRP 3.5.3 Table 1, which specifies the minimum thicknesses necessary to protect against tornado missiles. Confirm that when the equations shown in FSAR Sections 3.5.3.1.1.1 through 3.5.3.1.1.3 are used to compute concrete barrier thicknesses and the computed barrier thicknesses are greater than those of Table 3.5-2, the larger of the two thicknesses will be used for the EPR barrier design.

Response to Question 03.05.03-1:

A response to this question will be provided by April 22, 2009.

Question 03.05.03-2:

FSAR Section 3.5.3.1.1.1 (Penetration) provides a formula for calculating the depth of missile penetration. One of the factors in this formula is the missile shape factor which has an important influence on the penetration thickness. For the missiles considered in the AREVA design, describe what type missile shapes are used in the calculation and how they are determined.

Response to Question 03.05.03-2:

A response to this question will be provided by April 30, 2009.

Question 03.05.03-3:

SRP 3.5.3 1B accepts the use of the SRI equations developed from test data developed in ORNL/NSIC-5, Vol. 1, Chapter 6, by Cottrell and Savolainen for designing steel penetration thickness. The BRL equations may be used provided the results are comparable to those obtained by using the SRI equation or validated by penetration tests. FSAR Section 3.5.3.1.2 permits the use of either formula. If the BRL equation is used to calculate steel penetration thicknesses provide the test data verifying its application or confirm that the larger thickness requirement resulting from the use of either the BRL or SRI equation will be used in the design.

Response to Question 03.05.03-3:

A response to this question will be provided by April 22, 2009.

Question 03.05.03-4:

FSAR Section 3.5.3.1.3 (Composite Section Barrier Analysis) discusses the evaluation of composite barriers for use as missile protection.SRP 3.5.3 allows the use of composite sections where the first layer is steel provided that the guidance in Reference 6 of the SRP is followed.

Identify if and where composite barrier protection will be provided in the AREVA design.

Clarify whether any composite barriers are utilized where the first material is concrete and if so what procedures will be used in their analysis.

Response to Question 03.05.03-4:

A response to this question will be provided by April 22, 2009.

Question 03.05.03-6:

In FSAR Section 3.5.3.2, it states that ASCE 58 is used for the evaluation of steel barriers. What specific methods are used from this reference and how does their use meet the acceptance criteria of SRP 3.5.3?

Response to Question 03.05.03-6:

A response to this question will be provided by April 30, 2009.

Question 03.05.03-7:

In FSAR Table 3.5-3, the column entitled “Material” is not consistent with its contents, which are structural member categories. In addition, items c.ii and c.iii under this same column are not consistent with item c which is labeled axial compression and flexure. Also under this column (item c), the column slenderness ratio “l/r 20” appears to be missing a less than or equal sign. Provide the appropriate terms for c.ii and c.iii in column 1 and correct the slenderness ratio typographical error.

Response to Question 03.05.03-7:

U.S. EPR FSAR Tier 2, Table 3.5-3 will be revised as follows:

- Table heading will be changed from “Material” to “Structural Member Loading Categories.”
- Reinforced Concrete: Item c.ii. will be changed from ”Carried by concrete and stirrups” to “Flexure Controls.”
- Reinforced Concrete: Item c.iii. will be changed from ”Carried completely by stirrups” to ”Combined Compression + Flexure Load Condition.”
- Structural Steel: Item c.i will be changed from “1/r 20” to “1/r ≤ 20.”

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 3.5-3 will be revised as described in the response and indicated on the enclosed markup.

Question 03.05.03-8:

In FSAR Section 3.5.3.3 which addresses ductility requirements for missile barriers, the second and third paragraphs commit to meeting the code requirements of ACI 349, ASME III Division 2. Provide clarification as to whether meeting the code requirements is only for ductility or for all aspects of these codes as they relate to the design for dynamic impact loads. The method for determining the ductility ratios and the limits for these ductility ratios should be provided as was done for concrete barriers using ACI 349 and for steel barriers using ANSI/AISC N690.

Response to Question 03.05.03-8:

A response to this question will be provided by April 30, 2009.

Question 03.05.03-9:

In FSAR Section 3.5.2 (pg 3.5-11) it states that safety-related pipes and cables routed outside of missile protected structures are buried at sufficient depth to provide protection for these items from missile impact, or concrete or steel enclosures are provided that are designed to withstand missile impact. No criteria are provided to define how the sufficient depth of burial is determined. In FSAR Section 3.8.4.1.8, it states that the design of buried conduit and duct banks is site specific. It also states that the duct bank depth and encasement methods will also consider effects from external hazards (e.g. tornado missile). In the Acceptance Criteria Requirements of SRP 3.5.3 it states that the design of structures, shields and barriers must meet GDC 2 which requires that SSCs important-to-safety shall be designed to withstand the effects of natural phenomena such as tornados and GDC 4 which requires that SSCs important-to-safety shall be appropriately protected against the dynamic effects of missiles. Provide the criteria and basis of protection for buried safety-related SSCs including minimum depth of burial required for each tornado missile considered, or include in the FSAR a COL item that requires a COL applicant provide this information.

Response to Question 03.05.03-9:

A COL item exists for the analysis and design of duct bank, buried conduits, buried pipes and pipe ducts. Refer to U.S. EPR FSAR Tier 2, Table 1.8-2, Item 3.8-14.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 03.06.02-18:

The seismic protection of the control rod drive system presented in the FSAR Section 4.6.1 refers to FSAR Section 5.4.14 on component supports. These two sections describe the restricted displacements during seismic events and design-basis accidents. The natural ground motion based seismic events are part of the seismic analysis of the plant. However, large missiles, such as those that could be generated by a tornado, can also cause acceleration events inside the containment, where the direction of the force is different (i.e. from above and the side) than in the natural ground motion seismic events (from below and the side).

How does EPR design demonstrate that the impact direction has been considered in the seismic analysis of the control rod drive mechanism component supports? This information is required to confirm the compliance that SSCs be designed to meet the requirements of GDC 4 as it relates to protection against dynamic effects including external events.

Response to Question 03.06.02-18:

U.S. EPR FSAR Tier 2, Table 3.5-1 identifies missiles considered in containment design. The high kinetic energy missile has a total mass of 4000 lbs with a horizontal and vertical velocity of 135 ft/s and 90 ft/s, respectively. U.S. EPR FSAR Tier 2, Figure 3B-12 provides a cross-section of the Containment Building, Shield Building, and annulus between the two structures indicating isolation between the two structural components. This cross-section also identifies the Containment Building internal structure. U.S. EPR FSAR Tier 2, Figures 3.7.1-2 and 3.7.1-3 show comparative spectra for horizontal and vertical orientations.

Kinetic missiles required to be postulated in accordance with GDC 4 have insufficient energy to exceed the spectra at the location of the control rod drive mechanisms (CRDM). Evaluation of this effect is based on Containment Building, Shield Building and Reactor Building internals combined mass, lack of connectivity between the Containment Building and shield Building, and accelerations considered in the design of the structure.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

U.S. EPR Final Safety Analysis Report Markups

03.05.03-7

Table 3.5-3—Allowable Ductility Ratios
Sheet 1 of 2

~~Material~~Structural Member Loading Categories:	Ductility Ratio:	Notes:
Reinforced Concrete:		
a. Flexure (beams, walls, and slabs)	$\frac{0.05}{\rho - \rho'} \leq 10$ *and* $r_\theta < 0.0065\left(\frac{d}{c}\right) \leq 0.07$ *radians*	Notation: ρ= reinforcement ratio = A_s /bd , tension zone ρ' = reinforcement ratio = A'_s /bd , compression zone r_q = rotational capacity, radians c = distance from compression face to the neutral axis at ultimate strength d = distance from compression face to the tensile reinforcement For flexure to control the design, the load capacity of a structural element in shear shall be at least 20% greater than the load capacity in flexure, otherwise, the ductility ratios given in b) shear or c) axial compression + flexure shall be used. The allowable ductility ratio in flexure shall not exceed 1.0 for loads which could affect the integrity of the structural system; localized areas of the structure under the same loading conditions shall not exceed an allowable ductility ratio of 3.0.
b. Shear (beams, walls, and slabs)		
i. Carried by concrete alone	1.0	
ii. Carried by concrete and stirrups or bent bars	1.3	
iii. Carried completely by stirrups	3.0	

Next File

Table 3.5-3—Allowable Ductility Ratios
Sheet 2 of 2

03.05.03-7

~~Material~~Structural Member Loading Categories:	Ductility Ratio:	Notes:
c. Axial compression + flexure (beam-columns, walls, and slabs)		
i. Compression controls	1.0	When the compression load is greater than $0.1f_c'A_g$ or one-third of that which would produce balanced conditions, whichever is greater, the maximum permissible ductility ratio shall be 1.0.
ii. ~~Carried by concrete and stirrups~~Flexure Controls	See Note	When the compression load does not exceed $0.1f_c'A_g$ or one-third of that which would produce balanced conditions, whichever is smaller, the allowable ductility shall be as given in a) flexure.
iii. ~~Carried completely by stirrups~~Combined Compression + Flexure Load Condition	Varies – See Note	For conditions between those specified in i. and ii. the allowable ductility ratio shall vary linearly from 1.0 to that given in a) flexure.
Structural Steel:		
a. Axial tension members	$\mu_d \leq 0.25\frac{\varepsilon_u}{\varepsilon_y} \leq 0.1/\varepsilon_y$	ε_u =strain at ultimate strength (rupture) ε_y = strain at yield strength
b. Flexural members		
i. Tension controls	$\mu_d \leq 10$	
ii. Shear controls	$\mu_d \leq 5$	
c. Columns		
i. $l/r \leq 20$	$\mu_d \leq 1.3$	l = length; r = radius of gyration
ii. $l/r > 20$	$\mu_d \leq 1.0$	