ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Thursday, April 30, 2009 5:51 PM
To: Getachew Tesfaye
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 162, FSAR Ch 3, Supplement 2
Attachments: RAI 162 Supplement 2 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 6 of the 15 questions of RAI No. 162 on February 26, 2009. AREVA NP submitted Supplement 1 to the response on April 22, 2009 to address 4 of the remaining questions. The attached file, "RAI 162 Supplement 2 Response US EPR DC.pdf" provides technically correct and complete responses to the remaining 5 questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 162 Questions 03.04.02-2, 03.04.02-4, 03.05.03-6, and 03.05.03-8.

The following table indicates the respective pages in the response document, "RAI 162 Supplement 2 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 162 — 03.04.02-2	2	2
RAI 162 — 03.04.02-4	3	3
RAI 162 — 03.05.03-2	4	4
RAI 162 — 03.05.03-6	5	5
RAI 162 — 03.05.03-8	6	6

This concludes the formal AREVA NP response to RAI 162, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Ronda Pederson
ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
An AREVA and Siemens company
3315 Old Forest Road
Lynchburg, VA 24506-0935
Phone: 434-832-3694
Cell: 434-841-8788

From: Pederson Ronda M (AREVA NP INC)
Sent: Wednesday, April 22, 2009 5:13 PM
To: 'Getachew Tesfaye'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 162, FSAR Ch 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 6 of the 15 questions of RAI No. 162 on February 26, 2009. The attached file, "RAI 162 Supplement 1 US EPR DC.pdf" provides technically correct and complete responses to 4 of the remaining 9 questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 162 Questions 03.05.03-1 and 03.05.03-3.

The following table indicates the respective pages in the response document, "RAI 162 Supplement 1 US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 162 — 03.04.02-6	2	2
RAI 162 — 03.05.03-1	3	3
RAI 162 — 03.05.03-3	4	4
RAI 162 — 03.05.03-4	5	5

The schedule for technically correct and complete responses to the remaining 5 questions is unchanged and 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 — 03.05.03-2	April 30, 2009
RAI 162 — 03.05.03-6	April 30, 2009
RAI 162 — 03.05.03-8	April 30, 2009

Sincerely,

Ronda Pederson
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From: WELLS Russell D (AREVA NP INC)
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

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
RAI 162 — 03.04.02-2	4	4
RAI 162 — 03.04.02-3	5	5
RAI 162 — 03.04.02-4	6	6
RAI 162 — 03.04.02-5	7	7
RAI 162 — 03.04.02-6	8	8
RAI 162 — 03.05.03-1	9	9
RAI 162 — 03.05.03-2	10	10
RAI 162 — 03.05.03-3	11	11
RAI 162 — 03.05.03-4	12	12
RAI 162 — 03.05.03-6	13	13
RAI 162 — 03.05.03-7	14	14
RAI 162 — 03.05.03-8	15	15
RAI 162 — 03.05.03-9	16	16
RAI 162 — 03.06.02-18	17	17

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)
Ronda Pederson

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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: 441

Mail Envelope Properties (5CEC4184E98FFE49A383961FAD402D31DFFB8A)

Subject: Response to U.S. EPR Design Certification Application RAI No. 162, FSAR Ch 3, Supplement 2
Sent Date: 4/30/2009 5:50:52 PM
Received Date: 4/30/2009 5:50:53 PM
From: Pederson Ronda M (AREVA NP INC)

Created By: Ronda.Pederson@areva.com

Recipients:
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Tracking Status: None
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Tracking Status: None
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Tracking Status: None

Post Office: AUSLYNCMX02.adom.ad.corp

Files	**Size**	**Date & Time**
MESSAGE	7000	4/30/2009 5:50:53 PM
RAI 162 Supplement 2 Response US EPR DC.pdf		147606

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

Response to

Request for Additional Information No. 162 (914, 938, 1845), Supplement 2, 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 03.04.02-2:

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:

Protection from external flooding is provided by engineered structures designed to withstand hydrostatic loads associated with the bounding external flooding event.

Waterstops and waterproofing are weather resistant sacrificial barriers or coatings added to reduce direct exposure of external structural surfaces to environmental influences and mitigate resultant deterioration of these surfaces that may result from such exposure. They also reduce moisture seepage that can occur with concrete structures. Waterstops and waterproofing perform no structural function and are not credited in either design or analysis with preventing or mitigating external flooding. Due to their inaccessibility, waterproofing and waterstops are made of materials with significant inherent durability and will not be replaced or maintained during the design life of the structure.

U.S. EPR FSAR Tier 2, Section 03.04.02, Bullet No. 5 will be revised to read as follows:

- “Portions of Category I structures located below grade elevation incorporate the use of waterstops and waterproofing to mitigate environmental deterioration of exposed surfaces and thereby minimize long term maintenance.”

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.4.2 will be revised as described in the response and indicated on the enclosed markup.

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:

Emergency Power Generating Buildings (EPGB) and Essential Service Water Buildings (ESWB) are the other Category I (safety related) structures and these structures have no access openings or tunnels penetrating their exterior walls below grade. Refer to U.S. EPR FSAR Tier 2, Figures 3.8-89 through 3.8-102. U.S. EPR FSAR Tier 2, Section 3.4.2, Bullet 4 will be revised for clarity as follows:

- “No access openings or tunnels penetrate the exterior walls of the Nuclear Island or any other Seismic Category 1 Structure below grade.”

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.4.2 will be revised as described in the response and indicated on the enclosed markup.

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:

U.S. EPR missile penetration depth calculations assume a 6 inch schedule 40 pipe as the controlling case for barrier penetration depth, as described by Regulatory Guide 1.76. The calculation checks this missile for two cases; one using a shape factor of 0.72 (flat nose missile) and the other using a shape factor of 1.0 (average bullet nosed) conservatively assuming a deformed pipe end.

FSAR Impact:

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

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:

Evaluation of steel missile barriers will be in accordance with the methodology described in U.S. EPR FSAR Tier 2, Section 3.5.3.1.2. U.S. EPR FSAR Tier 2, Section 3.5.3.2, Paragraph 4 will be revised as follows to remove reference to ASCE 58:

> "Steel missile barriers will be evaluated using the equations as defined in Section 3.5.3.1.2."

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.5.3.2, 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:

U.S. EPR design for dynamic impulsive and impactive loads as well as overall structural design meet ACI 349, ASME III Division 2 code requirements for the specific structures referenced. U.S. EPR FSAR Tier 2, Section 3.5.3.3 will be revised for clarification to read as follows:

> "Safety-related concrete structures, other than the Reactor Containment Building, are designed for impactive and impulsive loads in accordance with ACI 349, Reference 1, with the exceptions noted in RG 1.142. The Reactor Containment Building is designed to the requirements (including those for impactive and impulsive loads) of the ASME Boiler and Pressure Vessel Code, Section III, Division 2, "Code for Concrete Containments" (Reference 7). Refer to Section 3.8.1 for more information of design of the post-tensioned concrete Reactor Containment Building.
>
> Safety-related steel structures are designed (including the design for impactive and impulsive loads) in accordance with ANSI/AISC N690, Reference 4."

For the Reactor Containment Building, the ductility limits used in the design for impulse loads are not to exceed one-third the ductility at failure and the ductility limits for impact loads are not to exceed two-thirds the ductility determined at failure. Supporting technical documents describing these limits are available for NRC inspection at AREVA NP offices.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.5.3.3 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

- The PMF elevation of the U.S. EPR generic design is one foot below finished yard grade (as noted in Section 2.4).
- The maximum groundwater elevation for the U.S. EPR generic design is 3.3 ft below finished yard grade (as noted in Section 2.4).
- The finished yard grade slopes away from Seismic Category I structures so that external flood water flows away from these structures.

03.04.02-4

- No access openings or tunnels penetrate the exterior walls of the ~~n~~Nuclear ~~i~~Island or any other Seismic Category I structures below grade.

03.04.02-2

- Portions of Seismic Category I structures located below grade elevation incorporate the use of waterstops and waterproofing to mitigate environmental deterioration of exposed surfaces and thereby minimize long term maintenance. ~~are protected from external flooding by waterstops and waterproofing. Below grade exterior construction joints have waterstops to prevent in-leakage.~~
- Exterior wall or floor penetrations of Seismic Category I structures below grade have watertight seals.
- The roofs of Seismic Category I structures prevent the undesirable buildup of standing water in conformance with RG 1.102. The roofs of the structures do not have parapets that could collect water.
- The maximum rainfall rate for roof design is 19.4 inches per hour and the maximum static roof load because of snow and ice is 100 pounds per square foot.
- Seismic Category I structures can withstand hydrostatic loads resulting from groundwater pressure and external flooding.

The reinforced concrete Seismic Category I structures, together with the waterproofing and sealing features described above, provide hardened protection from the effects of external flooding for safety-related SSC as defined in RG 1.59. Additionally, the external flood protection measures described above protect against flooding from postulated failures of onsite storage tanks. Further information on the potential causes of external flooding from natural phenomena is provided in Sections 2.4.1 through 2.4.14.

3.4.3 Analysis of Flooding Events

3.4.3.1 Internal Flooding Events

An internal flooding analysis was performed for Seismic Category I structures to determine the adequacy of the design to protect safety-related SSC from the effects of internal flooding caused by postulated component failures. The internal flooding analysis demonstrates that internal flooding resulting from a postulated initiating event does not cause the loss of equipment required to achieve and maintain safe shutdown of the plant, emergency core cooling capability, or equipment whose failure verify that they will not collapse or have excessive deformations that will impair the function of safe shutdown equipment. Non-linear, elasto-plastic response of structures may be assumed in the evaluation of the overall response of reinforced concrete and steel structures or barriers subjected to impactive or impulsive loads, provided the overall integrity of the structure is not impaired.

Evaluations of the overall damage from missile impact are performed by either considering missile impact in the elastic range of the structural element with other loadings applied and accounting for rebound effects of the impact, or by assuming that the inelastic capacity of the structural element resists missile impact loads. Section 3.8 provides additional information on loading combinations and analysis methods for reinforced concrete and structural steel. Inelastic impact analyses are performed by assuming that the full elastic capacity of the structural element is used to accommodate other loading conditions, and that the missile impact loads are accommodated inelastically based on the ductility of the structural element. Code requirements for ductility are met for missile impact evaluations.

Guidance provided in “A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects,” by R. P. Kennedy (Reference 5) is used for the evaluation of concrete missile barriers. Concrete missile barriers are designed in accordance with the requirements of ACI 349, including Appendix C (Reference 1).

03.05.03-6

~~ASCE No. 58, Reference 2, is used for the evaluation of steel missile barriers.~~Steel missile barriers will be evaluated utilizing the equations as defined in Section 3.5.3.1.2. Steel missile barriers are designed in accordance with the requirements of ANSI/AISC N690 (Reference 4).

The criteria recommended in Reference 10, SRP 3.5.3, and guidance provided in RG 1.142, are also used for design of concrete missile barriers. Procedures listed above are in agreement with methodology presented in “Impact Effect of Fragments Striking Structural Elements,” Holmes and Narver, Inc., by R.A. Williamson and R.R. Alvy (Reference 6). Other procedures may also be used, provided the results obtained are comparable to those referenced. Ductility requirements specified in Section 3.5.3.3 are satisfied for concrete and steel structures that are subjected to impactive missile barrier loadings.

3.5.3.3 Ductility Requirements for Missile Barriers

Deformation under impactive and impulsive loads is controlled by limiting the ductility ratio, μ_d, which is defined as the ratio of maximum acceptable displacement, X_m, (or maximum strain, ε_m) to the displacement at the effective yield point, X_y, (or yield strain, ε_y) of the structural element. In addition to the specified deformation limits, the maximum deformation does not result in the loss of intended function of the structural element nor impair the safety-related function of other systems and components.

Safety-related concrete structures, other than the Reactor Containment Building, are designed for impactive and impulsive loads in accordance with ACI 349, Reference 1, with the exceptions noted in RG 1.142. The Reactor Containment Building is designed to the requirements (including those for impactive and impulsive loads) of the ASME Boiler & Pressure Vessel Code, Section III, Division 2, "Code for Concrete Containments" (Reference 7). Refer to Reference 3.8.1 for more information on design of the post-tensioned concrete Reactor Containment Building.

03.05.03-8

Safety-related steel structures are designed (including the design for impactive and impulsive loads)~~for impactive and impulsive loads~~ in accordance with ANSI/AISC N690, Reference 4.

The ductility limits for concrete and structural steel safety-related structures, other than the Reactor Containment Building, are given in Table 3.5-3—Allowable Ductility Ratios.

The effective yield displacement for reinforced concrete members is computed using a cross-sectional moment of inertia equal to $0.5(I_g + I_{cr})$.

Where:

I_{cr} = moment of inertia of cracked section transformed to concrete.

I_g = moment of gross concrete section about centroidal axis, neglecting reinforcement.

3.5.4 References

1. ACI 349-01/349R-01, Appendix C, "Code Requirements for Nuclear Safety Related Concrete Structures and Commentary," American Concrete Institute, 2001.

2. ASCE Manual and Report on Engineering Practice No. 58, "Structural Analysis and Design of Nuclear Plant Facilities," ASCE Committee on Nuclear Structures and Materials, 1980.

3. Bechtel Power Corporation Topical Report, BC-TOP-9A, "Design of Structures for Missile Impact," Rev. 2, 1974.

4. ANSI/AISC N690-1994 (R2004) S2, "Specification for Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities," American Institute of Steel Construction, 2004.

5. "A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects," Paper No. NSS 5-940.1 by R. P. Kennedy Holmes