ArevaEPRDCPEm Resource

From: BRYAN Martin (EXTERNAL AREVA) [Martin.Bryan.ext@areva.com]
Sent: Wednesday, December 15, 2010 6:54 PM
To: Tesfaye, Getachew
Cc: DELANO Karen (AREVA); ROMINE Judy (AREVA); BENNETT Kathy (AREVA); CORNELL Veronica (EXTERNAL AREVA); COLEMAN Sue (AREVA); WILLIFORD Dennis (AREVA); HALLINGER Pat (EXTERNAL AREVA); SLAY Lysa (AREVA); HAYS Lynn (AREVA); BREDEL Daniel (AREVA); Miernicki, Michael
Subject: DRAFT Response to U.S. EPR Design Certification Application RAI No. 412, FSAR Ch. 3, Question 03.07.02-74
Attachments: RAI 412 Question 03.07.02-74 Response Rev.1 US EPR DC - DRAFT.pdf

Getachew,

To support a final response date of January 28, 2011, a draft response to RAI 412 question 03.07.02-74 is attached. Let me know if the staff has questions or if the response can be sent as final.

Thanks,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Monday, November 15, 2010 4:45 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB); 'Miernicki, Michael'
Subject: Response to U.S. EPR Design Certification Application RAI No. 412, FSAR Ch. 3, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 412 on June 24, 2010. On August 27, 2010, AREVA NP submitted Supplement 1 to provide an INTERIM response to Question 03.07.02-73. AREVA NP submitted a revised schedule for Question 03.07.02-74 in Supplement 2 on September 15, 2010.

The schedule for Question 03.07.02-74 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for the remaining question is unchanged.

The schedule for a technically correct and complete response to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 412 — 03.07.02-73	August 29, 2010 (Actual)	February 17, 2011
RAI 412 — 03.07.02-74	N/A	January 28, 2011

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Wednesday, September 15, 2010 9:42 AM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 412, FSAR Ch. 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 412 on June 24, 2010. On August 27, 2010, AREVA NP submitted Supplement 1 to provide an INTERIM response to Question 03.07.02-73.

The schedule for Question 03.07.02-74 is being revised to allow additional time for AREVA NP to interact with the NRC. The schedule for the remaining question is unchanged.

The schedule for a technically correct and complete response to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 412 — 03.07.02-73	August 29, 2010 (Actual)	February 17, 2011
RAI 412 — 03.07.02-74	N/A	December 13, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
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Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Friday, August 27, 2010 5:13 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 412, FSAR Ch. 3, Supplement 1-INTERIM

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 412 on June 24, 2010.

The attached file, “RAI 412 Supplement 1 Response US EPR DC - INTERIM.pdf” provides a technically correct and complete INTERIM response to 1 of the remaining 2 questions, as committed.

The following table indicates the respective pages in the response document, “RAI 412 Supplement 1 Response US EPR DC- INTERIM.pdf,” that contain AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 412 — 03.07.02-73	2	2

The schedule for a technically correct and complete response to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 412 — 03.07.02-73	August 29, 2010 (Actual-August 27, 2010)	February 17, 2011
RAI 412 — 03.07.02-74	N/A	September 20, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
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Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Thursday, June 24, 2010 2:00 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT); RYAN Tom (AREVA NP INC); GARDNER George Darrell (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 412, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.’s response to the subject request for additional information (RAI). The attached file, “RAI 412 Response US EPR DC.pdf” provides a schedule since a technically correct and complete response to the 2 questions is not provided.

The following table indicates the respective pages in the response document, “RAI 412 Response US EPR DC.pdf” that contain AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 412 — 03.07.02-73	2	2
RAI 412 — 03.07.02-74	3	3

A complete answer is not provided for 2 of the 2 questions. The dates provide are based upon the civil/structural re-planning activities and revised RAI response schedule presented to the NRC during the June 9, 2010, Public Meeting, and to allow time to interact with the NRC on the responses.

Prior to submittal of the final RAI response, AREVA NP will provide an interim RAI response that includes:

(1) a description of the technical work (e.g., methodology)
(2) U.S. EPR FSAR revised pages, as applicable

The schedule for a technically correct and complete response to these questions is provided below.

Question #	Interim Response Date	Response Date
RAI 412 — 03.07.02-73	August 29, 2010	February 17, 2011
RAI 412 — 03.07.02-74	N/A	September 20, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Friday, May 28, 2010 8:11 AM
To: ZZ-DL-A-USEPR-DL
Cc: Chakravorty, Manas; Hawkins, Kimberly; Miernicki, Michael; Patel, Jay; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 412(4744), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on May 25, 2010, and on May 27, 2010, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. 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: 2464

Mail Envelope Properties (BC417D9255991046A37DD56CF597DB71086ECC56)

Subject: DRAFT Response to U.S. EPR Design Certification Application RAI No. 412, FSAR Ch. 3, Question 03.07.02-74
Sent Date: 12/15/2010 6:53:48 PM
Received Date: 12/15/2010 6:53:52 PM
From: BRYAN Martin (EXTERNAL AREVA)

Created By: Martin.Bryan.ext@areva.com

Recipients:
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Files	**Size**	**Date & Time**
MESSAGE	7882	12/15/2010 6:53:52 PM
RAI 412 Question 03.07.02-74 Response Rev.1 US EPR DC - DRAFT.pdf	466382	

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

Response to

Request for Additional Information No. 412 (4744), Revision 0
Question 03.07.02-74, Revision 1
5/28/2010

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.07.02 - Seismic System Analysis
Application Section: 03.07.02

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

Question 03.07.02-74:

RAI from Audit 4/26-30, 2010

As part of the staff review of the SSI analysis of the Nuclear Island (NI) Common Basemat Structure, AREVA was asked to describe how seismic fluid-structure interaction was considered for those structures containing water in the NI (e.g., the IRWST, the spent fuel pool, etc.). AREVA stated that the entire mass of water is treated as a lumped mass which is added to the mass of the structure in which it is contained. In general the staff was satisfied with the method described but to ensure the analysis and design of the NI meets the requirements of GDC 2 for earthquake design and that the loads due to the seismic response of the water have been properly determined, the staff requests that AREVA provide the following information regarding fluid/structure interaction:

1. Describe how the contained water is modeled in the seismic analysis of the NI;
2. If convective loads are ignored, provide the basis for not considered them:
3. Justify the freeboard is sufficient to accommodate sloshing in the IRWST;
4. Provide the basis for water level assumptions when determining the effects of sloshing;
5. If they exist, describe the effect of sloshing loads; and,
6. Evaluate potential overspill in Spent Fuel Pool.

Provide the basis for not considering a seismic hydrodynamic impact load on the bottom of the spent fuel pool, the IRWST, or any other significant pool or tank in the NI, due to the response of the water from an earthquake acting in the vertical direction.

Response to Question 03.07.02-74:

1. Hydrodynamic loads are developed using the method provided in Chapter 6 and Appendix F of TID-7024. The results are presented as pressure distributions along the wall and slab.

   The impulsive effects are affected by the flexibility of the walls and slab, whereas the convective effects are insensitive to flexibility. For impulsive load, the natural frequencies of individual pool walls and floors are calculated and the safe shutdown earthquake (SSE) 7 percent spectra used to determine the corresponding accelerations. For convective loads, the natural frequency of sloshing water is determined and the corresponding acceleration based on 0.5 percent damping is used.

   The hydrodynamic forces in a pool due to a horizontal earthquake are idealized and represented by a combination of impulsive and convective forces acting on the pool walls, and another combination of impulsive and convective forces acting on the pool slab. For each pool, the impulsive and convective pressures are calculated for each horizontal (X and Y) direction at 1 meter increments. The total pressure is obtained by adding the convective pressure to the impulsive pressure at each increment.

   The hydrodynamic pressure on the slab and walls due to a vertical earthquake are calculated in accordance with the equation 3.5-7 in ASCE 4-98, using the fluid mass density multiplied by the vertical spectral acceleration as a function of water depth below the surface. A study was performed to identify the actual vertical acceleration at each pool slab location. The resulting vertical zero period accelerations (ZPAs) at the subject pool locations for the eight soil cases are less than 1 g. Therefore, no water mass impact on the pool slab due to vertical seismic excitation is expected. Pool slab ZPA mapping plots are available for NRC review,

In the static finite element model (FEM), seismic loads are applied statically in six directions (east, west, north, south, up, and down). In each direction, a set of hydrodynamic pressure loads are simultaneously applied on the walls and slab. For example, when the earthquake moves toward the east, the east wall is pushed outward, the west wall is pulled inward, the east half slab is pushed downward, and the west half slab is pulled upward. The application of hydrodynamic loads accounts for the rotational effects of water motion. In addition, if the sloshing height is more than the freeboard, the sloshing impact on the ceiling is applied to the impacted area as well. For the spent fuel pool (SFP), the combined rack and water loads are applied separately in ANSYS load files and are much higher than the pool seismic analysis results performed by Transnuclear Inc. Thus, the applied loads are considered conservative.

In the dynamic soil structure interaction (SSI) time history model, fluid mass on the pool walls and slab is included based on tributary mass contribution (i.e.,1/2 of water mass added to each wall and total water mass added to the slab). The tributary mass is higher than the actual hydrodynamic mass converted from a combination of impulsive pressure and convective pressure. For SFP, the total fuel/racks assembly mass is added to the slab in addition to the fluid total mass conservatively neglecting racks occupying volume.

U.S. EPR FSAR Tier 2, Sections 3.8.3 and 3.8.4 will be revised to describe the hydrodynamic load analysis methodology.

2. Convective loads are included in the hydrodynamic loads for the static FEM, as described in the response to item 1 of this question.
3. The ceiling of the in-containment refueling water storage tank (IRWST) is located at elevation -0.5 m and the normal water level is at elevation -2.35 m. Calculations show that there is adequate freeboard (1.85 m) to accommodate any sloshing in the IRWST.
4. For calculating freeboard values, pool volume calculations analyze pool water level at normal operating condition.
5. Sloshing height was calculated in accordance with the formulae in equation F.57 of TID-7024. The true amount of overspill is estimated assuming all water above the pool top wall spills over. By simplifying the area of water above the pool top wall as a triangular shape, the amount of water overspill is estimated for reference only.

   The available freeboard for each pool is checked to determine if water spillage in an open pool or ceiling impact, in a covered pool, occurs. Overspill occurs only in spent fuel and Reactor Building open pools. The Nuclear Island drain and vent system collects overflows. The Reactor Building pool is empty during normal operation, and is filled only during refueling outage. Thus, pool spillage will not affect the ability to safely shut down the plant. There is no safety-related equipment in the vicinity of the pools to be affected by the overflow.

   For covered pools such as emergency feedwater pool, the impact load on the pool roof is calculated based on the liquid column beneath the maximum impacted roof area, and a conservative assumption that the water column is fully constrained and responds impulsively. In addition to the pressure loads on the walls and slab, this impact load on limited roof area is also applied for each horizontal earthquake.

6. See response to item 5.
7. See response to item 1.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Sections 3.8.3.4.4 and 3.8.4.4.1 will be revised as described in the response and indicated on the enclosed markup.

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U.S. EPR Final Safety Analysis Report Markups

- Reinforced Concrete 7

Hydrodynamic Load Analyses

Hydrodynamic loads are applied to the IRWST and refueling canal walls and floors to account for the impulsive and ~~impactive~~convective effects of water moving and sloshing in the tank as a result of seismic excitation. These loads are considered as part of the seismic SSE loads, and components of these loads in the three orthogonal directions are combined in the same manner as other seismic loads. Methodology consistent with USAEC TID-7024 is used to determine hydrodynamic loadings. The effect of tank structure flexibility on spectral acceleration is included when determining the hydrodynamic pressure on the tank walls for the impulsive mode. The SSE 7 percent spectra are used to determine the corresponding impulsive accelerations. For convective mode, the natural frequency of sloshing water is determined and the corresponding acceleration based on 0.5 percent damping is used.

03.07.02-74

In the static finite element model, hydrodynamic loads are applied statically in each of six directions (east, west, north, south, up, and down). The hydrodynamic loads due to a horizontal earthquake are a combination of impulsive and convective forces simultaneously acting on the pool walls and slabs, consideration of water motion rotational effects, and calculations for each horizontal direction at each unit increment. The hydrodynamic pressure on the slab and walls due to a vertical earthquake are calculated using the fluid mass density multiplied by the vertical spectral acceleration of each pool slab location as a function of water depth below the surface. In addition, if the sloshing height is more than the freeboard, the sloshing impact on the ceiling is applied to the impacted area as well.

Design for hydrodynamic loads is within the elastic range of concrete and steel members and elements.

Polar Crane Seismic Analyses

Design of the RCB for seismic loads from the polar crane is performed with the crane in positions that result in maximum stresses on the supporting containment wall. See Section 3.8.1 for additional information on the design of the RCB.

For seismic load combinations, the polar crane design is based on the trolley being located in different positions along the bridge girders. Seismic evaluations are performed with and without the critical load raised to different positions for the trolley locations to determine which hook position produces the primary response of the crane. For analysis purposes, the critical load is defined as that of the reactor head. The design of the crane includes seismic restraints (up-kick lugs), which prevent the bridge and trolley from dislodging from their respective rails.

Refer to Section 9.1.5 for additional information on the polar crane.

Structural Stiffness Considerations

Conservative values of concrete creep and shrinkage are used in the design of other Seismic Category I structures. Moments, forces, and shears are obtained on the basis of uncracked section properties in the analysis. However, in sizing the reinforcing steel required, the concrete is not relied upon for resisting tension. Thermal moments are modified by cracked-section analysis using analytical techniques, when the state of loading indicates the development of cracks.

The effect of local wall and floor slab flexibility is included where the analysis indicates the existence of this condition. The concrete section properties used in calculating the amplified seismic forces include an appropriate level cracking for the particular element under consideration. The amplified forces are also used in the design of the structural members that support the flexible element.

Section 3.8.4.6 describes methods used to confirm that concrete properties satisfy design requirements.

Seismic Structural Damping

Seismic analysis of other Seismic Category I structures uses the following SSE structural damping values as recommended by RG 1.61.

Structure Type	Percent of Critical Damping
• Welded Steel	4
• Bolted Steel, Slip Critical Connections	4
• Bolted Steel, Bearing Connections	7
• Reinforced Concrete	7

Hydrodynamic Loads

Hydrodynamic loads are applied to the walls and floors of the spent fuel pool and liquid storage tanks in the SBs and in the ESWBs to account for the impulsive and ~~impactive~~convective effects of the water moving and sloshing in the tanks as a result of seismic excitation. These loads are considered as part of the seismic SSE loads, and components of these loads in the three orthogonal directions are combined in the same manner as other seismic loads. The requirements of ASCE Manual No. 58, USAEC TID-7024, and other proven methods are used to determine hydrodynamic loadings. The effect of tank structure flexibility on spectral acceleration is included when determining the hydrodynamic pressure on the tank wall for the impulsive mode. The SSE 7 percent spectra are used to determine the corresponding impulsive accelerations.

03.07.02-74

03.07.02-74

For convective mode, the natural frequency of sloshing water is determined and the corresponding acceleration based on 0.5 percent damping is used.

In the static finite element model, hydrodynamic loads are applied statically in each of six directions (i.e., east, west, north, south, up, and down). The hydrodynamic loads due to a horizontal earthquake are a combination of impulsive and convective forces simultaneously acting on the pool walls and slabs, consideration of rotational effects of water motion, and calculations for each horizontal direction at each unit increment. The hydrodynamic pressure on the slab and walls due to a vertical earthquake are calculated using the fluid mass density, multiplied by the vertical spectral acceleration of each pool slab location as a function of water depth below the surface. If the sloshing height is more than the freeboard, the sloshing impact on the ceiling is applied to the impacted area as well.

For the spent fuel pool, the combined rack and hydrodynamic loads including rack sliding and impact loads are applied separately in the static finite element model. The combined loads need to be higher than the whole pool seismic analysis results, considering the rack, fluid, and pool dynamic interaction. The impact (i.e., friction and/or hydrodynamic) peak instantaneous loads, due to rack rocking/sliding, is considered in a local design including liner plate for punching shear and bending checks.

Design for hydrodynamic loads is within the elastic range of concrete and steel members and elements.

Thermal Analysis and Design

Normal thermal loads (T_o) are considered in the analysis and design of other Seismic Category I structures. Abnormal pipe break accident thermal loads (T_a) are considered to have no effect on the overall structure of other Seismic Category I structures and are only considered in local analyses.

For concrete structures, the requirements of ACI 349, Appendix A, ACI 349.1R, or thermal analysis computer programs or similar procedures are used to evaluate thermally induced forces and moments. When considering the combined effects of thermal stress and stress due to other loads, the analysis satisfies the requirements of Appendix A of ACI 349.

Pipe Rupture Loads

Other Seismic Category I structures will be evaluated for pipe rupture loads. Local analyses of other Seismic Category I structures consider the following abnormal loads for areas that house high-energy piping systems:

- Subcompartment pressure loads (P_a).