ArevaEPRDCPEm Resource

From:	DUNCAN Leslie E (AREVA NP INC) [Leslie.Duncan@areva.com]
Sent:	Thursday, February 11, 2010 10:03 PM
To:	Tesfaye, Getachew
Cc:	DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); ROMINE Judy (AREVA NP INC); VAN NOY Mark (EXT)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 291, FSAR Ch. 3, Supplement 3
Attachments:	RAI 291 Supplement 3 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 1 of the 19 questions of RAI No. 291 on October 19, 2009. AREVA NP submitted Supplement 1 to the response on January 7, 2010 providing a revised schedule for the remaining 18 questions. AREVA NP submitted Supplement 2 to the response on January 19, 2010 to address 1 of the remaining 18 questions. The attached file, "RAI 291 Supplement 3 Response US EPR DC.pdf" provides technically correct and complete responses to 10 of the remaining 17 questions.

The commitment dates for responding to Questions 03.09.05-24, 03.09.05-25, 03.10-24, and 03.10-26 have been changed to March 11, 2010 because of interdependency with other design work. The response for Question 03.07.02-61, which had a commitment date of March 11, 2010, is being provided ahead of schedule in this supplement, Supplement 3.

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 291 Questions 03.07.02-62, 03.09.05-26, 03.10-28, and 03.10-30.

The following table indicates the respective pages in the response document, "RAI 291 Supplement 3 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 291 — 03.07.01-26	2	2
RAI 291 — 03.07.02-61	3	3
RAI 291 — 03.07.02-62	4	5
RAI 291 — 03.09.05-23	6	6
RAI 291 — 03.09.05-26	7	7
RAI 291 — 03.09.05-27	8	8
RAI 291 — 03.10-25	9	9
RAI 291 — 03.10-28	10	10
RAI 291 — 03.10-29	11	11
RAI 291 — 03.10-30	12	13

The schedule for technically correct and complete responses to the remaining 7 questions has been changed and is provided below:

Question #	Response Date
RAI 291 — 03.02.01-11	March 11, 2010
RAI 291 — 03.07.02-60	March 11, 2010
RAI 291 — 03.09.05-24	March 11, 2010
RAI 291 — 03.09.05-25	March 11, 2010
RAI 291 — 03.10-24	March 11, 2010
RAI 291 — 03.10-26	March 11, 2010
RAI 291 — 03.10-27	March 11, 2010

Sincerely,

Les Duncan
Licensing Engineer
AREVA NP Inc.
An AREVA and Siemens Company
Tel: (434) 832-2849
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From: DUNCAN Leslie E (AREVA NP INC)
Sent: Tuesday, January 19, 2010 12:02 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 291, FSAR Ch. 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 1 of the 19 questions of RAI No. 291 on October 19, 2009. AREVA NP submitted Supplement 1 to the response on January 7, 2010 providing a schedule for the remaining 18 questions. The attached file, "RAI 291 Supplement 2 Response US EPR DC.pdf" provides a technically correct and complete response to 1 of the remaining 18 questions, as committed.

The following table indicates the respective pages in the response document, "RAI 291 Supplement 2 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 291 — 03.07.02-59	2	2

The schedule for technically correct and complete responses to the remaining 17 questions is unchanged and provided below:

Question #	Response Date
RAI 291 — 03.02.01-11	March 11, 2010
RAI 291 — 03.07.01-26	February 11, 2010
RAI 291 — 03.07.02-60	March 11, 2010
RAI 291 — 03.07.02-61	March 11, 2010
RAI 291 — 03.07.02-62	February 11, 2010
RAI 291 — 03.09.05-23	February 11, 2010
RAI 291 — 03.09.05-24	February 11, 2010
RAI 291 — 03.09.05-25	February 11, 2010
RAI 291 — 03.09.05-26	February 11, 2010
RAI 291 — 03.09.05-27	February 11, 2010
RAI 291 — 03.10-24	February 11, 2010
RAI 291 — 03.10-25	February 11, 2010
RAI 291 — 03.10-26	February 11, 2010
RAI 291 — 03.10-27	March 11, 2010
RAI 291 — 03.10-28	February 11, 2010
RAI 291 — 03.10-29	February 11, 2010
RAI 291 — 03.10-30	February 11, 2010

Sincerely,

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Leslie.Duncan@areva.com

From: Pederson Ronda M (AREVA NP INC)
Sent: Thursday, January 07, 2010 5:31 PM
To: 'Tesfaye, Getachew'
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. 291, FSAR Ch. 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 19 questions of RAI No. 291 on October 19, 2009.

Due to changes in engineering design approaches and supporting documents, holiday work schedules, and the volume of requests for additional information, responses for the remaining 18 questions are delayed.

The schedule for technically correct and complete responses to the remaining 18 questions has been changed and is provided below:

Question #	Response Date
RAI 291 — 03.02.01-11	March 11, 2010
RAI 291 — 03.07.01-26	February 11, 2010
RAI 291 — 03.07.02-59	January 21, 2010
RAI 291 — 03.07.02-60	March 11, 2010
RAI 291 — 03.07.02-61	March 11, 2010
RAI 291 — 03.07.02-62	February 11, 2010
RAI 291 — 03.09.05-23	February 11, 2010
RAI 291 — 03.09.05-24	February 11, 2010
RAI 291 — 03.09.05-25	February 11, 2010
RAI 291 — 03.09.05-26	February 11, 2010
RAI 291 — 03.09.05-27	February 11, 2010
RAI 291 — 03.10-24	February 11, 2010
RAI 291 — 03.10-25	February 11, 2010
RAI 291 — 03.10-26	February 11, 2010
RAI 291 — 03.10-27	March 11, 2010
RAI 291 — 03.10-28	February 11, 2010
RAI 291 — 03.10-29	February 11, 2010
RAI 291 — 03.10-30	February 11, 2010

Sincerely,

Ronda Pederson
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From: Pederson Ronda M (AREVA NP INC)
Sent: Monday, October 19, 2009 6:54 PM
To: 'Tesfaye, Getachew'
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. 291, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 291 Response US EPR DC.pdf," provides a technically correct and complete response to 1 of the 19 questions.

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 291 Question 03.07.03-36

The following table indicates the respective page in the response document, "RAI 291 Response US EPR DC.pdf," that contains AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 291 — 03.02.01-11	2	2
RAI 291 — 03.07.01-26	3	3
RAI 291 — 03.07.02-59	4	4
RAI 291 — 03.07.02-60	5	5
RAI 291 — 03.07.02-61	6	6
RAI 291 — 03.07.02-62	7	7
RAI 291 — 03.07.03-36	8	9
RAI 291 — 03.09.05-23	10	10
RAI 291 — 03.09.05-24	11	11
RAI 291 — 03.09.05-25	12	12
RAI 291 — 03.09.05-26	13	13
RAI 291 — 03.09.05-27	14	14
RAI 291 — 03.10-24	15	15
RAI 291 — 03.10-25	16	16
RAI 291 — 03.10-26	17	17
RAI 291 — 03.10-27	18	18
RAI 291 — 03.10-28	19	19
RAI 291 — 03.10-29	20	20
RAI 291 — 03.10-30	21	21

A complete answer is not provided for 18 of the 19 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 291 — 03.02.01-11	January 7, 2010

RAI 291 — 03.07.01-26	January 7, 2010
RAI 291 — 03.07.02-59	January 7, 2010
RAI 291 — 03.07.02-60	January 7, 2010
RAI 291 — 03.07.02-61	January 7, 2010
RAI 291 — 03.07.02-62	January 7, 2010
RAI 291 — 03.09.05-23	January 7, 2010
RAI 291 — 03.09.05-24	January 7, 2010
RAI 291 — 03.09.05-25	January 7, 2010
RAI 291 — 03.09.05-26	January 7, 2010
RAI 291 — 03.09.05-27	January 7, 2010
RAI 291 — 03.10-24	January 7, 2010
RAI 291 — 03.10-25	January 7, 2010
RAI 291 — 03.10-26	January 7, 2010
RAI 291 — 03.10-27	January 7, 2010
RAI 291 — 03.10-28	January 7, 2010
RAI 291 — 03.10-29	January 7, 2010
RAI 291 — 03.10-30	January 7, 2010

Sincerely,

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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Thursday, September 17, 2009 7:43 AM
To: ZZ-DL-A-USEPR-DL
Cc: Wong, Yuken; Chakravorty, Manas; Chen, Pei-Ying; Dixon-Herrity, Jennifer; Samaddar, Sujit; Hawkins, Kimberly; Miernicki, Michael; Patel, Jay; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 291(3616,3691,3706,3707,3685,3703), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on September 10, 2009, and on September 16, 2009, 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: 1136

Mail Envelope Properties (F322AA625A7A7443A9C390B0567503A10193B257)

Subject: Response to U.S. EPR Design Certification Application RAI No. 291, FSAR Ch. 3, Supplement 3
Sent Date: 2/11/2010 10:02:57 PM
Received Date: 2/11/2010 10:03:01 PM
From: DUNCAN Leslie E (AREVA NP INC)

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Files	**Size**	**Date & Time**
MESSAGE	10570	2/11/2010 10:03:01 PM
RAI 291 Supplement 3 Response US EPR DC.pdf		178419

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

Response to

Request for Additional Information No. 291, Supplement 3

9/10/2009

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.02.01 - Seismic Classification
SRP Section: 03.07.01 - Seismic Design Parameters
SRP Section: 03.07.02 - Seismic System Analysis
SRP Section: 03.07.03 - Seismic Subsystem Analysis
SRP Section: 03.09.05 - Reactor Pressure Vessel Internals
SRP Section: 03.10 - Seismic and Dynamic Qualification of Mechanical and Electrical Equipment
Application Section: EPR FSAR Section 3.10

QUESTIONS for Engineering Mechanics Branch 2 (ESBWR/ABWR Projects) (EMB2)
QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)

Question 03.07.01-26:

Follow-up Question 03.07.01-19 (Audit follow-up)

The commentary for Section 3.3.1.9 of ASCE 4-98 states that effect of embedment on structure behavior is to increase resonant frequencies and *usually* decrease structure response when compared with the same structure founded on the surface of the soil. The applicant is requested to provide the details of the parametric analyses that were performed including the definition of the input motion and how it was derived for the embedded model. The applicant is also requested to provide the results from the parametric studies and compare these with the results for the surface founded NI common basemat structures.

Response to Question 03.07.01-26:

The Nuclear Island Common Basemat Structure surface-founded stick model has been replaced by an embedded finite element model meshed to capture high frequency response. The effects and differences between surface-founded and embedded-stick models are no longer applicable. Changes in soil-structure interaction (SSI) methodology and SSI analyses will be addressed in the Response to RAI 320, Question 03.07.02-63, including corresponding FSAR changes.

FSAR Impact:

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

Question 03.07.02-61:

Follow-up RAI to Question 03.07.02-41

In its response, the applicant states that seismic acceleration modification factors are used to normalize equivalent forces and moments with soil-structure interaction (SSI) model results and provides a reference to U.S. EPR FSAR, Tier 2, Section 3.8.3.4.4. The staff was unable to find any discussion regarding the normalization of equivalent forces and moments with the results from the SSI model in this section of the FSAR. The applicant is requested to provide an explanation of what the normalization consists of and include this in the FSAR.

Response to Question 03.07.02-61:

In the original methodology of applying loads from the SSI model to the static model, as described in the response to Question 03.07.02-41, the largest zero period acceleration (ZPA) at the lumped mass location and building corners was taken to be the ZPA for that elevation. The ZPA determined at the elevation of a lumped mass was conservatively applied to the finite element model (FEM) elements and loads that fall within the range bounded by that elevation and the key elevation below.

To improve the accuracy of this methodology while retaining conservatism, seismic acceleration modification factors were used to adjust the equivalent static forces to be consistent with the SSI model results. The seismic acceleration modification factors were calculated so that the static factored base forces using the factored ZPAs always match or exceed the corresponding SSI results, which are listed in U.S. EPR FSAR Tier 2, Table 3.7.2-18.

The SSI model is being revised from a stick model to a full finite element model to eliminate the need for the seismic acceleration modification factors. The updated SSI model and updated use of seismic acceleration modification factors (if applicable) will be addressed in the Response to RAI 320, Question 3.7.2-63, including corresponding FSAR changes.

FSAR Impact:

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

Question 03.07.02-62:

Follow-up RAI to Question 03.07.02-55

The applicant in its response has explained that only the 100-40-40 rule is used to determine the seismic loads on the NI Common Basemat Structures and will delete the reference to the SRSS in U.S. EPR FSAR Section 3.8.4.4.1. The staff finds this to be acceptable; however the applicant is requested to provide additional clarification on portions of the response and the FSAR markup, as shown below in the following questions:

1. What is the purpose of Tables 3.7.2-18 through 3.7.2-25 which contains maximum force profiles calculated by the SRSS? An explanation of their use and purpose should be included in the FSAR.
2. The markup on page 3.8-104 states the ZPA_x, ZPA_y, and ZPA_z are the maximum zero period accelerations in each of three directions. As there are a number of soil cases and input time histories used in the analysis, the applicant should describe how the maximum ZPAs used in the 100-40-40 rule shown on revised FSAR page 3.8-104 are selected. This information should be included in the FSAR.
3. On revised FSAR page 3.8-103, there is a sentence which states that seismic acceleration modification factors are used to adjust the equivalent static forces and moments to be consistent with the SSI model results. The applicant should describe how this adjustment is accomplished and provide an example of its application. The FSAR should be revised to include a description of this process.

Response to Question 03.07.02-62:

1. U.S. EPR FSAR Tier 2, Tables 3.7.2-18 through 3.7.2-25 are provided to present results of the soil-structure interaction (SSI) analysis performed using the SASSI computer code. These are the true dynamic results from the square root of the sum of the squares method of combining seismic loads from the three components of earthquake motion as opposed to the static-equivalent results produced by static analysis. Static analysis results envelope the dynamic results presented in U.S. EPR FSAR Tier 2, Tables 3.7.2-18 through 3.7.2-25.

2. U.S. EPR FSAR Tier 2, Section 3.8 describes the methodology for application of 100-40-40 to the maximum zero period accelerations, which is repeated for each soil case/seismic motion pair listed in U.S. EPR FSAR Tier 2, Table 3.7.1-6. U.S. EPR FSAR Tier 2, Section 3.8.4.4.1 will be revised to clarify usage.

3. In the original methodology of applying loads from the SSI model to the static model, as described in the response to RAI 215, Question 03.07.02-41, the largest zero period acceleration (ZPA) at the lumped mass location and building corners is taken to be the ZPA for that elevation. The ZPA determined at the elevation of a lumped mass is applied to all the finite element model (FEM) elements and loads that fall within the range bounded by that elevation and the key elevation below.

   To improve the accuracy of this methodology while retaining conservatism, seismic acceleration modification factors were used to adjust the equivalent static forces to be consistent with SSI model results. Seismic acceleration modification factors were calculated so that static factored base forces using factored ZPAs always match or exceed the corresponding SSI results, which are listed in U.S. EPR FSAR Tier 2, Table 3.7.2-18. Table 3.7.2-62-1 provides an example of this adjustment for soil/seismic motion case 5ah.

The SSI model is currently being revised to use a full finite element model instead of the previously used stick model. Use of seismic acceleration modification factors is being evaluated as part of this embedded FEM analysis and results will be included in the Response to RAI 320, Question 03.07.02-63, including corresponding FSAR changes.

Table 3.7.2-62-1—Static vs. SSI Base Forces and Overturning Moments

Case 5ah

	Vx (kN)	Vy (kN)	Pz (kN)	Myy (kN-m)	Mxx (kN-m)
Static Results with Un-factored ZPA	2.247e6	2.196e6	2.799e6	6.717e7	6.597e7
Static Results with Factored ZPA	1.461e6	1.867e6	1.679e6	4.635e7	5.585e7
SSI Results (U.S. EPR FSAR Tier 2, Table 3.7.2-18)	1.371e6	1.405e6	1.595e6	4.134e7	5.254e7

FSAR Impact:

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

Question 03.09.05-23:

Follow-up to Question 03.09.05-7

In RAI 03.09.05-7, the staff requested the applicant to characterize in the FSAR the volume and velocity of the core bypass flow, and discuss whether the bypass flow is sufficient to cause vortex shedding and flow-induced vibration in the internals component located in the RPV upper dome above the upper support plate. In the response, the applicant stated that SRP 3.9.5 does not request providing the flow volume and velocity, and provided no information on the core bypass flow volume or velocity.

Flow volume and velocity are contributors to flow-induced vibration and vortex shedding. Please provide in the FSAR a qualitative assessment of whether the bypass flow is sufficient to cause vortex shedding and flow-induced vibration in the internals components located in the RPV upper dome above the upper support plate.

Response to Question 03.09.05-23:

Calculations performed by AREVA NP demonstrate that the control rod guide assembly (CRGA) support columns will not experience excessive vibrations due to flow conditions in the upper plenum.

A minimum FSM computed for the CRGA support column arrays (between the upper support plate and the upper core plate) is well above the allowable FSM and therefore these support columns have substantial margin against fluid-elastic instability. The response of this support column to random turbulence resulting from cross flow conditions is also substantially below allowable limits. CRGA support columns are demonstrated to be not susceptible to vortex shedding lock-in conditions that could lead to rapid high cycle fatigue failure. Additionally, CRGA support reaction loads resulting from turbulent response of the CRGA support column are minimal at the upper core plate and upper support plate. Therefore, there will be no additional cyclic loading in these bolted connections as a result of separation between components. Results of analyses are presented in ANP-10306P “Comprehensive Vibration Assessment Program for U.S. EPR Reactor Internals Technical Report.”

CRGA upper housing columns in the reactor vessel (RV) channel head above the upper support plate are not exposed to significant cross flow conditions. Minimal flow into this region of the RV head through spray nozzles, and CRGA column tubes create insignificant flow excitation for these components. Therefore, CRGA upper housing component turbulent response is bounded by the results presented for CRGA support columns.

FSAR Impact:

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

Question 03.09.05-26:

Follow-up to Question 03.09.05-11

In RAI 03.09.05-11, the staff requested the applicant to provide a tabular summary in the FSAR, including each component of the reactor internals and core support structures, listing the maximum calculated total stress, deformation, and cumulative usage factor for each designated design and service limit defined in ASME Section III, Subsection NG. In the response, the applicant stated that providing a summary of maximum total stress, deformation, and cumulative usage fact values is the responsibility of the COL Applicant. However, FSAR Tier 2, Table 1.8-2, COL Item 3.9-11 is only for ASME Code Class 1 components. The calculated total stress, deformation, cumulative usage factor values for reactor internals have not been addressed by the applicant.

Please provide the requested information, revise COL Item 3.9-11 to include reactor internal structures and core support structures, or add a separate COL item.

Response to Question 03.09.05-26:

U.S. EPR FSAR Tier 2, Table 1.8-2 will be changed to add a new COL Item, 3.9-14 as follows:

> COL Item 3.9-14
>
> A COL applicant that references the U.S. EPR design certification will provide a summary of reactor core support structure maximum total stress, deformation, and cumulative usage factor values for each component and each operating condition in conformance with ASME Section III Subsection NG.

U.S. EPR FSAR Tier 2, Section 3.9.5.2 will be revised to state that a COL applicant that references the U.S. EPR design certification will provide a summary of reactor core support structure maximum total stress, deformation, and cumulative usage factor values for each component and each operating condition in conformance with ASME Section III Subsection NG.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 1.8-2 and Section 3.9.5.2 will be revised as described in the response and indicated on the enclosed markup.

Question 03.09.05-27:

Follow-up to Question 03.09.05-16

In RAI 03.09.05-16, the staff requested the applicant to revise the FSAR to include discussion of the environmental effect of fatigue on the reactor internals. The applicant responded that the heavy reflector analyses consider the irradiation-assisted stress-corrosion cracking, and the stress analyses of the tie rods and bolted joints take into account the preload relaxation of the fasteners. However, the applicant did not revise the FSAR. Revision 1 of FSAR Tier 2, Section 3.9.5.3 incorrectly references Sections 3.9.3.1.1 and 3.12 which do not address the environmental fatigue effects on the reactor internals. Please revise the FSAR. Additionally, the applicant stated in the response that the assessment of the fatigue on the reactor pressure vessel internals including relaxation and loss of preload is performed and verified through ITAAC. However, FSAR Tier 1, Table 2.2.1-5, Item 3.11 is only for ASME Class 1 components. Please revise Item 3.11 to include reactor internals or add a separate ITAAC.

Response to Question 03.09.05-27:

U.S. EPR FSAR Tier 2, Section 3.9.5.3 correctly references U.S. EPR FSAR Tier 2, Section 3.9.3.1, which addresses load combinations, system operating transients, and stress limits. U.S. EPR FSAR Tier 2, Section 3.9.5.3 does not reference U.S. EPR FSAR Tier 2, Section 3.12. The AREVA NP response to RAI 184, Question 03.09.05-16 describes how effects of environment on reactor vessels (e.g., irradiation-assisted stress-corrosion cracking, pre-load relaxation) are considered in analysis of reactor vessel internals.

The regulatory basis for the request for a discussion of environmental effects on fatigue of reactor vessel internals is unclear. RG 1.207, which provides guidance regarding environmental effects on fatigue, applies only to the reactor coolant pressure boundary and not to reactor pressure vessel internals.

U.S. EPR FSAR Tier 1, ITAAC item 3.16 of Table 2.2.1-5 provides for design and analysis of the reactor vessel internals.

FSAR Impact:

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

Question 03.10-25:

Follow-up to Question 03.10-03

In its letter dated February 27th, 2009, AREVA responded to Question 03.10-03 indicating that there are no in-plant tests such as in-situ impedance testing. The applicant identified that after installation, active components are subjected to hydrostatic tests, construction acceptance tests, and preoperational tests and, if applicable, periodic in-service inspections and operations to verify the functionality and reliability of the components. The staff found the response not completely acceptable because none of identified tests pertained to the seismic qualification of the equipment. However, the staff found that, as an example for verification of the adequacy of seismic qualification of equipment, there is ITAAC item 3.3 in Tier 1 Table 2.2.2-3 of the EPR FSAR related to Seismic Category I equipment of the In-Containment Refueling Water Storage Tank System (IRWSTS). Furthermore, Tier 1 Table 2.2.2-3 identified all the Seismic Category I equipment for the IRWSTS.

The staff requests the applicant to confirm that: (1) the scope of the ITAAC item 3.3 in Table 2.2.2-3 and other similar ITAAC in Tier 1 encompasses the verification of the seismic qualification of the equipment, and (2) all the equipment listed in Tier 2 Table 3.10-1 are included in Tier 1 ITAAC program.

Response to Question 03.10-25:

1. U.S. EPR FSAR Tier 1, Table 2.2.2-3, inspections, tests, analyses and acceptance criteria (ITAAC) item 3.3 and other similar ITAAC in Tier 1 encompass verification of equipment seismic qualification.

2. Not all equipment listed in U.S. EPR FSAR Tier 2, Table 3.10-1 is included in the Tier 1 material. Tier 1 material is not provided for equipment for which the sole function is to protect other equipment. If a feature is determined to be safety significant and that function requires it to be seismically qualified, then it is listed in Tier 1material.

U.S. EPR FSAR Tier 2, Section 14.3 describes the process by which equipment with “safety significant” features is differentiated from equipment without such features. This process is based on criteria in NUREG-0800 Section 14.3 and its appendices. U.S. EPR FSAR Tier 2, Section 14.3 is similar in this regard to corresponding sections of previously certified designs and is consistent with the NRC Safety Evaluation Reports.

FSAR Impact:

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

Question 03.10-28:

Follow-up to Question 03.10-11

In its letter dated February 27th, 2009, AREVA responded to Question 03.10-11 by re-stating information in IEEE standards and in the existing submittal that had already been reviewed by the staff. It should be noted that SRP 3.10 Acceptance Criteria (1)(A)(vi) indicated that the use of single axial test should be justified. The staff requests the applicant to (i) revise FSAR Appendix 3D, Attachment E, Section E.5.1.1 indicating that justification of using single axial test will be provided in the SQDP and (ii) modify Tab H of the SQDP in Appendix 3D attachment F to include a note showing that justification will be provided if Single Axis is selected.

Response to Question 03.10-28:

(1) U.S. EPR FSAR Tier 2, Appendix 3D, Attachment E, and Section E.5.1.1 will be revised to indicate that the justification of using single-axis testing is to be included in the SQDP, Tab H. The referenced section is revised as follows:

> "Single-axis testing can be used when it is demonstrated that a component responds independently in the three orthogonal directions and there is low or no cross coupling between the axes. It can also be used when a device is normally installed on a panel that amplifies motion in one direction only, or when it is restrained to motion in one direction. When single-axis testing is used, justification for its use shall be provided in the SQDP, Tab H."

(2) Tab H of the SQDP in Appendix 3D Attachment F will be modified to add Subsection number H.15 to document the justification when using single-axis testing.

FSAR Impact:

U.S. EPR FSAR Tier 2, Appendix 3D, Attachment E, Section E.5.1.1 and Tab H of Attachment F will be revised as described in the response and indicated on the enclosed markup.

Question 03.10-29:

Follow-up to Question 03.10-13

In its letter dated February 27th, 2009, AREVA responded to Question 03.10-13 by identifying Section 2.1.2.2 in the NRC Safety Evaluation Report (SER) of Topical Report, EMF-2110(NP)(A), Revision 1. This safety evaluation provided the results of the NRC staff's review of topical report EMF-2110 (NP)(A), Revision 1, "TELEPERM XS: A Digital Reactor Protection System" and accompanying proprietary documents. The Siemens Power Corporation submitted this topical report by letter dated September 1, 1999.

I. The SER identified that the input excitation for testing the TSX equipment was multiple frequency ranging from 5 to 35 Hz, 3 axes and each staggered by 90 degrees. However, by testing one axis at a time, the results may not be the same as multi-axis testing at the same time due to the potential effect of equipment directional coupling. Thus, the applicant is requested to submit the seismic qualification report (by Siemens) including the criteria and descriptions of the test procedures together with the detailed seismic test results, and provide the justification for using the single axis testing one at a time for three times.

II. The SER stated that "A US licensee that use the TXS system for a safety system application should compare its required seismic qualification level to the Siemens' qualified level, and identify areas requiring further action." The applicant is requested to address the issue of high frequency input excitation exceedance over the tested limit of 35Hz in the Topical Report.

Response to Question 03.10-29:

Topical Report EMF-2110(NP)(A) on TELEPERM XS (TXS) equipment design, including seismic qualification, was approved by NRC Safety Evaluation Report (SER) with certain "Plant-Specific Action Items." Among these was Plant-Specific Action Item 1, which states:

> "The licensee must demonstrate that the generic qualification bounds the plant specific condition (i.e., temperature, humidity, seismic, and electromagnetic compatibility) for the location(s) in which the TXS equipment is to be installed. The generic qualification data must comply with EPRI qualification requirements specified in EPRI TR-107330 and TR-102323-R1 (see Sections 2.1.2.1, 2.1.2.2, and 2.1.2.3)."

Seismic qualification methods are described in U.S. EPR FSAR Tier 2, Section 3.10. The input motion applied in the seismic qualification testing will be determined in accordance with U.S. EPR FSAR Tier 2, Section 3.10.1.4. Seismic qualification of TXS equipment consistent with Plant-Specific Action Item 1, as specified by the subject SER, will be performed as part of equipment procurement.

U.S. EPR FSAR Tier 1, Sections 2.4.1, 2.4.2, 2.4.4, and 2.4.5 contain ITAAC commitments for seismic qualification of TXS equipment installed on a plant-specific basis. Seismic qualification documentation packages will be used to close these ITAAC.

FSAR Impact:

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

Question 03.10-30:

Follow-up to Question 03.10-21

In its letter dated February 27th, 2009, AREVA responded to Question 03.10-21 claiming that equipment supports for seismic qualification testing are rigid, where flexibility of the supports can be eliminated. The staff found that this claim is not realistically possible and cannot even be approximately achieved for many cases (e.g. electrical cabinets and racks). Accordingly, the staff found that the applicant's response is not acceptable. SRP 3.10 identified that for establishing design adequacy of supports, analyses or tests should be performed for all supports of mechanical and electrical equipment to ensure their structural capability. While the applicant provided some information about qualification by analysis and testing in Section 3.10.3 the section neither reflected the guidance provided in SRP 3.10, Acceptance Criteria (1)(B)(ii) and (iii) nor provide alternative to demonstrate design adequacy of supports. Therefore, the applicant is requested to revise Section 3.10.3 of the submittal to properly address requirements for design adequacy of supports, in a manner consistent with SRP 3.10.

Response to Question 03.10-30:

U.S. EPR FSAR Tier 2, Section 3.10.3 will be revised so that rather than generically refer to equipment supports, at least two types are recognized: one type for electrical equipment mounted on flexible structural metal enclosures such as cabinets and racks, and the other type for mechanical equipment and components such as pumps and motors mounted on substantial steel or concrete bases.

In accordance with SRP 3.10, an analysis or test is required for equipment support qualification, to demonstrate their structural capability. Adequacy of equipment supports, either light electrical enclosures or heavy-bases for equipment mounts, will be established by analysis or test in accordance with the guidance in SRP 3.10, Acceptance Criteria, (II) (1) (B).

a) Flexible Structures

   Flexible structures will be analyzed or tested as a unit to include the interaction between the supports and the equipment.

b) Non-flexible Structures

   Heavy-bases for equipment mounts may be decoupled from the supported equipment if it can be shown by testing or analysis that it is a rigid base and will not amplify the input motion, in-structure response spectra (ISRS).

c) Adequacy of Supports – Design Methodology

   Equipment supports will be tested with equipment installed or with a dummy weight simulating the equivalent equipment inertial mass effects and dynamic coupling to the support in accordance with the guidance provided in SRP 3.10, Acceptance Criteria (II) (1) (B) (iii). When performing analysis, the combined stresses of equipment supports are in accordance with SRP 3.9.3. When complete testing is not practicable, simple and passive equipment may be analyzed to confirm their structural integrity under postulated event loadings. However, complex active devices which are vital to the operation of equipment should be additionally monitored and/or tested for functionality.

d) Input Motion for Qualification of Equipment Supports

Input motions are represented by ISRS curves at the equipment support mounting locations. The detailed methodology for derivation of ISRS is discussed in U.S. EPR FSAR Tier 2, Section 3.7.2.5.

The required response spectra (RRS), which are based on the ISRS, shall include a 1.4 performance-based factor for the critical equipment during severe accident scenarios in accordance with ASCE/SEI 43-05, Section 8.3.2. The 10 percent margin for uncertainties required by IEEE Standard 323 in the RRS is included in the 1.4 factor described above. The test response spectra (TRS) closely resemble and envelop the RRS.

e) Functionality Check

Equipment functionality adequacy will be demonstrated by testing. The equipment support will be included in the test using the representative ISRS input motion at the equipment support mounting location. If the equipment is installed in a non-operational mode for the support test, the response in the test at the equipment mounting locations should be monitored and characterized in a manner consistent with SRP 3.10, Acceptance Criteria (II) (1) (A) (iii). In such a case, equipment should be tested separately for functionality, and the actual input motion to the equipment in this test should be more conservative in amplitude and frequency content than the monitored response from the support test.

f) Seismic Testing

The seismic and dynamic qualification testing performed using single-axis or multi-axes test methods are in accordance with IEEE 344-1987.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.10.3 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

Table 1.8-2—U.S. EPR Combined License Information Items
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Item No.	Description	Section	Action Required by COL Applicant	Action Required by COL Holder
3.9-12	A COL applicant that references the U.S.EPR design certification will provide a table identifying the safety-related systems and components that use snubbers in their support systems, including the number of snubbers, type (hydraulic or mechanical), applicable standard, and function (shock, vibration, or dual-purpose snubber). For snubbers identified as either a dual-purpose or vibration arrester type, the COL applicant shall indicate whether the snubber or component was evaluated for fatigue strength.	3.9.6.4		Y
3.9-13	A COL applicant that references the U.S. EPR design certification will identify the implementation milestones and applicable ASME OM Code for the preservice and inservice examination and testing programs. These programs will be consistent with the requirements in the latest edition and addenda of the OM Code incorporated by reference in 10 CFR 50.55a on the date 12 months before the date for initial fuel load.	3.9.6	Y	
3.9-14	A COL applicant that references the U.S. EPR design certification will provide a summary of reactor core support structure maximum total stress, deformation, and cumulative usage factor values for each component and each operating condition in conformance with ASME Section III Subsection NG.	3.9.5.2		Y
3.10-1	A COL applicant that references the U.S. EPR design certification will create and maintain the SQDP file during the equipment selection and procurement phase.	3.10.4		Y
3.10-2	A COL applicant that references the U.S. EPR design certification will identify any additional site specific components that need to be added to the equipment list in Table 3.10-1.	3.10.1.1	Y	

03.09.05-26

R = the reaction force or moment that is applied in the three orthogonal directions x, y, and z:

$R = (\pm 1.0R_X \pm 0.4R_Y \pm 0.4R_Z)$

$R = (\pm 0.4R_X \pm 1.0R_Y \pm 0.4R_Z)$

$R = (\pm 0.4R_X \pm 0.4R_Y \pm 1.0R_Z)$.

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Seismic acceleration loads in three orthogonal directions are combined using a 100-40-40 percent rule. For each soil case/seismic motion pair listed in Table 3.7.1-6, let ZPA_x, ZPA_y, and ZPA_z be the maximum zero period accelerations in each of the three orthogonal directions at any given location. For each load combination (defined in U.S. EPR FSAR, Tier 2, Section 3.8.4.3.2) that contains seismic loads, the following (24) permutations of seismic accelerations are used to calculate seismic loads for consideration in design analyses:

- $\pm ZPA_x$, $\pm 0.4\ ZPA_y$, $\pm 0.4\ ZPA_z$
- $\pm 0.4\ ZPA_x$, $\pm ZPA_y$, $\pm 0.4\ ZPA_z$
- $\pm 0.4\ ZPA_x$, $\pm 0.4\ ZPA_y$, $\pm ZPA_z$

Design is based on the worst case scenario.

The effects of local flexibilities in floor slabs and wall panels are considered to determine if additional seismic accelerations should be applied to their design beyond those determined from the seismic stick model. Local flexibility evaluations are performed by determining the natural frequency of the floor or wall panel and comparing this to the frequency of the zero period acceleration on the applicable response spectra. Additional acceleration is applied when the natural frequency of the panel results in higher accelerations than the zero period acceleration. In cases where local flexibilities are determined to be a factor, additional out-of-plane accelerations are applied to the inertia loads on these panels for determining out-of-plane bending and shear loads.

Additional seismic loads due to accidental torsion are considered as described in Section 3.7.2. This is to account for variations in material densities, member sizes, architectural variations, equipment loads, and other variations from the values used in the analysis and design of other Seismic Category I structures. Due to these potential variations, an additional eccentricity of the mass is included at the floor elevations that are equivalent to 5 percent of the maximum building dimension.

Seismic Category I concrete structural elements and their connections are detailed for ductility in accordance with ACI 349-2001, Chapter 21.

3.9.5.2 Loading Conditions

The design, analysis, fabrication, and non-destructive examination of the RPV internals, Class CS core support structures, is in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NG (Reference 1). The design documentation for these Class CS core support structures includes a certified design specification and a certified design report conforming to the provisions of Subsection NCA of Reference 1.

Those RPV internals components not designated as ASME Code, Section III, Class CS core support structures are designated as internal structures in accordance with ASME Code, Section III, Subsection NG-1122. The components designated as internal structures are designed such that they meet the guidelines of NG-3000 and are in accordance with ASME Code Section III, Subsection NG-1122(c). Table 3.9.5-1—Component Classification lists the core support structures (CS) and internal structures (IS) for the RPV internals.

Evaluations of rupture locations, rupture loads, and dynamic effects of postulated rupture of piping are provided in Section 3.6.2. Evaluation of the adequacy of analysis methods for Seismic Category I RPV internals is provided in Section 3.9.1. The plant and system operating conditions and design-basis events that provide the basis for the design of the RPV internals are addressed in Section 3.9.3. The preoperational vibration test program for the RPV internals is consistent with the guidelines of RG 1.20 and is addressed in Section 3.9.2.

03.09.05-26

A COL applicant that references the U.S. EPR design certification will provide a summary of reactor core support structure maximum total stress, deformation, and cumulative usage factor values for each component and each operating condition in conformance with ASME Section III Subsection NG.

3.9.5.3 Design Bases

Pursuant to GDC 10, the reactor internals are designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.

The combinations of design and service loadings accounted for in the design of the RPV internals, and the method of combining loads for normal, upset, emergency, and faulted service conditions, are addressed in Section 3.9.3. The allowable design or service limits to be applied to the RPV internals and the effects of service environments, deflection, cycling, and fatigue limits are addressed in Section 3.9.3.1.

Evaluation of the adequacy of dynamic analyses under steady-state and operational flow transient conditions, and the proposed program for pre-operational and startup the valve is simultaneously applied to the valve during the static pull test. The valve then performs its safety-related function, while in the deflected position, within the specified operating time limits.

Motor operators are seismically qualified by testing as recommended in IEEE Std 382 and IEEE Std 344.

3.10.2.3 Seismic Qualification of Non-Active Mechanical Equipment

Non-active mechanical equipment is only required to maintain its structural and pressure boundary integrity during and after the seismic event. Seismic qualification by analysis, as described in Section 3.7, Section 3.9, and Appendix 3D, Attachment E, is preferred for this equipment.

The following are typical analyses that are used for qualification:

- An analysis to determine the vibratory input to a valve or pump.
- An analysis to determine the system natural frequencies and the movement of the pump or valve during the dynamic events.
- An analysis to determine the pressure differential and the impact energy on a valve disc during a LOCA or main steam line break and to verify the design adequacy of the disc.
- An analysis to verify the design adequacy of the wall thickness of valve and pump pressure-retaining components.
- An analysis to determine the natural frequencies of a pump shaft and rotor assembly to determine whether they are within the frequency range of the vibratory excitations. If the minimum natural frequency of the assembly is beyond the excitation frequencies, a static deflection analysis of the shaft is acceptable to account for dynamic effects. If the assembly natural frequencies are close to the excitation frequencies, an acceptable dynamic analysis is performed to determine the structural response of the assembly to the excitation frequencies.

These analyses are acceptable for simple and passive elements, such as valves and pump bodies, to confirm structural integrity under postulated event loadings.

3.10.3 Methods and Procedures for Qualifying Supports of Mechanical and Electrical Equipment and Instrumentation

03.10-30 →

Adequacy of equipment supports will be established by analysis or test in accordance with the guidance provided in SRP 3.10, Acceptance Criteria, (II) (1) (B).

Supports will be tested with equipment installed or with a dummy weight simulating the equivalent equipment inertial mass effects and dynamic coupling to the support in accordance with the guidance provided in SRP 3.10, Acceptance Criteria (II) (1) (B)

03.10-30

(iii). When performing analysis, the combined stresses of equipment supports are in accordance with SRP 3.9.3. The critical support component stresses, and deflections if applicable, are determined and are compared to allowable levels per applicable codes and regulations (e.g., ASME Boiler and Pressure Vessel Code). When complete testing is not practicable, simple and passive equipment may be analyzed to confirm their structural integrity under postulated event loadings. However, complex active devices which are vital to the operation of equipment should be additionally monitored and/or tested for functionality.

Input motions are represented by ISRS curves at the equipment support mounting locations. The detailed methodology for derivation of ISRS is addressed in Section 3.7.2.5.

The Required Response Spectra (RRS), which are based on the ISRS, shall include a 1.4 performance-based factor for the critical equipment during severe accident scenarios in accordance with ASCE/SEI 43-05, Section 8.3.2. The 10 percent margin for uncertainties required by IEEE Standard 323 in the RRS is included in the 1.4 factor described above. The Test Response Spectra (TRS) closely resembles and envelops the RRS.

Equipment functionality adequacy will be demonstrated by testing. The equipment support will be included in the test using the representative ISRS input motion at the equipment support mounting location. If the equipment is installed in a non-operational mode for the support testing, the response in the test at the equipment mounting locations should be monitored and characterized in a manner consistent with SRP 3.10, Acceptance Criteria (II) (1) (A) (iii). In such a case, equipment should be tested separately for functionality, and the actual input motion to the equipment in this test should be more conservative in amplitude and frequency content than the monitored response from the support test.

The seismic qualification of equipment requires consideration of actual or installed equipment mounting. The mounting conditions and methods for the tested or analyzed equipment simulate the expected or installed conditions. ~~The equipment supports are designed as rigid supports so that the vibration induced amplification on the equipment due to the flexibility of the support is eliminated.~~ The equipment mounting considered in the analysis or testing is identified in the SQDP.

~~If qualified by analysis, the critical support component stresses, and deflections if applicable, are determined and are compared to allowable levels per applicable codes and regulations (e.g., ASME Boiler and Pressure Vessel Code). If qualified by testing, the test response spectra must envelop the RRS at the mounting location of the support, over the frequency range of interest.~~

Next File

additional amplification of the ISRS due to the flexibility of the equipment supporting structure. The TRS is the response spectrum used for the measured time-history motion actually achieved by the test shake table. Acceptable seismic qualification is demonstrated by showing that the TRS envelopes the RRS, for comparable damping values, over the frequency range of interest.

The three methods of testing are described in the following sections.

E.5.1.1 Single-Axis Testing

03.10-28

Single-axis testing ~~is~~can be used when it ~~can be shown~~is demonstrated that a component responds independently in the three orthogonal directions and there is low or no cross coupling between the axes. It can also be used when a device is normally installed on a panel that amplifies motion in one direction only, or when it is restrained to motion in one direction. When single-axis testing is used, justification for its use shall be provided in the SQDP, Tab H-15.

Simulation of seismically induced fatigue effects are considered as previously outlined and as detailed in Section 3.7.3.2.

E.5.1.2 Biaxial Testing

The input motion, during a biaxial test, should be applied in the vertical direction and one principal horizontal direction.

When independent random input motions are used, the test is performed in two steps, with the equipment rotated 90° horizontally about the vertical axis for the second step.

When independent random input motions are not used, the test is performed in four steps. The first step is done with the input motions in phase, and the second step with the input motions 180° out of phase. The third and fourth steps are repeated with the equipment rotated 90° horizontally about the vertical axis from the first and second steps.

Simulation of seismically induced fatigue effects are considered as previously outlined and as detailed in Section 3.7.3.2.

E.5.1.3 Triaxial Testing

Triaxial testing is done with a simulator capable of independent random input motions in the three orthogonal directions. Simulation of seismically induced fatigue effects are considered as previously outlined and as detailed in Section 3.7.3.2.

Reference #

H. QUALIFICATION BY TEST

(For Qualification by combination of Analysis and Testing complete both sections H & I)

1. Single Frequency: _______ Multi-Frequency: _____ Random: _______

2. Single Axis : _______ Multi-Axis: _______ Tri-Axial: _______

03.10-28 → (Provide justification in Subsection H.15)

3. Natural Frequency (Hz) in Each Direction

Vertical: ______ S/S: _________ F/B: __________

4. Number of Tests: OBE: ___________ SSE: ______

5. Frequency Range: ________

6. TRS Envelopes RRS: Yes ________ No _____ N/A __________

7. TRS Damping Used: ________

8. Test Duration Meets IEEE 344 Requirements: Yes ________ No _____

9. Input Acceleration Level

OBE Vertical: _______ S/S: _______ F/B: _______

SSE Vertical: _______ S/S: _______ F/B: _______

10. Functional Operability Verified: Yes ______ No _____

11. Laboratory Mounting:

Bolted: _______ Bolt Size: _______ # of Bolts: _______

Welded: _______ Weld Length: _______

12. Orientation of Tested Equipment:

Vertical ______ Horizontal _______

Other : ____

____

Reference #

H. QUALIFICATION BY TEST (CONT'D)

13. Test Results/Anomalies

14. Other Tests Performed

03.10-28

15. Justification When Using Single-Axis Testing