ArevaEPRDCPEm Resource

From:	Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent:	Tuesday, September 29, 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. 215, FSAR Ch 3, Supplement 3
Attachments:	RAI 215 Supplement 3 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 2 of the 24 questions of RAI No. 215 on June 18, 2009. AREVA NP submitted Supplement 1 to the response on August 19, 2009, to address 6 of the remaining 22 questions. AREVA NP submitted Supplement 2 to the response on September 17, 2009, to address 2 of the remaining 16 questions. The attached file, "RAI 215 Supplement 3 Response US EPR DC.pdf" provides technically correct and complete responses to 4 of the remaining 14 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 215 Questions 03.07.02-40, 03.07.03-27, and 03.07.03-33.

The following table indicates the respective pages in the response document, "RAI 215 Supplement 3 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 215 — 03.07.02-39	2	2
RAI 215 — 03.07.02-40	3	3
RAI 215 — 03.07.03-27	4	4
RAI 215 — 03.07.03-33	5	5

The schedule for technically correct and complete responses to the remaining 10 questions has been changed due to their interdependence with other responses that remain in process and is provided below:

Question #	Response Date
RAI 215 — 03.07.01-22	October 20, 2009
RAI 215 — 03.07.01-23	October 20, 2009
RAI 215 — 03.07.01-24	October 20, 2009
RAI 215 — 03.07.02-38	October 20, 2009
RAI 215 — 03.07.03-22	October 20, 2009
RAI 215 — 03.07.03-23	October 20, 2009
RAI 215 — 03.07.03-24	October 20, 2009
RAI 215 — 03.07.03-25	October 20, 2009
RAI 215 — 03.07.03-32	October 20, 2009
RAI 215 — 03.07.03-34	October 20, 2009

Sincerely,

Ronda Pederson
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From: Pederson Ronda M (AREVA NP INC)
Sent: Thursday, September 17, 2009 4:58 PM
To: 'Tesfaye, Getachew'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); VAN NOY Mark (EXT); RYAN Tom (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 215, FSAR Ch 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 2 of the 24 questions of RAI No. 215 on June 18, 2009. AREVA NP submitted Supplement 1 to the response on August 19, 2009, to address 6 of the remaining 22 questions. The attached file, “RAI 215 Supplement 2 Response US EPR DC.pdf” provides technically correct and complete responses to 2 of the remaining 16 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 215 Question 03.07.01-21

The following table indicates the respective pages in the response document, “RAI 215 Supplement 2 Response US EPR DC.pdf,” that contain AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 215 — 03.07.01-21	2	2
RAI 215 — 03.07.03-26	3	5

The schedule for technically correct and complete responses to the remaining 14 questions has been changed due to design change processing delays for several of the responses and is provided below:

Question #	Response Date
RAI 215 — 03.07.01-22	September 29, 2009
RAI 215 — 03.07.01-23	September 29, 2009
RAI 215 — 03.07.01-24	September 29, 2009
RAI 215 — 03.07.02-38	September 29, 2009
RAI 215 — 03.07.02-39	September 29, 2009
RAI 215 — 03.07.02-40	September 29, 2009
RAI 215 — 03.07.03-22	September 29, 2009
RAI 215 — 03.07.03-23	September 29, 2009
RAI 215 — 03.07.03-24	September 29, 2009
RAI 215 — 03.07.03-25	September 29, 2009
RAI 215 — 03.07.03-27	September 29, 2009
RAI 215 — 03.07.03-32	September 29, 2009
RAI 215 — 03.07.03-33	September 29, 2009
RAI 215 — 03.07.03-34	September 29, 2009

Sincerely,

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From: Pederson Ronda M (AREVA NP INC)
Sent: Wednesday, August 19, 2009 4:51 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. 215, FSAR Ch 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 2 of the 24 questions of RAI No. 215 on June 18, 2009. The attached file, "RAI 215 Supplement 1 Response US EPR DC.pdf" provides technically correct and complete responses to 6 of the remaining 22 questions, as committed.

The responses to three questions cannot be provided as originally commited at this time. Responses to RAI 215, Questions 03.07.01-24, 03.07.02-38, and 03.07.03-23 are being deferred due to their interdependence with other responses that are not scheduled to be submitted until September 29, 2009.

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 215 Questions 03.07.01-20, 03.07.02-42, 03.07.03-29, and 03.07.03-30.

The following table indicates the respective pages in the response document, "RAI 215 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 215 — 03.07.01-20	2	2
RAI 215 — 03.07.02-41	3	4
RAI 215 — 03.07.02-42	5	5
RAI 215 — 03.07.03-28	6	6
RAI 215 — 03.07.03-29	7	7
RAI 215 — 03.07.03-30	8	8

The schedule for technically correct and complete responses to the remaining 16 questions has been revised as provided below:

Question #	Response Date
RAI 215 — 03.07.01-21	September 18, 2009
RAI 215 — 03.07.01-22	September 18, 2009

RAI 215 — 03.07.01-23	September 29, 2009
RAI 215 — 03.07.01-24	September 29, 2009
RAI 215 — 03.07.02-38	September 29, 2009
RAI 215 — 03.07.02-39	September 29, 2009
RAI 215 — 03.07.02-40	September 29, 2009
RAI 215 — 03.07.03-22	September 18, 2009
RAI 215 — 03.07.03-23	September 29, 2009
RAI 215 — 03.07.03-24	September 18, 2009
RAI 215 — 03.07.03-25	September 18, 2009
RAI 215 — 03.07.03-26	September 18, 2009
RAI 215 — 03.07.03-27	September 18, 2009
RAI 215 — 03.07.03-32	September 29, 2009
RAI 215 — 03.07.03-33	September 29, 2009
RAI 215 — 03.07.03-34	September 29, 2009

Sincerely,

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From: WELLS Russell D (AREVA NP INC)
Sent: Thursday, June 18, 2009 4:14 PM
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. 215, FSAR Ch 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 215 Response US EPR DC.pdf" provides technically correct and complete responses to 2 of the 24 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 215 Question 03.07.03-31.

The following table indicates the respective pages in the response document, "RAI 215 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 215 — 03.07.01-20	2	2
RAI 215 — 03.07.01-21	3	3

RAI 215 — 03.07.01-22	4	4
RAI 215 — 03.07.01-23	5	6
RAI 215 — 03.07.01-24	7	7
RAI 215 — 03.07.02-38	8	8
RAI 215 — 03.07.02-39	9	9
RAI 215 — 03.07.02-40	10	10
RAI 215 — 03.07.02-41	11	11
RAI 215 — 03.07.02-42	12	12
RAI 215 — 03.07.03-22	13	13
RAI 215 — 03.07.03-23	14	14
RAI 215 — 03.07.03-24	15	15
RAI 215 — 03.07.03-25	16	16
RAI 215 — 03.07.03-26	17	17
RAI 215 — 03.07.03-27	18	18
RAI 215 — 03.07.03-28	19	19
RAI 215 — 03.07.03-29	20	20
RAI 215 — 03.07.03-30	21	21
RAI 215 — 03.07.03-31	22	22
RAI 215 — 03.07.03-32	23	23
RAI 215 — 03.07.03-33	24	24
RAI 215 — 03.07.03-34	25	25
RAI 215 — 03.12-17	26	27

A complete answer is not provided for 22 of the 24 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 215 — 03.07.01-20	August 19, 2009
RAI 215 — 03.07.01-21	September 18, 2009
RAI 215 — 03.07.01-22	September 18, 2009
RAI 215 — 03.07.01-23	September 29, 2009
RAI 215 — 03.07.01-24	August 19, 2009
RAI 215 — 03.07.02-38	August 19, 2009
RAI 215 — 03.07.02-39	September 29, 2009
RAI 215 — 03.07.02-40	September 29, 2009
RAI 215 — 03.07.02-41	August 19, 2009
RAI 215 — 03.07.02-42	August 19, 2009
RAI 215 — 03.07.03-22	September 18, 2009
RAI 215 — 03.07.03-23	August 19, 2009
RAI 215 — 03.07.03-24	September 18, 2009
RAI 215 — 03.07.03-25	September 18, 2009
RAI 215 — 03.07.03-26	September 18, 2009
RAI 215 — 03.07.03-27	September 18, 2009
RAI 215 — 03.07.03-28	August 19, 2009
RAI 215 — 03.07.03-29	August 19, 2009
RAI 215 — 03.07.03-30	August 19, 2009
RAI 215 — 03.07.03-32	September 29, 2009
RAI 215 — 03.07.03-33	September 29, 2009
RAI 215 — 03.07.03-34	September 29, 2009

Sincerely,

(Russ Wells on behalf of)
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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, May 19, 2009 9:33 PM
To: ZZ-DL-A-USEPR-DL
Cc: Manas Chakravorty; Jim Xu; Sujit Samaddar; Kaihwa Hsu; Anthony Hsia; Michael Miernicki; Jay Patel; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 215 (2560, 2561,2565, 2588), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on April 14, 2009, and on May 19, 2009, you informed us that the RAI is clear but you needed clarification for Questions 3.7.3-26 and 3.7.3-31. To support the review schedule, we have decided to issue the RAI as is and conduct the clarification telecon at a later time. 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: 841

Mail Envelope Properties (5CEC4184E98FFE49A383961FAD402D31014383F4)

Subject: Response to U.S. EPR Design Certification Application RAI No. 215, FSAR Ch 3, Supplement 3
Sent Date: 9/29/2009 6:54:19 PM
Received Date: 9/29/2009 6:54:30 PM
From: Pederson Ronda M (AREVA NP INC)

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Files	**Size**	**Date & Time**
MESSAGE	12082	9/29/2009 6:54:30 PM
RAI 215 Supplement 3 Response US EPR DC.pdf		147145

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

Response to

Request for Additional Information No. 215, Supplement 3

5/19/2009

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
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: 03.12 - ASME Code Class 1, 2, and 3 Piping Systems and Piping Components and Their Associated Supports
Application FSAR Ch. 3

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)
QUESTIONS for AP1000 Projects Branch 1 (NWE1)

Question 03.07.02-39:

Follow-Up RAI to Question 03.07.02-8:

With regard to the stability analysis performed for the NI common basemat structures the staff requests the following additional information:

a. In the SASSI model, the "stiffness/damping" transfer functions are frequency dependent. For layered sites, the transfer functions can be expected to be strongly frequency dependent. As such, describe the methodology and assumptions that were used to obtain the constant soil values applied in the time domain calculations from the frequency dependent parameters utilized in the SASSI analysis.

b. As indicated in SRP 3.7.1, SAC-1.B, when performing calculations associated with nonlinear evaluations, multiple time histories should be used to assess how strong motion duration, magnitudes, shape of energy growth, etc. will impact the results of the nonlinear calculation. Please provide information to show that the use of the three EUR motions satisfies the SRP acceptance criteria.

c. Provide information on the relationship between generic site parameters and values of soil springs and damping selected for the particular analyses performed, including the potential effects of the uncertainty in these values on the results of the analysis.

d. Since the SASSI analyses do not consider the effects of sliding and uplift in determining the seismic response (both displacements and accelerations) and the floor response spectra of the EPR NI common basemat structures, information should be provided that shows the assumption of a linear SASSI analysis to obtain these results is conservative relative to the results that would be obtained if the non linear effects of sliding and liftoff were included.

Response to Question 03.07.02-39:

a. Because an alternative stability analysis approach is used as discussed in the Response to RAI 155, Question 03.08.05-8(2), this stability analysis using equivalent soil springs and dampers is no longer applicable.

b. Because the alternative stability analysis approach discussed in Part a is a linear analysis, the question regarding multiple time histories is no longer applicable.

c. Because the alternative stability analysis approach discussed in Part a is a linear analysis, the question regarding soil spring and damping values is no longer applicable.

d. The Response to RAI 155, Question 03.08.05-8(8) describes the new stability analysis using SASSI results. There is a factor of safety against sliding and the amount of uplift is negligible (less than 1 percent of basemat area). Therefore, the SASSI derived results are applicable.

FSAR Impact:

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

Question 03.07.02-40:

Follow-Up RAI to Question 03.07.02-22:

The applicant is requested to reconcile the coefficient of friction of 0.7 provided in its response to Question 03.07.02-22 with the information provided in its response to Question 03.04.02-1 contained in RAI 162 which states that the stability calculation is carried out using a coefficient of friction of 0.7 and 0.5.

The staff will evaluate the response to overturning and sliding in AREVA's response to RAI 155, Question 03.08.05-8 for the Nuclear Island and the Response to RAI 155, Questions 03.08.05-9 and 03.08.05-12 for the EPGB and ESWB once the response is received.

Response to Question 03.07.02-40:

Stability analyses were originally performed using a coefficient of friction of 0.7. Subsequently, the minimum coefficient of friction was reduced to 0.5. U.S. EPR FSAR Tier 2, Section 3.7.2 is revised to reflect this change.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.7.2 will be revised as described in the response and indicated on the enclosed markup.

Question 03.07.03-27:

Follow-Up RAI to Question 03.07.03-9:

The FSAR markup provided with the response (second bullet, page 3.7-299) states that when the indicated mass ratio is satisfied, decoupling criteria can be done if R_f is less than or equal to 0.8 or R_f is greater than or equal to 1.25. This is in agreement with the acceptance criteria of SRP 3.7.2, SAC-3.B.ii. However the following sentence in the same bullet states that when R_f is greater or equal to 1.25, the mass of the subsystem is included in the supporting system model. The applicant should clarify whether a separate analysis of the supported subsystem is still done for the case where R_f is greater or equal to 1.25 and provide a technical justification if a separate analysis is not performed.

Response to Question 03.07.03-27:

U.S. EPR FSAR Tier 2, Section 3.7.3.1 and Section 3.7.3.3 describe seismic analysis methods and analytical modeling procedures for supported subsystems. These procedures establish a separate analysis for subsystems when they are not included (i.e., coupled) with the primary system model. Decoupling criteria provided in U.S. EPR FSAR Tier 2, Section 3.7.3.3 perform mathematical decoupling of the subsystem and primary system, and admission of the subsystem's mass into the primary system model. Hence, decoupled subsystems for the case when $0.01 \leq R_m \leq 0.1$ and $R_f \geq 1.25$ are analyzed separately and the subsystem's mass is also included in the supporting primary system model. U.S. EPR FSAR Tier 2, Section 3.7.3.3 will be revised to provide clarification.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.7.3.3 will be revised as described in the response and indicated on the enclosed markup.

Question 03.07.03-33:

Follow-Up RAI to Question 03.07.03-16:

In its response to **Question 03.07.03-16**, the applicant states that relative displacements may be obtained from the dynamic analysis of the supporting structure. The applicant is requested to describe how the relative displacements are obtained from the dynamic analysis and include how the 12 soil cases for the NI Common Basemat Structures and the 10 soil cases for the EPGB and ESWB are accounted for in this calculation. The applicant also needs to describe how these are imposed (in-phase/out-of-phase) at the support points to determine the stresses in a multi-supported system. In addition, the FSAR markup is not clear as a word or words are missing in the revised write-up (First paragraph within the boxes on Pages 3.7-310 and 3.7-311 of the mark-up). The applicant is requested to correct the markup in its response to this RAI.

Response to Question 03.07.03-33:

The relative support displacements will be obtained for each structure and for each soil case, or for an upper-bound envelope of all individual analytical cases. Relative displacements will be obtained from static analysis using the 3D Finite Element Models (FEM) of the structures. Dynamic analysis will be performed in lieu of static analysis when more realistic results are warranted. For the Nuclear Island structures, relative displacements will be obtained using the SASSI stick model. For the Emergency Power Generating Building (EPGB) and Essential Service Water Building (ESWB), relative support displacements will be obtained from the 3D FEM SASSI models.

The displacements at supports are combined in the most unfavorable combination as stated in the U.S. EPR FSAR Tier 2, Section 3.7.3.9 and in accordance with SRP 3.7.3-II-SAC-9. The most unfavorable combination is conservatively recommended by the SRP because the phasing between the supports is assumed to be unknown. Examination of support displacements and engineering judgment are used in establishing whether displacements are to be imposed in-phase or out-of-phase.

The markup provided as part response to Question 03.07.03-16 is corrected and provided with this response.

FSAR Impact:

U.S. EPR FSAR Tier 2, Sections 3.7.3.9 and 3.7.3.9.1 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

Nuclear Auxiliary Building

Figure 3B-1 shows that the separation gap between the Nuclear Auxiliary Building and the NI Common Basemat Structures is 18 in. An evaluation of the potential for seismic interaction between the NAB and the NI Common Basemat Structures indicates that the maximum relative seismic displacement between the two structures is less than the gap dimension. The evaluation is performed using results from a series of nonlinear analyses using dynamic finite element models of each structure. The model used for the NI Common Basemat Structures is the nonlinear lumped parameter model described in the second of half of Section 3.8.5.4.2. A similar nonlinear model was created for the NAB building based upon the linear lumped parameter stick model described in Section 3.7.2.3.1.2. An analysis was ~~Analyses were~~ conducted for a minimum coefficient of friction at the soil-structure interface of 0.5 ~~and 0.7~~.

03.07.02-40

To provide sufficient design margin to prevent collapse or unacceptable performance under SSE loading, the design forces and moments for critical structural elements of the NAB are modified in accordance with the guidance of Reference 5. A reduction in the forces and moments due to seismic effects is taken using an inelastic energy absorption factor (F_μ) from Table 5-1 of ASCE 43-05 (Section 5.) for reinforced concrete shear walls. The inelastic energy absorption factor is based on the Limit State A criterion of ASCE 43-05 where permanent distortion, short of collapse, is permitted. The factor is for seismic design criteria and, hence, no reduction in force and moments is taken for other load cases including tornado effects. The F_μ factor is applied to tension, in-plane shear, and out-of-plane bending moment. A value of $F_\mu = 2$ is adopted for in-plane bending moments and shear in conjunction with axial tension. Per Section C5.1.2.3 of ASCE 43-05, a value of $F_\mu = 1$ is used for out-of-plane shear in conjunction with axial tension. For elements subjected to combined axial force and bending, a value of $F_\mu = 2$ is only applied to moment. Applicable provisions and design criteria for RS structures are also applied in finalizing the design.

Access Building

[[The separation gaps between the AB and SBs 3 and 4 is 0.98 ft and 1.31 ft, respectively (see Figure 3B-1).]] The walls of the AB are not physically connected to the SBs except through crossovers (passageways) providing access to the SBs. SB 3 is protected by the aircraft hazard (ACH) shield wall which not only protects the structure but also isolates control room personnel from adverse impact effects. SB 4 is not protected by the ACH shield wall. The seismic interaction assessment of the AB confirms that the separation gaps between SBs 3 and 4 are sufficient to preclude interaction. The crossover passageways are designed to accommodate the differential displacements without imparting unacceptable loads to the supporting structures.

the mass lumped at the center of mass of the system. Otherwise, a multiple-mass model is developed by concentrating the mass of the system at a sufficient number of locations including locations where mass concentration or a drastic change in stiffness or orientation occurs, and by connecting the lumped masses with beam elements or spring elements. In lieu of a lumped multiple-mass model, a finite element model may also be used for the seismic analysis of the system. Dynamic properties of the supporting structural elements such as floor slab, roof slab, walls, miscellaneous steel platforms, and framing on which the system is attached, are included in the analysis model of the system unless:

- Such structural element may be demonstrated to be dynamically rigid.
- The particular floor slab, roof slab, or wall is dynamically flexible but an amplified ISRS that accounts for both the mass of the system and the flexibility of the floor slab, roof slab, or wall is available.

When developing the dynamic model of such structural elements (i.e., floor slab, roof slab, wall, miscellaneous steel platform, or framing) supporting the system, masses equal to 25 percent of the floor live load or 75 percent of the roof snow load, whichever is applicable, and miscellaneous dead loads of at least 50 psf, are included.

In most cases, the subsystems, equipment, and components are analyzed (or tested) as a decoupled system from the primary structure. For the decoupling of the subsystem and the supporting system, the following criteria are used:

- If $R_m < 0.01$, decoupling can be done for any R_f. Mass of the subsystem is considered in the supporting system model through uniformly distributed load.
- If $0.01 \leq R_m \leq 0.1$, decoupling can be done if $R_f \leq 0.8$ or $R_f \geq 1.25$. When $R_f \geq 1.25$, mass of the subsystem is included in the supporting system model. When $R_f \leq 0.8$, mass of the subsystem is not included in the supporting system model.
- If $R_m > 0.1$ or if $0.01 \leq R_m \leq 0.1$ and $0.8 < R_f < 1.25$, an approximate model of the subsystem should be included in the primary system model.

03.07.03-27

Where:

R_m and R_f are defined as:

R_m = Ratio of total mass of the supported subsystem to total mass of the supporting system.

R_f = Ratio of fundamental frequency of the supported subsystem to dominant frequency of the support motion.

Seismic input for the subsystem and component design are the peak-broadened ISRS envelopes described in Section 3.7.2.5 or the floor acceleration time histories described

3.7.3.8.2 Interaction Evaluation

Non-seismic SSC may be located in the vicinity of safety-related SSC without being qualified as Seismic Category II, provided an impact evaluation is performed to verify that no possible adverse impacts occur. In this evaluation, the non-seismic components are assumed to fall or overturn as a result of a seismic event. Any safety-related subsystem or component which may be impacted by the non-seismic component is identified as an interaction target and is evaluated to establish that there is no loss of ability to perform its safety-related function.

The following assumptions and guidelines are used to evaluate non-seismic and seismic interactions:

As a result of the seismic event:

- Every non-seismic hanger on the non-seismic distribution subsystems is assumed to fail instantaneously.
- Every connection on the non-seismic distribution subsystem is assumed to fail, thus allowing each section of a subsystem to fall independently.
- Every flange on bolted connections on a non-seismic system and other distributed subsystems is assumed to fail, thus allowing each section of piping to fall independently.

3.7.3.9 Multiply-Supported Equipment and Components with Distinct Inputs

03.07.03-33

The criteria presented are primarily applicable to distribution subsystems that span between multiple locations within a structure or between locations in different structures and, as a result, experience non-uniform support motion. Two conventional methods are presented: the uniform support motion (USM) method and the independent support motion (ISM) method. For both methods: relative displacements at the support points are considered and determined by conventional static analyses, or conservatively approximated from floor response spectra. When displacements are determined from floor response spectra, the maximum displacement is predicted by the following relationship:

$$S_d = \frac{S_a g}{\omega^2}$$

Where:

S_d = maximum displacement at each support.

S_a = spectral acceleration in "g's" at the ZPA cutoff frequency.

ω = fundamental frequency of the building (rad/sec).

The support displacements are imposed on the subsystems in the most unfavorable combination. The responses due to support displacements are combined with inertial responses as described in Sections 3.7.3.9.1 or 3.7.3.9.2.

3.7.3.9.1 Uniform Support Motion Method

Distribution subsystems supported at multiple elevations within one or more buildings may be analyzed using the USM method. This analysis method applies a single spectrum, called a uniform response spectrum, at each support location. This spectrum envelops the individual response spectra for other locations. The enveloping response spectrum is developed and applied for each of the three orthogonal directions of input motion. The modal and directional responses are then combined as described in Sections 3.7.3.7 and 3.7.3.6, respectively. The responses due to relative displacements at the support points are combined with the inertial responses by the absolute sum method.

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3.7.3.9.2 Independent Support Motion Method

Distribution subsystems supported at multiple locations within one or more buildings with different seismic input response maybe analyzed using the ISM method. In this method of analysis, supports may be divided into support groups. A single ISRS is applied to all supports of each group, but different ISRS are applied to different groups. Typically, a support group is made up of supports attached to the same structure, floor, or portion of a floor. For distribution subsystems analyzed using the ISM method, criteria presented in NUREG-1061 (Reference 8) are followed.

In lieu of performing a response spectrum analysis with USM or ISM inputs, time histories of support motions may be utilized as input excitations. The responses due to relative displacements at the support points are combined with the inertial responses by the SRSS method.

3.7.3.10 Use of Equivalent Vertical Static Factors

Equivalent vertical static factors are not used in the design of subsystems for the U.S. EPR design. Seismic loads are calculated assuming that the vertical seismic motion occurs simultaneously with the two horizontal motions.

3.7.3.11 Torsional Effects of Eccentric Masses

Torsional effects due to the effect of eccentric masses connected to a subsystem are included in that subsystem analysis. For rigid components (i.e., those with natural frequencies greater than the ZPA cutoff frequency of 40 Hz), the lumped mass is modeled at the center of gravity of the component with a rigid link to the subsystem