ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Friday, August 14, 2009 5:23 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. 201, FSAR Ch. 3, Supplement 1
Attachments: RAI 201 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 3 of the 7 questions of RAI No. 201 on May 6, 2009. The attached file, "RAI 201 Supplement 1 Response US EPR DC.pdf" provides technically correct and complete responses to 4 of the remaining 4 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 201 Question 03.07.02-37.

The following table indicates the respective pages in the response document, "RAI 201 Supplement 1 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 03.07.01-19	2	2
RAI 03.07.02-35	3	14
RAI 03.07.02-36	15	15
RAI 03.07.02-37	16	17

This concludes the formal AREVA NP response to RAI 201 and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Ronda Pederson
ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
An AREVA and Siemens company
3315 Old Forest Road
Lynchburg, VA 24506-0935
Phone: 434-832-3694
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From: Pederson Ronda M (AREVA NP INC)
Sent: Wednesday, May 06, 2009 3:16 PM
To: 'Getachew Tesfaye'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); VAN NOY Mark (EXT); WELLS Russell D (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 201, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 201 Response US EPR DC.pdf" provides technically correct and complete responses to 3 of the 7 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 201 Question 03.02.01-10.

The following table indicates the respective pages in the response document, "RAI 201 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 201 — 03.02.01-8	2	3
RAI 201 — 03.02.01-9	4	5
RAI 201 — 03.02.01-10	6	6
RAI 201 — 03.07.01-19	7	7
RAI 201 — 03.07.02-35	8	8
RAI 201 — 03.07.02-36	9	9
RAI 201 — 03.07.02-37	10	10

A complete answer is not provided for 4 of the 7 questions. The schedule for a technically correct and complete response to this question is provided below.

Question #	Response Date
RAI 201 — 03.07.01-19	August 17, 2009
RAI 201 — 03.07.02-35	August 17, 2009
RAI 201 — 03.07.02-36	August 17, 2009
RAI 201 — 03.07.02-37	August 17, 2009

Sincerely,

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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Wednesday, April 08, 2009 1:13 PM
To: ZZ-DL-A-USEPR-DL
Cc: Yuken Wong; Jennifer Dixon-Herrity; Manas Chakravorty; Jim Xu; Michael Miernicki; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 201 (2123, 2206,2207), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on March 12, 2009, and discussed with your staff on April 1, 2009. No changes were made to the Draft RAI Questions as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 733

Mail Envelope Properties (5CEC4184E98FFE49A383961FAD402D3101262BB6)

Subject: Response to U.S. EPR Design Certification Application RAI No. 201, FSAR Ch. 3, Supplement 1
Sent Date: 8/14/2009 5:23:17 PM
Received Date: 8/14/2009 5:23:20 PM
From: Pederson Ronda M (AREVA NP INC)

Created By: Ronda.Pederson@areva.com

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RAI 201 Supplement 1 Response US EPR DC.pdf		204986

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

Response to

Request for Additional Information No. 201, Supplement 1, Revision 0

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
Application FSAR Ch.: 3

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

Question 03.07.01-19

(Audit follow-up) In Section 3.7.1.1.1 (Design Ground Motion Response Spectra) it indicates that the SSI model of the NI Common Basemat Structure is considered as a surface founded model in the SASSI calculations even though it is embedded to a depth of 41.3 feet. The acceptance criteria of SRP 3.7.2 states that the effect of embedment of the structure should be accounted for in the SSI analysis. Please provide justification for neglecting the depth of embedment on SSI results and quantify the impact on structural design loads as well as on the computation of in-structure response spectra.

Response to 03.07.01-19:

U.S. EPR FSAR Tier 2, Section 3.7.2.4.4 describes the basis for using a surface-founded configuration in the soil-structure interaction (SSI) analyses. Guidelines from ASCE 4-98, Commentary for Section 3.3.1.9 indicate that the effect on NI common basemat structures SSI response, caused by structural embedment, is reduction of in-structure response and may be ignored.

A parametric analysis was performed to determine embedment effect on analysis results. The U.S. EPR design SSI model was modified to include embedment. SSI analyses of the embedded U.S. EPR model were performed for generic U.S. EPR soil profile and control motion combinations. Embedded model and surface-founded model results were compared. The embedded model produces in-structure response spectra (ISRS) that are not significantly different from those generated using the surface-founded model.

FSAR Impact:

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

Question 03.07.02-35:

(Audit follow-up) Within the U.S. EPR standard design organization, one group is responsible for the seismic analysis of the NI common basemat structures and another group is responsible for the seismic analysis of the reactor coolant system (RCS). The NI seismic model contains a simplified model of the RCS provided by the group responsible for RCS seismic analysis. In a similar way, the seismic analysis of the RCS includes, in addition to a detailed model of the RCS, a seismic model of the Reactor Containment Building internal structure which supports the RCS. The seismic input for this coupled model consists of the time histories at the foundation mat determined from the NI seismic analysis. What are the methods used to verify that similar results are obtained in each of these analyses so as to verify that the interface forces are correct and that the coupled seismic model used in the analysis of the RCS is providing results consistent with the results obtained in the analysis of the NI common basemat structure? Include in your response a comparison of displacements and forces at key interface points of the RCS and internal structure from each of the models that document the adequacy of the results and methodology.

Response to Question 03.07.02-35:

A simplified model of the RCS is included in the Reactor Building Internal Structure (RBIS) model to represent RCS effect on RBIS response in the soil-structure interaction (SSI) analysis. Likewise, to properly model building response in the RCS analysis, the RBIS model is coupled with the RCS model. Building seismic analysis is performed using the SASSI computer program and RCS analysis is performed using the BWSPAN computer program. The same RBIS model is used in both analyses but a simplified RCS model is used for building analysis.

Comparing acceleration response spectra generated at RCS support locations by these analyses shows that responses of the two models are similar. Figures 3.7.2-1 through 3.7.2-9 show X, Y, and Z comparisons for the reactor coolant pump (RCP) and lower steam generator supports, and the reactor pressure vessel supports and upper steam generator supports. The relationship of these support locations to the RCS model is shown in Figure 3.7.2-10.

In addition to response spectra comparisons, RCS support reactions are also reviewed. Table 3.7.2-1 summarizes these reactions from each analysis model.

Good agreement between loads calculated by the two models is confirmed.

Table 3.7.2-1—Comparison of Reactions Due to Different Analysis Models

Location (Mass Point)	Forces (kips)	Differences in Force (Delta in %)
RPV:		
Horizontal		
BWSPAN	3450	19
SASSI	4099	
Vertical		
BWSPAN	1910	30
SASSI	1338	
SG Upper Support:		
Horizontal		
BWSPAN	13728	7
SASSI	12708	
SG Lower:		
Horizontal		
BWSPAN	4820	16
SASSI	4046	
Vertical		
BWSPAN	7098	1
SASSI	7042	
RC Pump:		
Horizontal		
BWSPAN	1970	14
SASSI	1685	
Vertical		
BWSPAN	879	8
SASSI	805	

Differences in spectra represent simplified versus detailed RCS models. These differences are minor and do not significantly affect design and qualification of components or piping.

Dynamic effects of RCS and RBIS are thus adequately modeled.

FIGURE 3.7.2-1

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 1.5m, X(E-W) Direction, 5% Damping

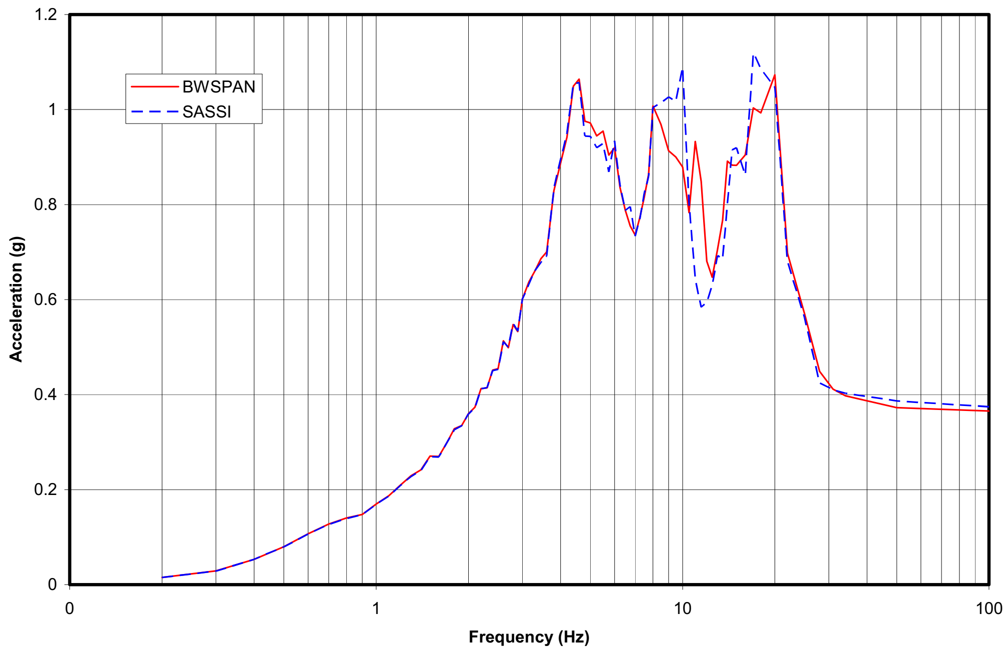


FIGURE 3.7.2-2

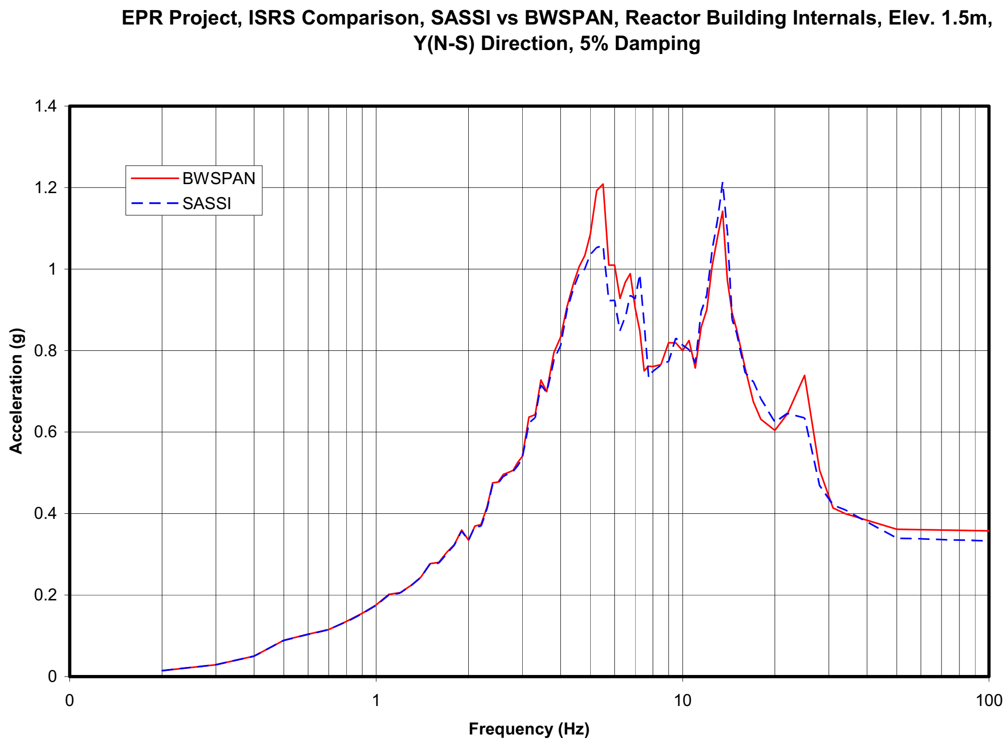

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 1.5m, Y(N-S) Direction, 5% Damping
BWSPAN
SASSI
Acceleration (g)
Frequency (Hz)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1
10
100

FIGURE 3.7.2-3

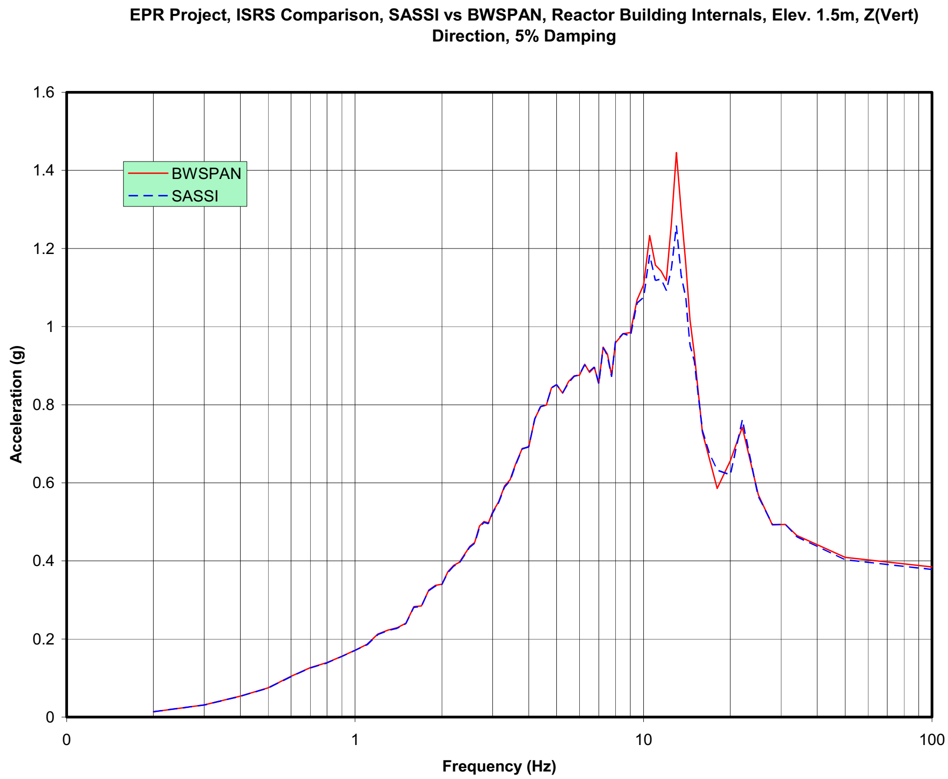

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 1.5m, Z(Vert) Direction, 5% Damping
BWSPAN
SASSI
Acceleration (g)
Frequency (Hz)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
1
10
100

FIGURE 3.7.2-4

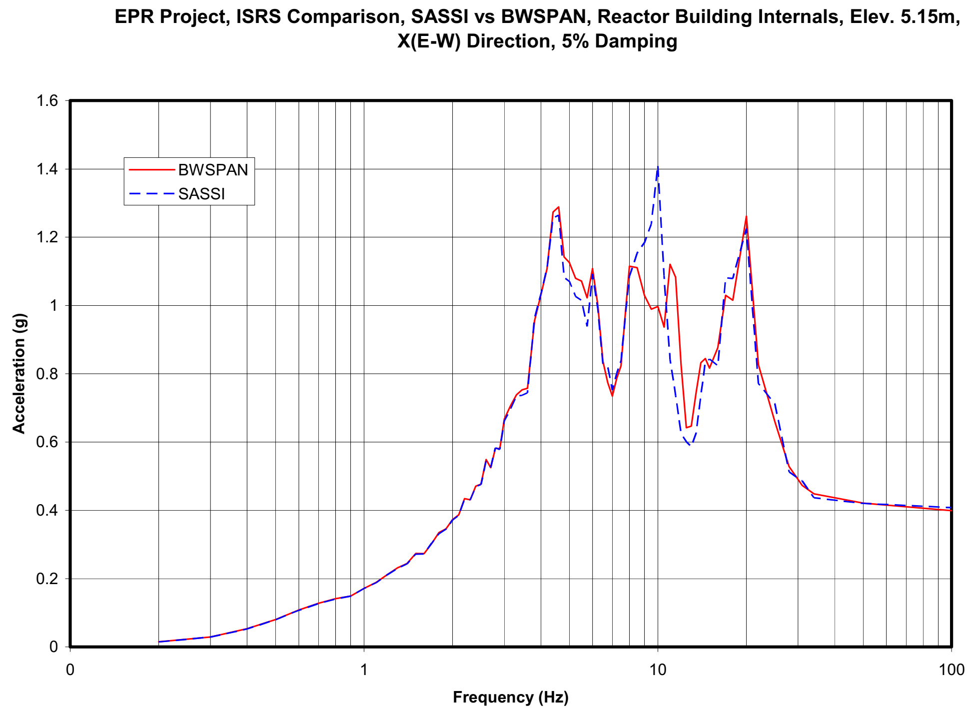

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 5.15m, X(E-W) Direction, 5% Damping
BWSPAN
SASSI
Acceleration (g)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1
10
100
Frequency (Hz)

FIGURE 3.7.2-5

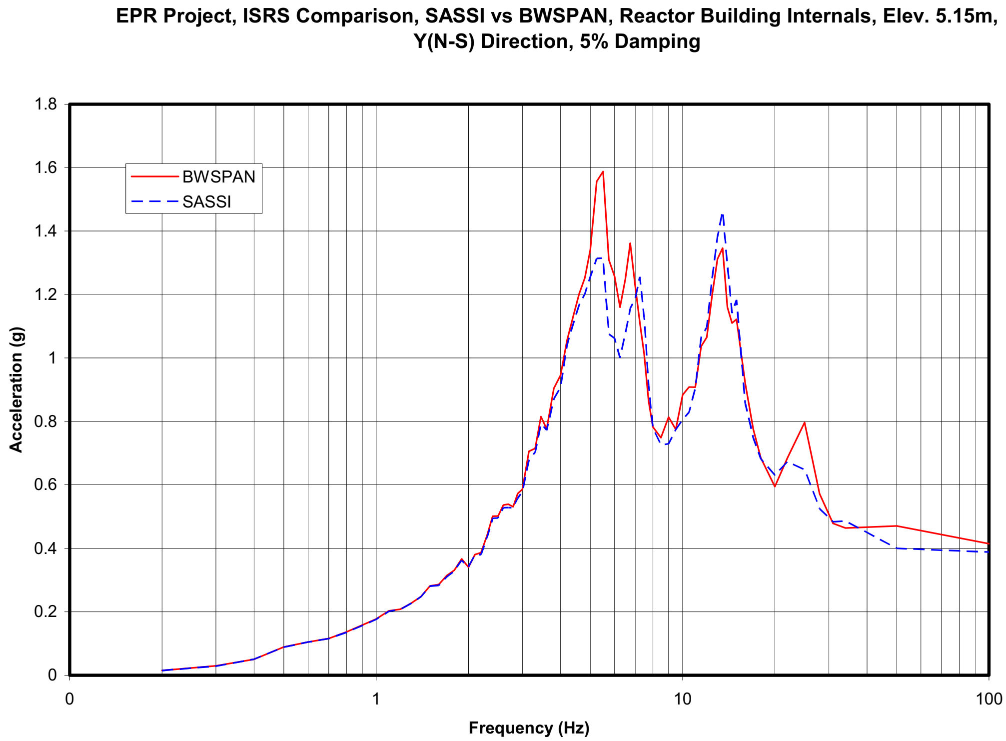

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 5.15m, Y(N-S) Direction, 5% Damping
BWSPAN
SASSI
Acceleration (g)
Frequency (Hz)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1
10
100

FIGURE 3.7.2-6

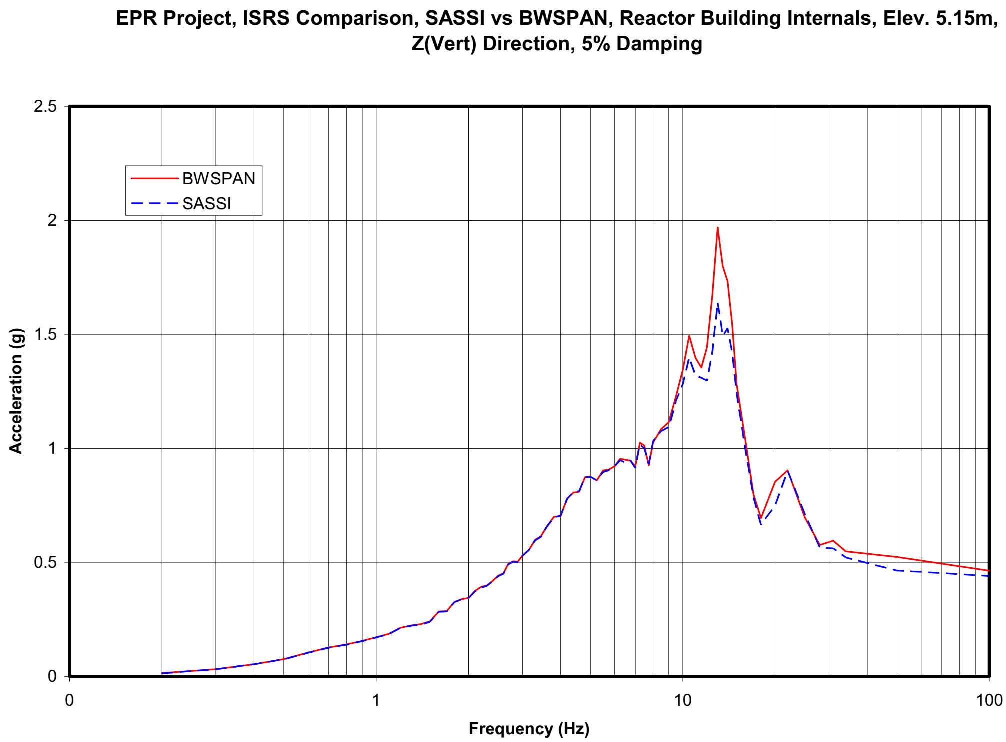

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 5.15m, Z(Vert) Direction, 5% Damping
BWSPAN
SASSI
Acceleration (g)
2.5
2
1.5
1
0.5
0
0
1
10
100
Frequency (Hz)

FIGURE 3.7.2-7

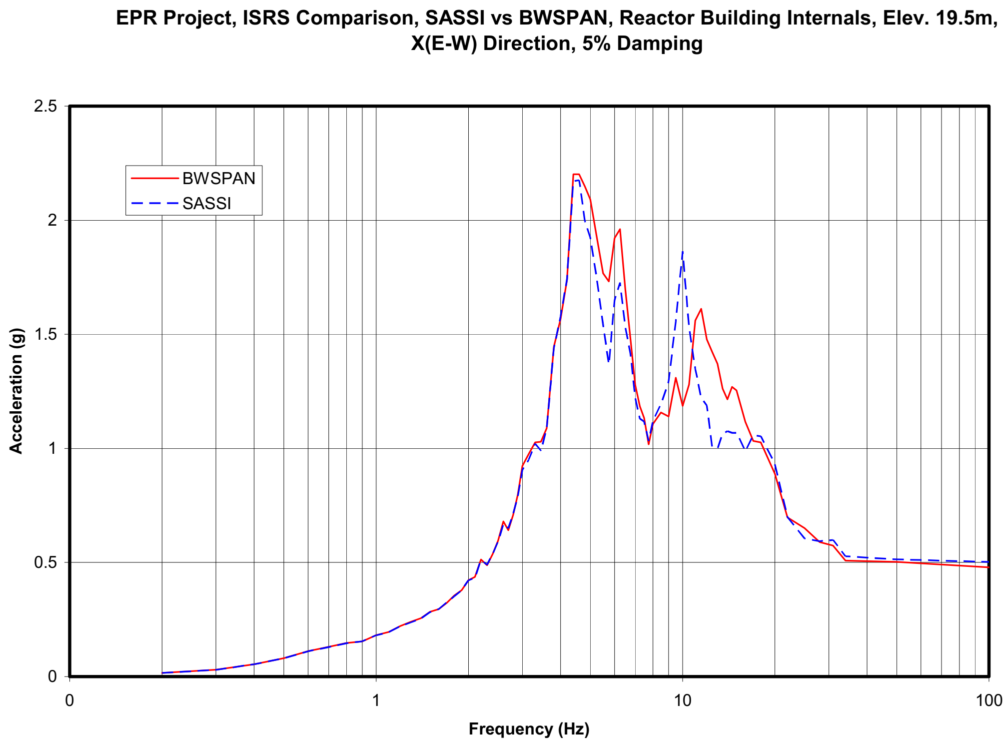

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 19.5m,
X(E-W) Direction, 5% Damping
BWSPAN
SASSI
Acceleration (g)
0
0.5
1
1.5
2
2.5
0
1
10
100
Frequency (Hz)

FIGURE 3.7.2-8

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 19.5m, Y(N-S) Direction, 5% Damping

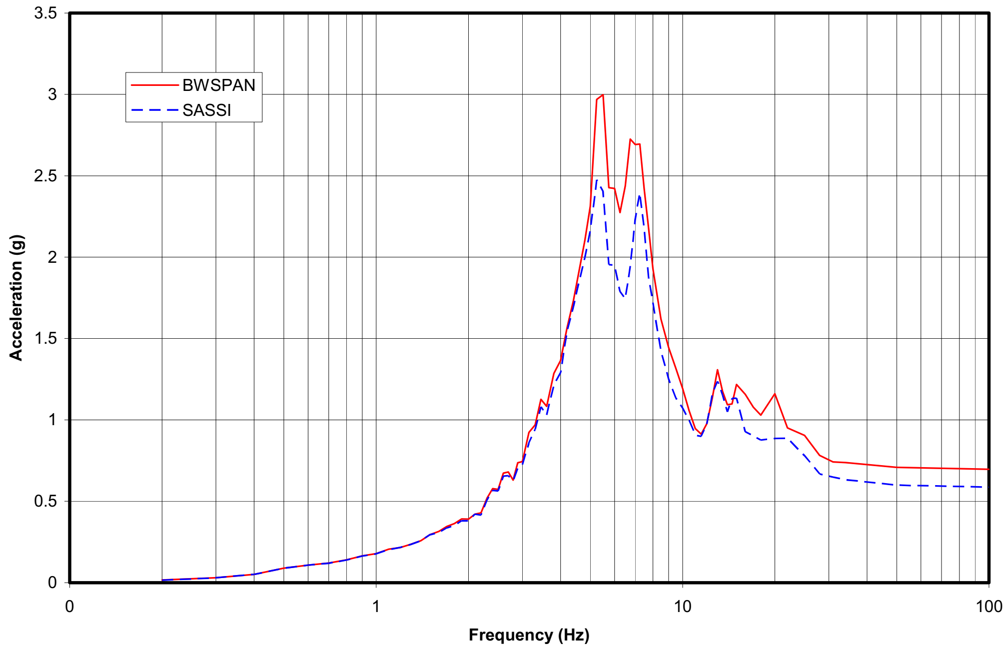


FIGURE 3.7.2-9

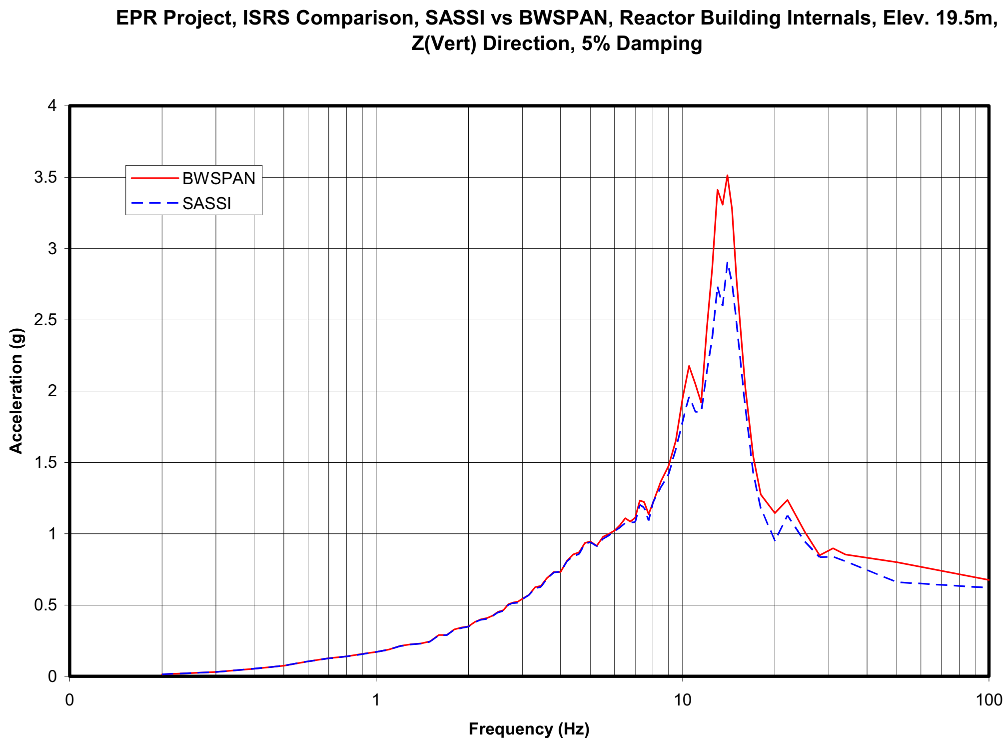
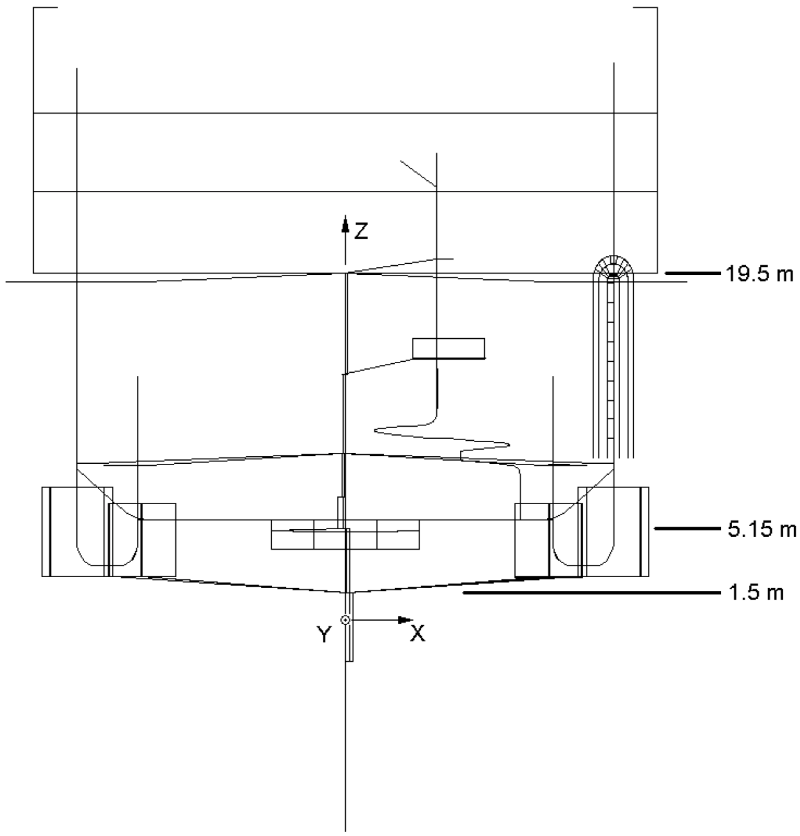

EPR Project, ISRS Comparison, SASSI vs BWSPAN, Reactor Building Internals, Elev. 19.5m, Z(Vert) Direction, 5% Damping
BWSPAN
SASSI
Acceleration (g)
Frequency (Hz)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
1
10
100

FIGURE 3.7.2-10—RCS Seismic Model Profile



FSAR Impact:

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

Question 03.07.02-36:

(Audit follow-up) In the Structural Stick Model Development for the U.S. EPR Design Certification (Document 32-5062562-004), it states on page 20 that the variable area live loads are not taken from Reference 17 as they may not be representative of loads to be used for seismic analysis. Instead a live load value of 200 psf is used for the Fuel Building and Reactor Containment Building which is determined to be more appropriate for use in seismic analysis. On page 56 of the System Design Requirements Document for EPR Standard Plant Structures (Document 115-9005678-005), it states that for the Fuel Building and Reactor Containment Building a live load of 400 psf shall be used for design. What is the basis for each of these values and why was a lower value selected for seismic analysis of these structures? What is the impact if, instead of 200 psf live load, a value of 400 psf live load had been used in the seismic analysis of these structures?

Response to Question 03.07.02-36:

The lower value used in seismic analysis represents a realistic live load. The heavier load is applied in floor design and represents movable equipment and machinery used during maintenance operations. The incremental mass, due to the larger live load compared to the lumped mass at that elevation, affects the frequency by a maximum of 4 percent which is within the +/- 15 percent peak broadening of in-structure response spectra (ISRS) to account for frequency and material uncertainties. This difference in mass has an insignificant effect on analytical results.

The 200 psf live load is adequate and appropriate for seismic analysis.

FSAR Impact:

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

Question 03.07.02-37:

(Audit follow-up) In the seismic analyses of the EPR Seismic Category I structures, a number of assumptions regarding the elevation of the building foundations and the properties of the supporting subgrade under each are made. In the EPR certified design, the SSI analyses of the NI common basemat structures assumes the top of the generic soil profiles are at an elevation corresponding to the bottom of the NI basemat foundation. This is 40 feet below the actual plant grade for this structure. The SSI analyses of EPGB and ESWB assume the top of the generic soil profiles are located at grade elevation. Thus there is an inconsistency in the application of those generic soil profiles that assume the soil properties are variable with depth between the NI common basemat structures and the other two structures. In determining SSSI effects, it is assumed that the foundations of the EPGB and ESWB are at the same elevation as the foundation of the NI common basemat structures when in reality the foundations of all three are at different elevations. EPR FSAR Section 2.5.2.6 provides evaluation guidelines for the COL applicant to follow in verifying the site specific seismic response of structures, systems and components is enveloped by the US EPR Certified Design seismic response. Step five of these guidelines states that the applicant will demonstrate that the idealized site soil profile is bounded by the 10 generic soil profiles used for the EPR design. Step eight of these guidelines states that site specific evaluations will use methodologies described in EPR FSAR Section 3.7.1 and 3.7.2. The staff believes the guidelines are inadequate for the COL applicant to make a site specific comparison of seismic response to the U.S. EPR design and requests that the following be addressed:

a) For the NI SSI analysis, the EPR generic soil profile was assumed to start at the foundation elevation, whereas for a site the soil properties are normally defined starting at plant grade. Therefore, additional guidance should be provided regarding how to compare the site specific soil profiles with the U.S. EPR soil profiles.

b) The site-specific EPGB and ESWB may be founded on structural fill. How this is accounted for in the comparison of soil profiles or in the calculation of site specific FIRS for these structures needs to be addressed in the guidelines.

c) The SSSI effects determined for the EPGB and ESWB of the U.S. EPR design do not account for the difference in elevations of these structures with the NI common basemat structures. Additional guidance should be provided to COL applicant regarding how this issue should be addressed.

Response to Question 03.07.02-37:

a) The U.S. EPR FSAR will be revised to require that site soil properties for soil beneath the NI common basemat must be bounded by the design soil properties listed in U.S. EPR FSAR Tier 2, Tables 3.7.1-6 and 3.7.2-9 . Otherwise, the COL applicant must perform a site-specific reconciliation.

b) The U.S. EPR FSAR will be revised to require that site soil properties for soil columns beneath the Emergency Power Generating Building (EPGB) and Essential Service Water Building (ESWB) foundations, starting at grade, must be bounded by the design soil properties listed in U.S. EPR FSAR Tier 2, Tables 3.7.1-6 and 3.7.2-9. Otherwise, the COL applicant must perform a site-specific reconciliation.

c) U.S. EPR FSAR Tier 2, Figure 3.7.1-30 and Section 3.7.1.1.1 describe the seismic reconciliation of certified seismic design response spectra (CSDRS) and foundation input response spectra (FIRS).

FIRS include soil column amplification effects including overburden, and are represented by the ratio of FIRS2 to FIRS1.

Structure-soil-structure interaction (SSSI) motion is the envelope of "ground node" response spectra at NI elevation. Thus, the modified FIRS2 = (FIRS2/FIRS1) (SSSI motion) and is used for seismic reconciliation as follows:

(FIRS2/FIRS1)(SSSI motion) ≤ CSDRS x SSSI Factor

where SSSI motion = FIRS1 x SSSI Factor, then

(FIRS2/FIRS1)(FIRS1 x SSSI Factor) ≤ CSDRS x SSSI Factor

therefore,

FIRS2 ≤ CSDRS

Similarly, FIRS3 ≤ CSDRS.

If this relationship is not satisfied, a site-specific analysis must be performed.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 2.5.2.6 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

soil-structure interaction analyses performed for the U.S. EPR in addressing the following evaluation guidelines.

1. The applicant will confirm that the peak ground acceleration for the GMRS is less than 0.3g.

2. The applicant will confirm that the low-strain, best-estimate, value of shear wave velocity at the bottom of the foundation basemat of the NI Common Basemat Structures and other Seismic Category I structures is 1000 fps, or greater. This comparison will confirm that the NI Common Basemat Structures and other Seismic Category I structures are founded on competent material.

3. The applicant will demonstrate that the FIRS are enveloped by the CSDRS for the U.S. EPR using the guidance provided in Section 3.7.1.1.1.

4. The applicant will demonstrate that the site-specific profile is laterally uniform by confirming that individual layers with the profile have an angle of dip no greater than 20 degrees.

5. The applicant will demonstrate that the idealized site soil profile is similar to or bounded by the 10 generic soil profiles used for the U.S. EPR. The 10 generic profiles include a range of uniform and layered site conditions. The applicant also considers the assumptions used in the SSI analyses, as described in Section 3.7.1 and Section 3.7.2. Site soil properties of soil columns beneath Category I structures must be bounded by design soil properties listed in Tables 3.7.1-6 and 3.7.2-9. The soil column beneath the embedded NI Common Basemat and the soil column, starting at grade, for the EPGB and ESWB must meet this requirement.

03.07.02-37

6. If the conditions of steps one through five are met, the characteristics of the site fall within the site parameters for the U.S. EPR and the site is acceptable.

7. If the conditions of steps one through five are not met, the applicant will demonstrate by other appropriate means that the U.S. EPR is acceptable at the proposed site. The applicant may perform intermediate-level additional studies to demonstrate that the particular site is bounded by the design of the U.S. EPR. An example of such studies is to show that the site-specific motion at top-of-basemat level, with consideration of the range of structural frequencies involved, is bounded by the U.S. EPR design.

8. If the evaluations of step 7 are not sufficient, the applicant will perform detailed site-specific SSI analyses for the particular site. This site-specific evaluation will include dynamic seismic analyses and development of in-structure response spectra (ISRS) for comparison with ISRS for the U.S. EPR. These analyses will be performed in accordance with the methodologies described in Section 3.7.1 and Section 3.7.2. Results from this comparison will be acceptable if the amplitude of the site-specific ISRS do not exceed the ISRS for the U.S. EPR by greater than 10 percent on a location-by-location basis. Comparisons will be made at the following key locations, defined in Section 3.7.2: