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August 30, 2010

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffery A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10238

Subject: MHI's Response to US-APWR DCD RAI No. 603-4666

References: 1) "Request for Additional Information No. 603-4666 Revision 2, SRP Section: 03.07.02 - Seismic Subsystem Analysis," dated 6/25/2010.
2) "Response to Request for Additional Information No. 603-4666, Revision 2," UAP-HF-10217, dated 7/27/2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 603-4666, Revision 2."

Enclosed is the response to 1 RAI contained within Reference 1. This transmittal, in addition to the one RAI response previously provided in Reference 2, completes the response to this RAI.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosure:

1. Response to Request for Additional Information No. 603-4666, Revision 2

D081
NRO

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Enclosure 1

UAP-HF-10238
Docket No. 52-021

Response to Request for Additional Information No. 603-4666, Revision 2

August, 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

8/30/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 603-4666 REVISION 0**
SRP SECTION:	**03.07.02 – Seismic Subsystem Analysis**
APPLICATION SECTION:	**3.7.2**
DATE OF RAI ISSUE:	**6/25/10**

QUESTION NO. RAI 03.07.02-10:

The staff's review of MUAP-10001 (R0) has resulted in several observations that question the adequacy of the seismic lumped mass stick models that MHI propose to use for computing the design basis seismic responses of SSCs. The staff's guidance to develop adequate number of discrete mass degrees of freedom in dynamic modeling of lumped mass stick models is provided in SRP 3.7.2.II.1.A.iv and DC/COL-ISG-1 (ML081400293). Staff expects MHI to demonstrate that the lumped mass stick models of the PCCV, PS/B, and other structures are properly developed to include adequate number of discrete mass degrees of freedom in dynamic modeling. The staff requires technical bases and justification to the following observations in order to evaluate the adequacy of the proposed lumped mass stick models.

1. The SSI and structural seismic models should be adequately refined to sufficiently capture the high frequency contents of the horizontal and vertical input seismic spectra in the structural response. The interim staff guidance DC/COL-ISG-1 requires that the range of high frequency to be transmitted should cover a model refinement frequency of at least equal to 50 Hz. The 40 Hz cutoff frequency of for the SDOF oscillators described in Sections 4.3.2 and 5.3.1.1 is not in conformance with the guidance of ISG-1, which recommends that models be sufficiently refined to transmit frequencies up to 50 Hz.

2. The fundamental mode and corresponding mass participation in the X and Y directions (Figures 5.3.3.2-1 and 5.3.3.2-2) from the lumped mass stick model is different than that from the detailed three-dimensional model. Discuss its significance on the validity of the lumped mass stick model.

3. The mass participation response in vertical direction (Figure 5.3.3.2-3) is shown to be less than 100%. Discuss the adequacy of the vertical seismic model and how the missing mass is accounted for in calculating the vertical seismic responses.

4. The seismic response of PCCV based on the lumped mass stick model is under predicted (e.g. 22% in Figures 5.3.3.3-4 and 5.3.3.3-9) compared to the response based on the refined 3D finite element model.

5. The seismic response of PS/B based on the lumped mass stick model is under predicted (e.g. Figures 5.4.2-13, 5.4.2-15) compared to the response based on the refined 3D finite element model.

6. There appears to be a relative scarcity of SASSI analysis points near the fundamental frequency in the ANSYS dynamic model transfer functions in X and Y directions (Figure 5.4.2-7 and 5.4.2-8). This introduces the potential for error in the SASSI interpolation scheme if the dominant frequency shifts for any reason. Discuss its significance on seismic responses computed based on the SASSI model.

7. In order to estimate the extent of concrete cracking, MHI in section 4.5.1 references Appendix 3H of the US-APWR DCD, Rev. 2 to estimate stress level in structural members. A validation of the initially assumed locations and extent of cracking should be provided considering stress levels based on design load combinations that include seismic forces from the analyses of lumped mass stick models developed to include adequate number of discrete mass degrees of freedom.

[SEB question 37]

ANSWER:

ITEM 1

The single degree of freedom (SDOF) models used to capture the out-of-plane response of flexible slabs and walls were developed by considering both cracked and un-cracked reinforced concrete properties. The results of the site independent soil structure interaction (SSI) analyses of the reactor building (R/B) complex were used to develop seismic demands for standard design. The results were obtained using a lumped mass stick model of R/B structure that incorporated SDOF models representing the stiffness of the flexible slabs and walls that corresponds to cracked concrete properties where cracking occurs. A lower bound value was assigned for the stiffness to these SDOF models that is 50% of the stiffness of the uncracked concrete.

In-structure response spectra (ISRS) were developed representing the envelope of the out-of-plane response of a group of slabs or walls. These ISRS serve to define the seismic demands for design of seismic category I and II SSCs supported at the mid-span of any of the flexible slabs or walls in the group. The responses of each SDOF model obtained from SSI analyses of the eight different generic soil cases were enveloped. The peaks of the enveloped acceleration response spectra (ARS) were broadened and then enveloped into groups as described in Section 3.5 of Technical Report, MUAP-10006. These group ISRS provide a bounding input for design of seismic category I and II SSCs supported by the flexible slabs or walls at all locations within the group.

Table 1 below provides the results of the modal analyses of three representative floors for slabs, for which natural frequency of out-of-plane vibrations is below 50 Hz. The table shows that the frequencies of 7 slabs are within the range of 40 to 50 Hz. The response frequency of the slabs and walls are based on a lower bound cracking stiffness, and therefore these slabs are likely to have a higher frequency response then that considering 50% reduced out-of-plane stiffness.

The flexible slabs and walls for which the out-of-plane response, considering reduced cracked stiffness, is characterized by natural frequencies between 40 Hz and 50 Hz, are to be grouped with the appropriate group of ISRS defined in Technical Report, MUAP-10006. These ISRS are deemed adequately conservative to envelope the response of the flexible slabs and walls with

fundamental frequencies between 40 and 50 Hz. This will be validated at a later date by performing a set of site-independent SSI analyses using a 3-D Finite Element (FE) structural model of the R/B complex structures that will be capable of capturing local responses up to 50 Hz.

Table 1 – Flexible Slabs at Three Representative Floors Considering Cracking

ISRS Groups	Slab ID#	x (ft)	y (ft)	z (ft)	Frequency (Hz)	Weight (kips)	Spring Constant (kip/ft)
RE41Z1	101_10a	-120.79	-80.17	101.00	13.4	140	3.076E+04
RE41Z1	101_10b	-79.00	-80.17	101.00	17.3	105	3.837E+04
RE41Z3	101_11	-43.17	-72.38	101.00	28.4	85	8.420E+04
RE41Z2	101_12b	-77.08	-53.75	101.00	39.9	74	1.452E+05
RE41Z3	101_40	39.00	-76.83	101.00	32.6	78	1.015E+05
RE41Z3	101_41a	68.33	-83.25	101.00	23.1	140	9.175E+04
RE41Z2	101_41b	68.33	-50.17	101.00	30.0	185	2.048E+05
RE41Z2	101_43a	110.50	-50.17	101.00	35.4	131	2.020E+05
RE42Z1	101_21	-57.79	40.54	112.00	10.0	308	3.748E+04
RE42Z1	101_22	-70.08	57.63	112.00	27.0	58	5.216E+04
RE42Z1	101_23	-56.58	79.63	112.00	12.8	291	5.818E+04
RE42Z1	101_23a	-56.58	79.63	112.00	27.0	58	5.216E+04
RE42Z1	101_24a	-56.58	99.08	112.00	29.1	23	2.439E+04
RE04Z1	101_30	42.50	73.75	101.00	34.2	123	1.765E+05
RE04Z1	101_30a	42.50	73.75	101.00	38.2	79	1.413E+05
RE04Z1	101_33a	110.50	81.58	101.00	30.3	136	1.523E+05
RE41Z2	101_13c	-25.67	-98.58	101.00	43.1	138	1.817E+05
RE41Z2	101_24b	0.00	99.08	112.00	43.3	59	1.366E+05
RE01Z4	25_20a	-121.50	29.73	25.25	27.4	307	2.830E+05
RE01Z3	25_20b	-132.42	52.88	25.25	21.8	85	4.947E+04
RE01Z5	25_20c	-104.92	59.67	25.25	39.1	314	5.891E+05
RE01Z3	25_20d	-142.88	75.88	25.25	21.8	85	4.947E+04
RE01Z3	25_20e	-119.71	75.88	25.25	21.8	85	4.947E+04
RE01Z3	25_20f	-132.42	98.58	25.25	21.8	85	4.947E+04
RE01Z5	25_22e	-78.83	75.88	25.25	36.9	143	2.388E+05
RE01Z5	25_23	-43.17	75.88	25.25	32.3	228	2.927E+05
RE01Z1	25_30b	42.50	77.00	25.25	33.0	210	2.814E+05
RE01Z1	25_33b	116.50	56.00	25.25	35.3	221	3.365E+05
RE01Z2	25_33d	143.50	56.00	25.25	21.0	485	2.613E+05
RE01Z2	25_34b	133.00	19.42	25.25	17.9	594	2.324E+05
RE01Z1	25_42d	139.50	-95.79	25.25	34.6	112	1.645E+05
RE01Z2	25_43d	143.50	-54.42	25.25	20.9	196	1.056E+05
RE01Z2	25_44b	133.00	-19.42	25.25	17.9	594	2.324E+05
RE01Z5	13_17	-127.04	-54.25	14.33	32.0	52	6.470E+04
RE01Z4	13_31	149.42	95.79	14.08	25.5	49	3.926E+04
RE01Z4	13_42	143.50	-95.79	14.08	21.3	72	4.025E+04

Table 1 – Flexible Slabs at Three Representative Floors Considering Cracking (ontinued)

ISRS Groups	Slab ID#	x (ft)	y (ft)	z (ft)	Frequency (Hz)	Weight (kips)	Spring Constant (kip/ft)
RE01Z1	25_11a	-100.42	-95.79	25.25	46.6	88	2.351E+05
RE01Z1	25_12b	-138.00	-74.04	25.25	42.4	148	3.276E+05
RE01Z1	25_40a	42.50	-76.33	25.25	42.6	75	1.676E+05
RE00Z1	3_32a	133.00	54.42	3.58	27.4	1,593	1.461E+06
RE00Z2	3_32b	133.00	19.42	3.58	20.2	554	2.785E+05
RE00Z2	3_32c	133.00	-19.42	3.58	20.2	554	2.785E+05
RE00Z1	3_32d	133.00	-54.42	3.58	27.1	343	3.088E+05
RE00Z3	3_10a	-78.83	-75.88	3.58	30.4	314	3.547E+05
RE00Z3	3_20a	-78.83	76.88	3.58	29.3	315	3.323E+05
RE00Z3	3_15c	-127.92	-41.25	3.58	36.5	247	4.033E+05
RE00Z3	3_15d	-127.92	-23.29	3.58	36.5	247	4.033E+05
RE00Z3	3_15	-131.54	39.04	3.58	38.0	327	5.773E+05
RE00Z3	3_15e	-127.92	-7.54	3.58	43.9	157	3.695E+05
RE00Z3	3_15f	-131.54	8.75	3.58	43.9	157	3.695E+05

ITEM 2

Figures 5.3.3.2-1 and 5.3.3.2-2 present the results from the modal analyses of the lumped mass stick model and detailed FE model of PCCV in terms of cumulative mass participation factors of the extracted modes versus frequencies. The jumps in the plotted cumulative mass participation factors indicate modes that have a significant contribution for the response of the structure in the North-South (X) or East-West (Y) direction. The plots show that the horizontal response of the PCCV is essentially that of a symmetric structure with respect to the vertical axis and is characterized by two modes. The analyses of the detailed FE model yielded a frequency of 4.60 Hz for the first mode representing the response in X direction and 4.61 Hz for the second mode representing the response in Y direction. The modal analysis of the lumped mass stick model yielded the same frequency of 4.47 Hz for the response of the structure in the two horizontal directions. The response of the structure in X direction and Y direction is split between the two modes as shown in the table below.

Mode	Detailed FE Model			Lumped Mass Stick Model		
	Freq. (Hz)	Mass Fraction		Freq. (Hz)	Mass Fraction	
		X	Y		X	Y
1	4.60	73%	0%	4.47	14%	59%
2	4.61	0%	74%	4.47	59%	14%

The PCCV structure in the detailed model is represented by 3-D shell elements in which the stiffness and mass inertia of the structure is equally distributed in the horizontal direction in a number of degrees of freedom. In the lumped mass stick model, 3-D beam elements represent the stiffness of the structure and the mass of the structure is lumped at lumped mass locations. The stiffness of the PCCV cylindrical structure is modeled by assigning to the 3-D beams the same cross-sectional properties in the two horizontal directions. The difference in modeling of stiffness and mass explains why the response of the lumped mass stick model in the horizontal direction is represented by two modes with same frequency.

The results of the modal analyses clearly show that the horizontal response of the PCCV is characterized by a natural frequency of 4.6 Hz. The difference between the results of the detailed FE model and lumped mass stick model is less than 3% which is deemed to be acceptable.

ITEM 3

Figure 5.3.3.2-3 present the results from the modal analyses of the lumped mass stick model and detailed FE model of PCCV in terms of cumulative mass participation factors of the extracted modes for frequencies up to approximately 50 Hz. The modal analyses of the detailed finite element model extracted 250 modes that included more than 99.99% of the total vertical mass. The vertical mass captured by the modes with frequency below 50 Hz is 95.7% of the total mass. The modal analyses of the lumped mass stick model extracted a total of 66 modes that captured 100% of the total mass assigned to the model. The vertical mass captured by the modes with frequency below 50 Hz is 93.2% of the total mass.

The site-independent SSI analyses of the R/B complex resting on generic layered profiles are performed in a frequency domain using the ACS SASSI computer program. The response of the structure to ground motion excitation is calculated for the selected frequencies of analyses and then interpolated for the frequencies between. The input ground motion and the response of the structure is translated form time domain to frequency domain and from frequency domain to time domain using Fast Furrier Transformation (FFT) and inverse FFT.

The amplifications of the response of the structure above the cut-off frequency of analyses are neglected, i.e. the response above the cut-off frequency is treated as a rigid body response. The intensity of the design ground motion defined by the CSDRS at frequency above 50 Hz is very small. Therefore, the possible amplifications of the structural response at the modes with frequency above 50 Hz which represent less than 7% of the total mass of the structure will be minimal. It is deemed that the lumped mass stick model of the PCCV provides an adequate representation of the dynamic properties of the pre stressed concrete structure for calculating the response excited by the input design motion.

ITEM 4

A review of Figure 5.3.3.3-4 and 5.3.3.3-9 of Technical Report MUAP-10001 (R0) revealed that the results from the ANSYS time history analysis of the lumped mass stick model were plotted incorrectly. The data labeled in the figures as 'Stick Model – Nd. 9_CV03' were actually the response spectra calculated for the node CV02 located at elevation below CV03. The corrected plots are presented below. The corrected plots provide the results of the SASSI analysis of the lumped-mass stick model resting on the surface of a very stiff half space that simulates a fixed base condition. The comparison of the acceleration response spectra (ARS) results obtained from the three different types of analyses demonstrates that the lumped-mass stick model adequately represents the dynamic behavior of the PCCV.

Rev. 0 Plots

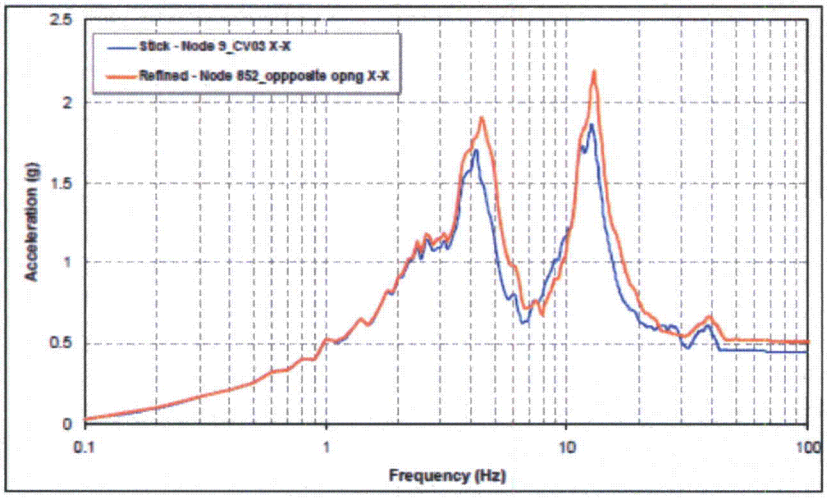


Figure 5.3.3.3-4 ARS, Node CV03, Horizontal Direction

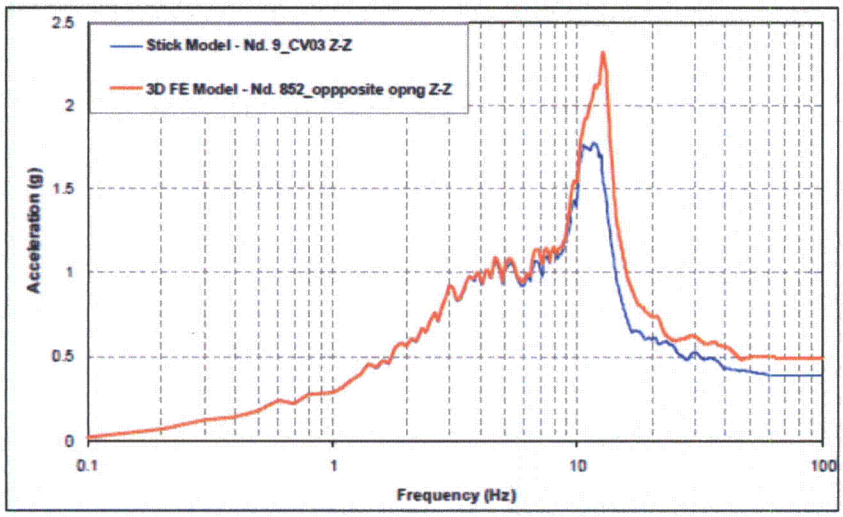


Figure 5.3.3.3-9 ARS, Node CV03, Vertical Direction

Corrected Plots

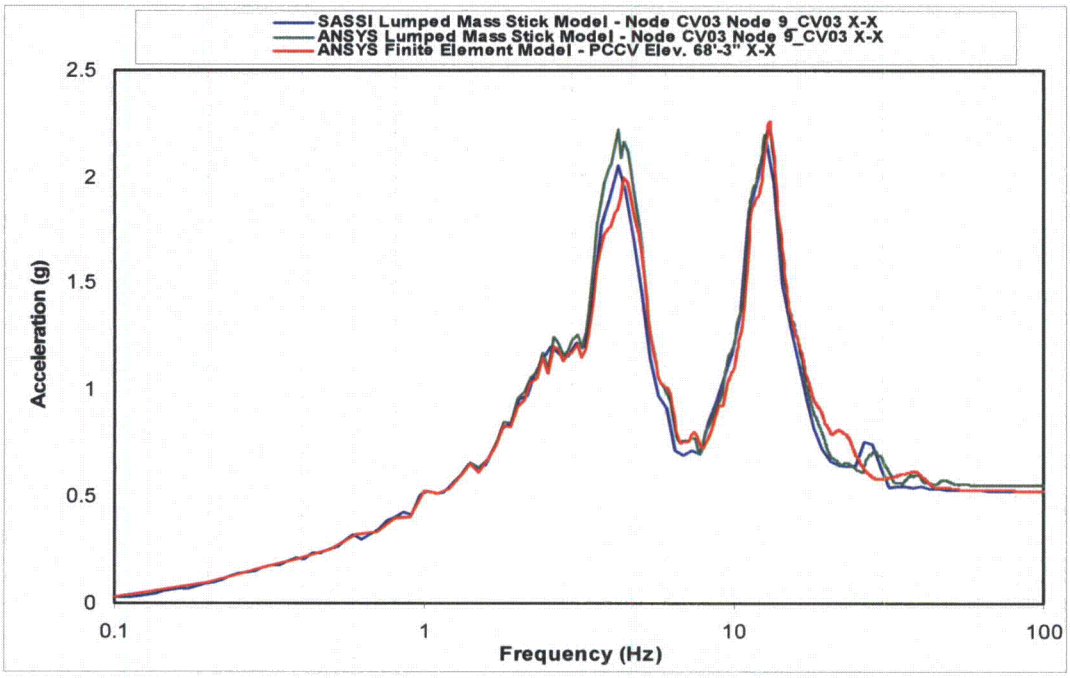


Figure 5.3.3.3-4, ARS, Node CV03, Horizontal Direction (MUAP 10001, Rev. 1)

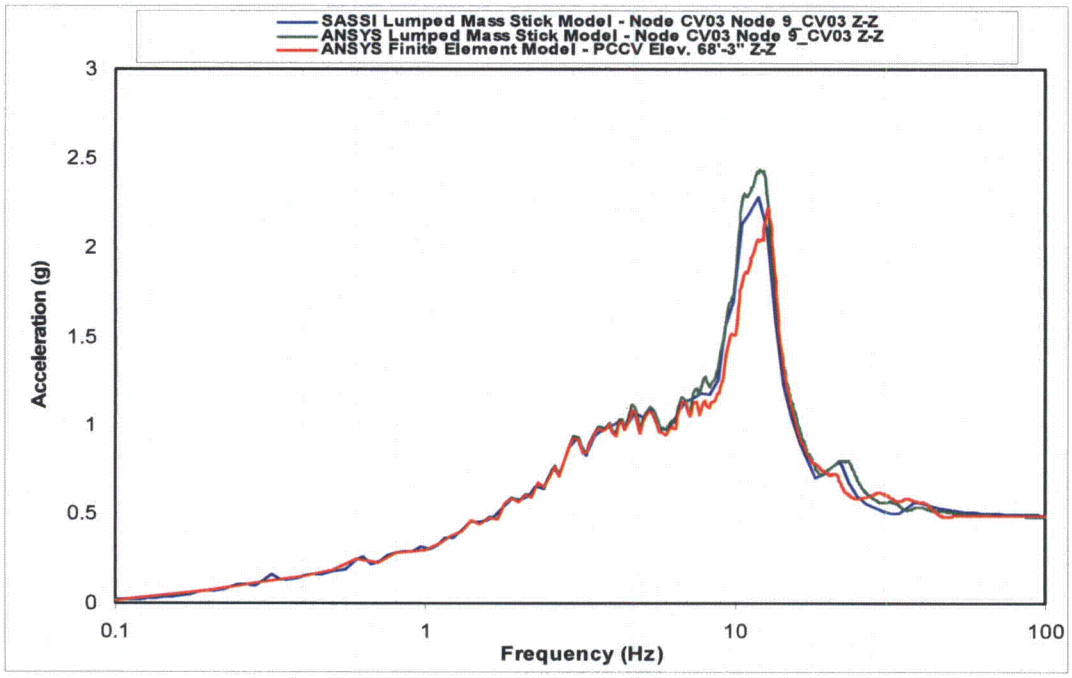


Figure 5.3.3.3-9, ARS, Node CV03, Vertical Direction (MUAP 10001, Rev. 1)

ITEM 5

The site-independent soil-structure interaction (SSI) analyses of the Power Source Buildings (PS/Bs) use a 3-D dynamic finite element (FE) model created in ANSYS and then translated into ACS SASSI format. The model includes shell elements representing the walls and slabs of the building, beam elements representing the beams and the columns, and solid elements representing the basemat. The mesh size of the model is approximately 8 ft as compared to the 3 ft size of the detailed static model for static analyses providing the demands for the design of PS/B structural members.

Figures 5.4.2-13 and 5.4.2-15 provide comparison of the acceleration response spectra (ARS) at representative node locations obtained from ANSYS modal-superposition time history analyses of the fixed base detailed static model and SSI analyses of ACS-SASSI FE model resting on the surface of a half-space with hard rock properties. The comparison of the results reveals the following, which is provided in the figures that follow:

Figure 5.4.2-13: ARS for PS/B response at Column Line BP-3P, X-Direction

The peak of the ARS obtained from the modal superposition time history analysis of the detailed static model is 1.49 g at frequency of 8 Hz. The ARS obtained from the SSI analyses of the ACS SASSI model at 8 Hz is 1.42 g, which represents a difference of 5%. The nearby peak in the ARS obtained from the SSI analyses of the ACS SASSI model is 1.47 g at frequency of 9.3 Hz. The second peak of 1.37 g in the ARS obtained from ANSYS analysis of the detailed static model is at frequency of 20.5 Hz. The ARS obtained from ACS SASSI analysis of PS/B dynamic FE model has peak of 1.28 g at frequency of 21.3 Hz, which represents a difference of 7% and a frequency shift of 4%.

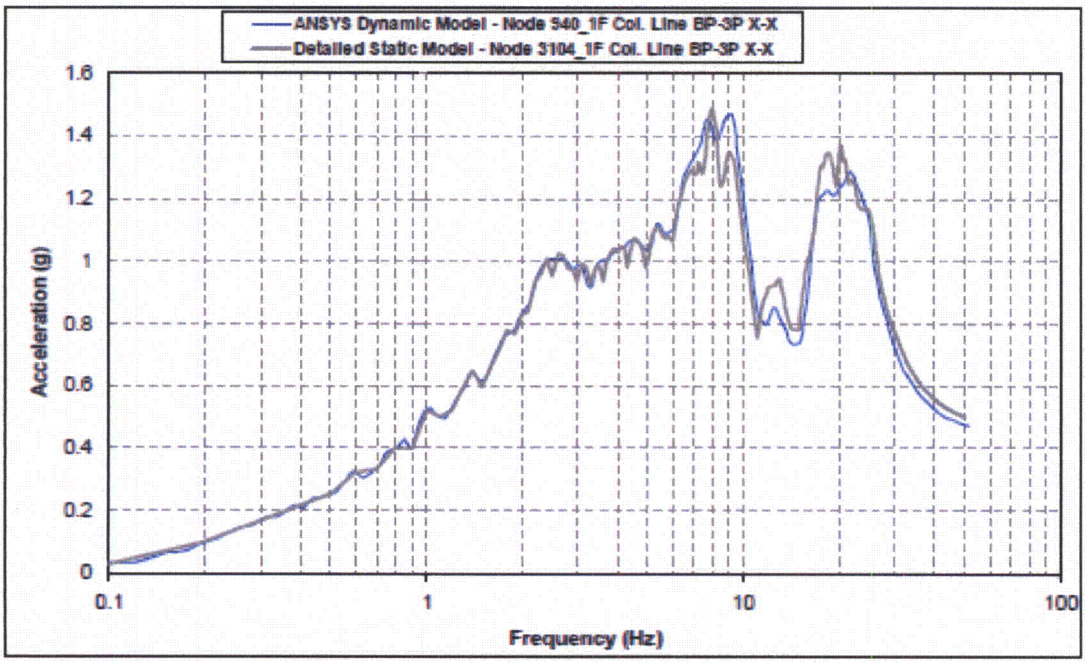


Figure 5.4.2-13 Comparison of ISRS, Ground Floor X-Direction

Figure 5.4.2-15: ARS for PS/B response at Column Line BP-3P, X-Direction

This figure shows that the ARS obtained from the ANSYS analysis of the Detailed Static Model has peak of 1.26 g at frequency of 15.2 Hz. The corresponding peak of 1.22 g of the ARS obtained from the ACS SASSI analysis of the dynamic FE model is at frequency of 15.1 Hz. This is a difference of 3% in the peak spectral values and a frequency shift of less then 1%.

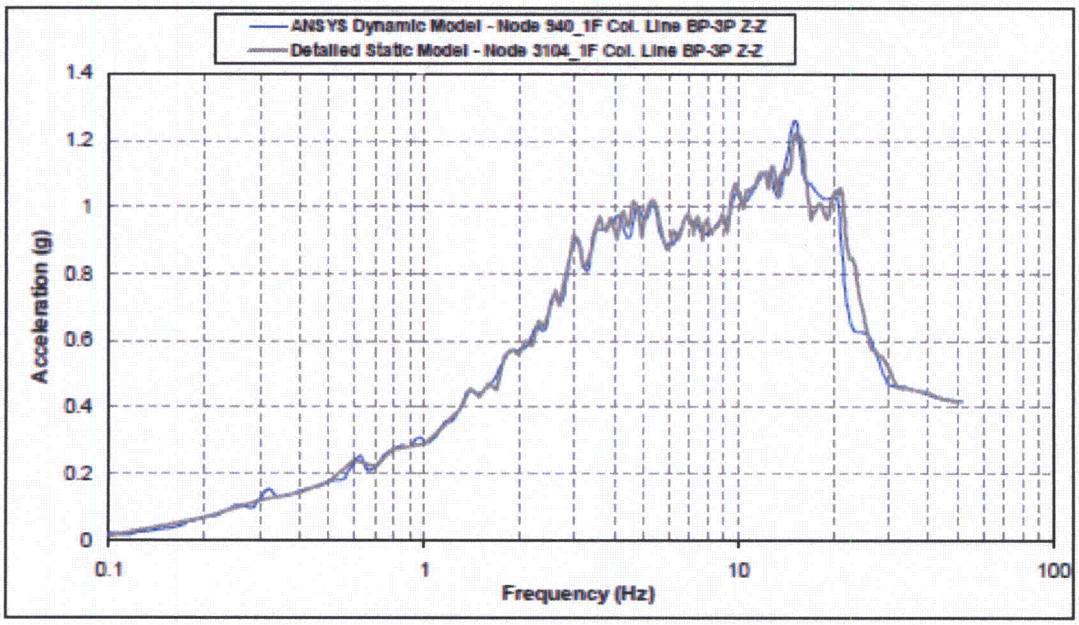


Figure 5.4.2-15 Comparison of ISRS, Ground Floor Z-Direction

The ARS presented in Figures 5.4.2-13 and 5.4.2-15 are obtained from two different types of time history analyses of two different FE models of PS/B: (1) ANSYS modal superposition time history analysis of the detailed FE model with fixed base; and (2) ACS SASSI SSI analysis of dynamic FE model resting on a half-space with hard rock properties that simulates fixed base conditions. The differences in the ARS results are relatively small and are within the expectations considering the differences in the methodology of analysis and modeling of boundary conditions. Therefore, the ARS results presented in these figures supports the conclusion that the ACS SASSI dynamic model provides an adequate representation of the dynamic properties of the PS/B structure.

ITEM 6

In order to confirm the SASSI interpolation of the transfer functions between the selected frequencies of analyses, additional runs were performed as suggested at frequencies near the fundamental natural frequency of the PS/B structure. These results were combined with the existing results. The figures below compare the plots of the transfer function amplitudes obtained using additional frequencies of analyses with the transfer function diagrams presented in Figure 5.4.2-7 and 5.4.2-8 of Technical Report, MUAP-10001. The comparison demonstrates that the original transfer functions are almost identical with those obtained using additional frequencies of analyses and thus confirms that the SASSI interpolation scheme provided accurate results.

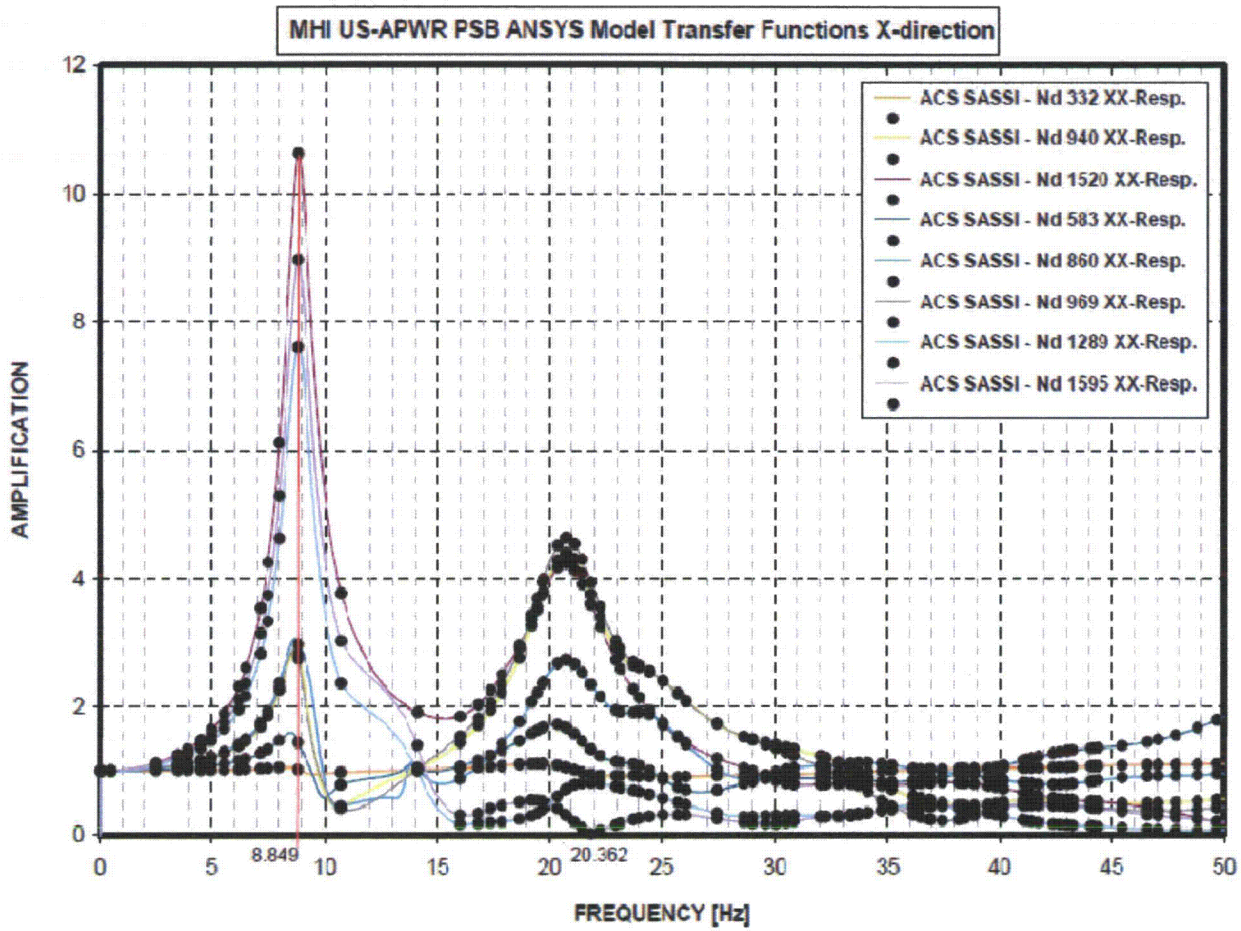
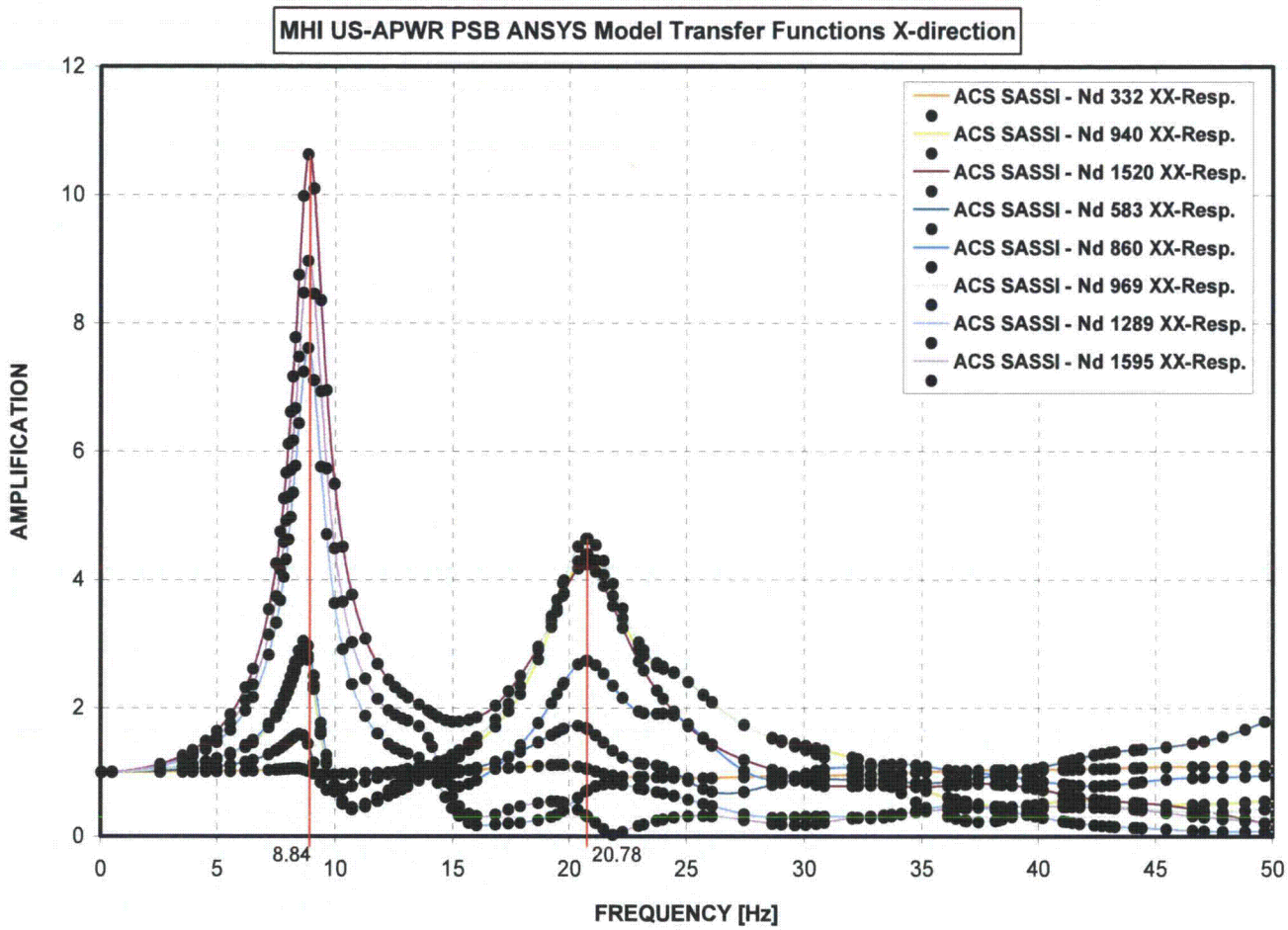


Figure 5.4.2-7 ANSYS Dynamic Model Transfer Functions, X-Direction


MHI US-APWR PSB ANSYS Model Transfer Functions X-direction
AMPLIFICATION
FREQUENCY [Hz]
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
40
45
50
8.84
20.78
ACS SASSI - Nd 332 XX-Resp.
ACS SASSI - Nd 940 XX-Resp.
ACS SASSI - Nd 1520 XX-Resp.
ACS SASSI - Nd 583 XX-Resp.
ACS SASSI - Nd 860 XX-Resp.
ACS SASSI - Nd 969 XX-Resp.
ACS SASSI - Nd 1289 XX-Resp.
ACS SASSI - Nd 1595 XX-Resp.

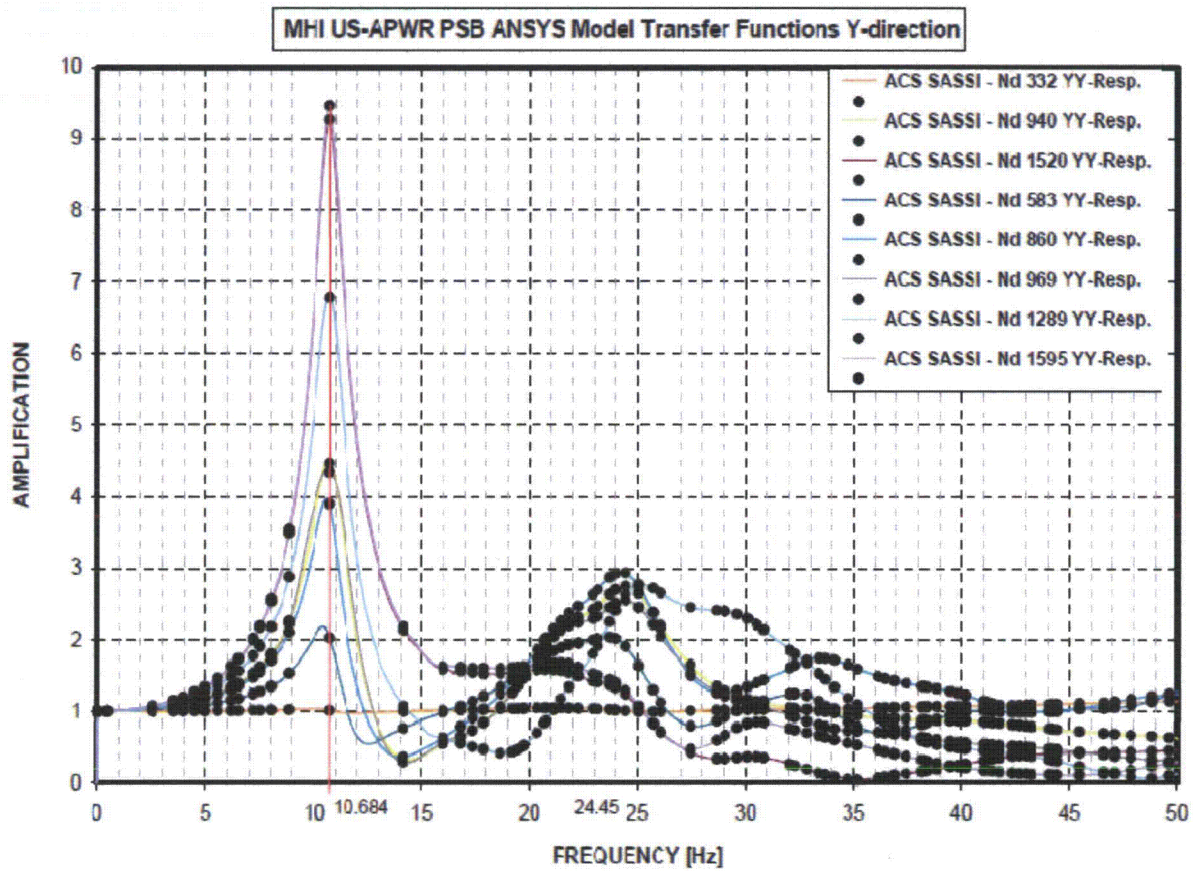
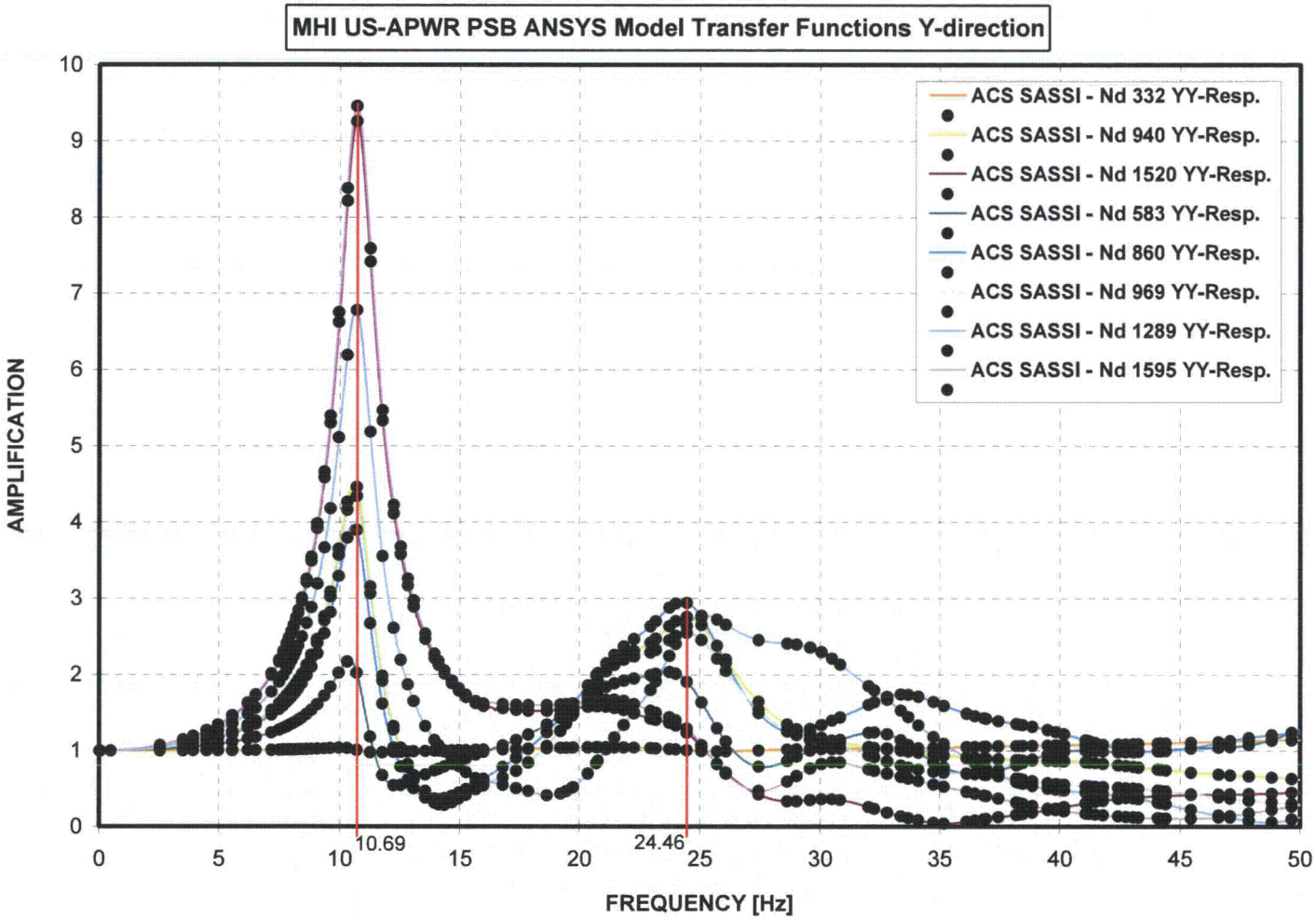


Figure 5.4.2-8 ANSYS Dynamic Model Transfer Functions, Y-Direction


MHI US-APWR PSB ANSYS Model Transfer Functions Y-direction
AMPLIFICATION
FREQUENCY [Hz]
10.69
24.46
ACS SASSI - Nd 332 YY-Resp.
ACS SASSI - Nd 940 YY-Resp.
ACS SASSI - Nd 1520 YY-Resp.
ACS SASSI - Nd 583 YY-Resp.
ACS SASSI - Nd 860 YY-Resp.
ACS SASSI - Nd 969 YY-Resp.
ACS SASSI - Nd 1289 YY-Resp.
ACS SASSI - Nd 1595 YY-Resp.

ITEM 7

The methodology used in Section 5.5.2 of MUAP-10001(R0) to calculate the shear stress levels in the shear walls of the R/B that are presented in Table 5.5.2-1 is used to calculate the shear stress levels in the R/B structure equivalent to the response obtained from the updated set of site-independent soil structure interaction (SSI) analyses documented in technical report MUAP-10006(R0). The table below compares the nominal concrete shear stress capacity with the results obtained using seismic loads from the SASSI analyses of generic layered profiles in MUAP-100006(R0) and the seismic stress levels presented in Table 5.5.2-1 of MUAP-100001(R0) that were calculated using the seismic loads obtained from the previous set of SSI analyses documented in Appendix 3H of the US-APWR DCD, Rev. 2. The comparison shows that the difference in the estimated shear stress levels between the two sets of analyses is less than 25%. The shear stress levels obtained from the SASSI analyses remain below the nominal concrete shear stress capacities of the shear walls for all walls but the NS shear walls of the fuel handling area (FHA), which in the lumped mass stick model are the only ones considered having reduced shear stiffness due to concrete cracking.

Reactor Building Seismic Stresses

Location	Elev. (ft)	Shear Stress Levels (psi)				Nominal Concrete Shear Stress Capacity (psi)	
		DCD Rev. 2		MUAP-10001, Rev. 0		NS	EW
		NS	EW	NS	EW		
FH08	154.5	368	115	373	139	276	
FH07	125.67	358	184	406	225	276	404
FH06	101	401	247	464	304	276	404
RE41	101	162	240	159	271	450	415
RE42	101	119	103	151	134		
RE05	115.5	108	145	98	145		463
RE04	101	181	232	152	203	462	455
RE03	76.42	171	183	234	209	461	454
RE02	50.167	216	244	269	268	461	455
RE01	25.25	260	278	322	308	463	458

Based on the results of the previous set of site-independent analyses documented in DCD Rev 2, Table 5.5.2-2 in MUAP-100001(R0) demonstrated that except for the FH/A, out-of-plane bending moments of selected elements at various elevations are less than the cracking moment capacity of the concrete, with few exceptions. Tables 5.5.1-1 through 5.5.1-3 present the evaluation of stress levels in the members of the PS/B that are also based on seismic loads obtained from the previous set of site-independent analyses documented in DCD Rev 2. A revised set of static analyses are underway in which the seismic loads generated from the updated set of SSI analyses presented in MUAP-10006(R0) will be applied on a updated detailed FE models of R/B complex and PS/B. The demands calculated from these analyses will be used to estimate the possibility of concrete cracking of different structural members following the methodology specified in Section 4.5 of MUAP-10001.

The updated horizontal seismic loads that are presented in MUAP-10006(R0) that are based on the results of the site-independent SASSI analyses are of similar magnitudes as those used for the standard design of the R/B complex and PS/B as documented in DCD Rev. 2. The DCD Rev. 2 design did not consider the amplification of the response due to the out-of-plane flexibility of the slabs and walls. Based on these observations, it can be concluded that the levels of shear or flexure stress of the shear walls that are mainly due to horizontal seismic loads will be similar to those obtained from the previous set of analyses, and that the conclusion that the concrete cracking does not affect the in-plane shear stiffness will remain valid. The consideration of out-of-plane response of flexible slab and walls will results in higher flexure stresses in these reinforced concrete members which will help demonstrate the validity of the modeling approach to reduce the out-of-plane stiffness of these elements in order to consider effects of concrete cracking.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes MHI's responses to the NRC's questions.