

## CHAPTER 3

high frequency range ( $\geq 25$  Hz.) except for the horizontal spectra at node 2078. At this node, the AP1000 HRHF FRS provides sufficient additional margin.

The second SSI analysis was performed using the 2D “Coarse” and “Fine” models for the BE soil profile. The SASSI Direct method was used. The 5 percent damped FRS at the six key nodes were generated. Frequency dependent Bump Factors ( $\geq 1.0$ ) were calculated from the FRS as the ratio of the 2D Fine model and the 2D Coarse model FRS at the six key nodes.

The third SSI analysis was performed using the 3D 5-layer embedded model for the BE soil profile. The SASSI Direct method was used. The 5 percent damped FRS at the six key nodes were generated. The frequency dependent Bump Factors calculated from the 2D model were applied to the 3D 5-layer model FRS along the frequency spectrum to amplify the 3D 5-layer model FRS. These factored FRS are compared to the AP1000 generic and HRHF (as necessary) FRS envelopes at the six key locations in [Figures 3.7-220, 3.7-221, 3.7-222, 3.7-223, 3.7-224, and 3.7-225](#). The HRHF FRS envelope is presented for 3D nodes 2078, 2199, and 2675 to demonstrate that additional margin exists at the three nodes in the high frequency region (20-50 Hz.). As shown in the figures, the LNP site-specific factored FRS are enveloped by the AP1000 generic and HRHF FRS envelopes at each of the six nodes with sufficient margin.

### 3.7.2.4.1.6 Bearing Pressure and Base Shear

Based on the SSI analysis, the maximum bearing pressure on the RCC bridging mat beneath the NI basemat for the BE, UB, LB and LLB soil profiles is 20.29 ksf. The maximum bearing pressure corresponds to the BE soil profile. The LNP site specific maximum bearing pressure is enveloped by the AP1000 soft rock site maximum bearing pressure of 24 ksf for soft rock sites.

Based on the SSI analysis, the maximum base shear on the RCC bridging mat for the BE, UB, LB and LLB soil cases is 77,600 kips. The maximum base shear corresponds to the BE soil profile. The maximum 77,600 kips base shear yields a base shear to vertical load ratio of 0.12 for the NI. This ratio is enveloped by the AP1000 maximum ratio of 0.55.

### 3.7.2.4.1.7 Sensitivity Evaluations for Regulatory Guide 1.60 Spectra FIRS

The Regulatory Guide 1.60 Foundation Input Response Spectra (FIRS) is anchored at peak ground accelerations for the scaled site-specific FIRS in Table 2.5.2-236 (0.1g horizontal and 0.0695g vertical). The scaled site-specific FIRS was developed using the updated EPRI SOG methodology and scaled to meet 10 CFR Part 50 Appendix S requirements. Tables 3.7-203 and 3.7-204 present the 5% damped site specific FIRS, the 5% damped Regulatory Guide 1.60 FIRS, and the ratio of the Regulatory Guide FIRS and the site specific FIRS at various frequencies for horizontal and vertical spectra respectively.

Sensitivity evaluations were performed to assess whether the FRS at the six key locations using the Regulatory Guide 1.60 FIRS instead of the scaled site-specific FIRS remains bounded by the Certified Seismic Design Response Spectra (CSDRS) FRS. The sensitivity evaluations were performed using conservative simplified methodology by scaling the entire site specific FRS by the ratio of the Regulatory Guide 1.60 FIRS and the scaled site specific FRS at the predominant response frequency at the node/direction. The predominant response frequency was determined from the peaks in the site specific FRS at each of the six nodes in the X, Y, and Z directions. The site specific FRS at the six nodes in the X, Y, and Z directions are shown in Figures 3.7-214, 3.7-215, 3.7-216, 3.7-217, 3.7-218, and 3.7-219. For this evaluation the lowest predominant response frequency is used because it will yield a larger scaling factor and is thus conservative. Table 3.7-205 presents the predominant response frequencies at the six key nodes in the X, Y, and Z directions, the ratio of the Regulatory Guide 1.60 FIRS and the scaled site specific FRS at the predominant response frequency (scaling factor), and the minimum margin for site specific FRS with respect to the CSDRS FRS when the whole site specific FRS is scaled by the scaling factor for the predominant response frequency for the node and direction. Because the scaling factors to develop the Regulatory Guide 1.60 FRS are always smaller than the available margin with respect to the CSDRS FRS, the Regulatory Guide 1.60 FRS will be bounded by the CSDRS FRS. In addition, because the Regulatory Guide 1.60 spectra has only a small frequency content above 20 Hz. and no frequency content above 33 Hz., the Regulatory Guide 1.60 FRS peaks in the high frequency range (>20 Hz.) will be lower than that obtained by the simple scaling used, thus providing additional margin with respect to the CSDRS FRS.

As stated in Subsections 2.5.4.5.4 and 2.5.4.10.1.1, the conceptual design of the RCC bridging mat is based on a bearing pressure of 8.9 kips per square foot [ksf] for static loading and 24.0 ksf for dynamic loading. The static bearing pressure is based on DCD Tier 1 Table 5.0.1. The dynamic bearing pressure is the maximum subgrade pressure at the AP1000 basemat that results from the generic AP1000 analysis for soft rock sites. For the subsurface rock bearing capacity calculations, the RCC self weight was included as an additional bearing pressure load of 5.16 ksf. The buoyancy effects due to the hydrostatic pressure acting at the bottom of the RCC were considered in this analysis. A base shear load of 136,000 kips based on the AP1000 generic analysis was applied at the top of the RCC bridging mat. Because the AP1000 generic analyses are based on the CSDRS (0.3g Regulatory Guide 1.60 spectra enhanced in the high frequency region), the RCC design is conservative for the Regulatory Guide 1.60 FIRS.

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#### 3.7.2.8.1 Annex Building

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Add the following text to the end of DCD **Subsection 3.7.2.8.1**.

In DCD [Subsection 3.7.2.8.1](#), the maximum displacement of the roof of the Annex Building is reported as 1.6 inches for response spectra input at the base of the building that envelops the SSI spectra for the six soil profiles and also the CSDRS. The Annex Building foundation (top of mat) is at design grade. [Figure 2.5.2-297](#) shows a comparison of the LNP scaled performance based surface response spectra (PBSRS) at the plant design grade and the CSDRS. The CSDRS envelops the LNP PBSRS by a wide margin. Thus, the LNP Annex Building roof displacement relative to its foundation is expected to be less than the 1.6 inches in the DCD for the CSDRS. The computed probable maximum relative displacement during SSE between the NI and the Annex Building foundation mat is less than 2.5 cm (1 in.) [for both the scaled Performance Based Surface Response Spectra \(PBSRS\) or the Regulatory Guide 1.60 spectra anchored at peak ground acceleration of 0.1g applied at the foundation elevation of the Annex Building as shown in Table 3.7-206](#). The probable maximum relative displacement calculation included the drilled shaft supported foundation mat displacements including the drilled shaft to drilled shaft interaction effects, additional displacement due to soil column displacement, and the NI displacement at design grade. The square root of the sum of squares (SRSS) method was used to compute the probable maximum relative displacement. Thus, the LNP Annex Building roof displacement during SSE is expected to be less than 2.6 inches. As stated in DCD [Subsection 3.7.2.8.1](#), the minimum clearance between the structural elements of the Annex Building above grade and the nuclear island (NI) is 4 inches. [Figure 3.7-226](#) shows the conceptual design detail for the interface between the Nuclear Island (NI) and the drilled shaft supported foundation mat of the Annex Building. This design detail provides a 5.0 cm (2 in.) gap between the Annex Building foundation and the NI consistent with DCD [Subsection 3.8.5.1](#). The top of the diaphragm wall and controlled low strength material fill between the diaphragm wall and the NI wall is at least 1.5 m (5 ft.) below the bottom of the Annex Building foundation mat as stated in [Subsection 2.5.4.5.1](#). Engineered fill is used from the top of the controlled low strength material fill to the bottom of the Annex Building foundation as stated in [Subsection 2.5.4.5.4](#). This interface is designed to avoid hard contact between the NI and the Annex Building foundation mat resulting from the relative displacement between the NI and the Annex Building foundation mat during the seismic event. Thus, no seismic interaction between the Annex Building and the NI is expected.

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#### 3.7.2.8.2 Radwaste Building

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Add the following text to the end of DCD [Subsection 3.7.2.8.2](#).

LNP SUP 3.7-5

The computed probable maximum relative displacement between the NI and the Radwaste Building foundation mat [is less than 2.5 cm \(1 in.\) for both the scaled PBSRS or the Regulatory Guide 1.60 spectra anchored at peak ground acceleration of 0.1g applied at the foundation elevation of the Radwaste Building as shown in Table 3.7-206](#). The probable maximum relative displacement calculation included the drilled shaft supported foundation mat displacements including the drilled shaft to drilled shaft interaction effects, additional

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displacement due to soil column displacement, and the NI displacement at design grade. The SRSS method was used to compute the probable maximum relative displacement. **Figure 3.7-226** shows the conceptual design detail for the interface between the Nuclear Island (NI) and the drilled shaft supported foundation mat of the Radwaste Building. This design detail provides a 5.0 cm. (2 in.) gap between the Radwaste Building foundation and the NI consistent with DCD **Subsection 3.8.5.1**. The top of the diaphragm wall and controlled low strength material fill between the diaphragm wall and the NI wall is at least 1.5 m (5 ft.) below the bottom of the Radwaste Building foundation mat as stated in **Subsection 2.5.4.5.1**. Engineered fill is used from the top of the controlled low strength material fill to the bottom of the Radwaste Building foundation as stated in **Subsection 2.5.4.5.4**. This interface is designed to avoid hard contact between the NI and the Radwaste Building foundation mat resulting from the relative displacements during the seismic event. Thus, no seismic interaction between the Radwaste Building foundation mat and the NI is expected.

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#### 3.7.2.8.3 Turbine Building

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Add the following text to the end of DCD **Subsection 3.7.2.8.3**.

LNP SUP 3.7-5

The computed probable maximum relative displacement between the NI and the Turbine Building foundation mat **is less than 2.5 cm (1 in.) for both the PBSRS or the Regulatory Guide 1.60 spectra anchored at peak ground acceleration of 0.1g applied at the foundation elevation of the Turbine Building as shown in Table 3.7-206.** The probable maximum relative displacement calculation included the drilled shaft supported foundation mat displacements including the drilled shaft to drilled shaft interaction effects, additional displacement due to soil column displacement, and the NI displacement at design grade. The SRSS method was used to compute the probable maximum relative displacement. **Figure 3.7-226** shows the conceptual design detail for the interface between the Nuclear Island (NI) and the drilled shaft supported foundation mat of the Turbine Building. This design detail provides the 5.0 cm. (2 in.) gap between the Turbine Building foundation and the NI consistent with DCD **Subsection 3.8.5.1**. The top of the diaphragm wall and controlled low strength material fill between the diaphragm wall and the NI wall is at least 1.5 m (5 ft.) below the bottom of the Turbine Building foundation mat as stated in **Subsection 2.5.4.5.1**. Engineered fill is used from the top of the controlled low strength material fill to the bottom of the Turbine Building foundation mat as stated in **Subsection 2.5.4.5.4**. This interface is designed to avoid hard contact between the NI and the Turbine Building foundation mat resulting from the relative displacements during the seismic event. Thus, no seismic interaction between the Turbine Building foundation mat and the NI is expected.

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#### 3.7.2.8.4 Median Centered Adjacent Building Relative Displacements for $10^{-5}$ UHRS

TABLE 3.7-203

Ratio of Horizontal RG 1.60 FIRS and Site Specific (SS) FIRS

Frequency (Hz)	Site Specific FIRS (g)	RG 1.60 FIRS (g)	RG 1.60 / SS FIRS Ratio
1.00	0.108	0.147	1.36
1.50	0.156	0.206	1.32
2.00	0.176	0.261	1.48
2.50	0.196	0.313	1.60
3.00	0.214	0.305	1.43
3.50	0.230	0.298	1.30
4.00	0.245	0.293	1.20
5.00	0.273	0.284	1.04
6.00	0.276	0.276	1.00
9.00	0.265	0.261	0.98
10.00	0.263	0.241	0.92
12.00	0.260	0.211	0.81
15.00	0.253	0.179	0.71
20.00	0.231	0.145	0.63
30.00	0.183	0.107	0.59
33.00	0.175	0.100	0.57
100.00	0.100	0.100	1.00

TABLE 3.7-204

Ratio of Vertical RG 1.60 FIRS and Site Specific (SS) FIRS

Frequency (Hz)	Site Specific FIRS (g)	RG 1.60 FIRS (g)	RG 1.60 / SS FIRS Ratio
1.00	0.068	0.071	1.05
2.00	0.104	0.129	1.24
3.00	0.122	0.182	1.49
3.50	0.130	0.207	1.59
4.00	0.139	0.203	1.46
5.00	0.154	0.197	1.28
6.00	0.157	0.192	1.22
7.00	0.157	0.188	1.20
9.00	0.157	0.181	1.15
10.00	0.159	0.168	1.06
15.00	0.170	0.124	0.73
18.00	0.174	0.109	0.63
20.00	0.175	0.101	0.58
33.00	0.144	0.070	0.49
100.00	0.070	0.070	1.00

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LNP SUP 3.7-6

LNP SUP 3.7-3

**Table 3.7-205**  
**Predominant Frequencies, Scale Factors for Regulatory Guide 1.60 FIRS, and CSDRS FRS Margin**

Node / Direction	Predominant Frequency (Hz.)	Ratio RG 1.60 and Scaled FIRS	Minimum CSDRS FRS Margin
1761-X	3.0	1.43	>1.43
1761-Y	5.5	1.02	>1.02
1761-Z	5.0	1.28	>1.28
2078-X	20.0	0.63	>1.00
2078-Y	12.0	0.81	>1.00
2078-Z	20.0	0.58	>1.00
2199-X	20.0	0.63	>1.00
2199-Y	5.5	1.02	>1.02
2199-Z	20.0	0.58	>1.00
2675-X	30.0	0.59	>1.00
2675-Y	3.0	1.43	>1.43
2675-Z	6.0	1.22	>1.22
2788-X	5.0	1.04	>1.04
2788-Y	5.5	1.02	>1.02
2788-Z	18.0	0.63	>1.00
3329_X	3.5	1.30	>1.30
3329-Y	3.0	1.43	>1.43
3329-Z	7.0	1.20	>1.20

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**Table 3.7-206**  
**Probable Maximum Relative Displacements between the Nuclear Island (NI) and Adjacent Buildings**

Adjacent Building	Probable Maximum Relative Displacement (in.)	
	Site Specific FIRS	RG 1.60 FIRS
Between NI and Annex Building	0.70	0.59
Between NI and Radwaste Building	0.77	0.64
Between NI and Turbine Building	0.40	0.35

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