Smooth UHRS are developed from the UHRS amplitudes in Table 2.5.2-32, using controlling earthquake **M** and R values shown in Table 2.5.2-34 and using the hard rock spectral shapes for CEUS earthquake ground motions recommended in NUREG/CR-6728. Separate spectral shapes are developed for high frequency (HF) and low frequency (LF). In order to reflect accurately the UHRS values calculated by the PSHA as shown in Table 2.5.2-32, the HF spectral shape is anchored to the UHRS values from Table 2.5.2-32. For the $10^{-4}$ AFE hazard level, the HF spectral shape, derived from NUREG/CR-6728, is scaled to the UHRS amplitudes at 5, 10, 25, and 100 Hz (PGA). The NUREG/CR-6728 spectral shape defines the HF spectrum between 0.5 and 5 Hz anchored (scaled) to the UHRS amplitude at 5 Hz. For the $10^{-5}$ and $10^{-6}$ HF response spectrum, the HF spectral shape scaled to 5 Hz exceeds the 2.5 Hz UHRS value, therefore, the HF spectral shape, derived from NUREG/CR-6728, is scaled to the UHRS amplitudes at 2.5, 5, 10, 25, and 100 Hz (PGA). The NUREG/CR-6728 spectral shape defines the HF spectrum between 0.5 and 2.5 Hz anchored (scaled) to the UHRS amplitude at 2.5 Hz.

For each AFE hazard level, the LF spectral shape, derived from the NUREG/CR-6728, is scaled to the UHRS amplitudes at 0.5, 1, and 2.5 Hz. The NUREG/CR-6728 spectral shape defines the LF spectrum above 2.5 Hz when anchored (scaled) to the UHRS amplitude at 2.5 Hz. To create these spectral shapes, the single-corner and double-corner models recommended in NUREG/CR-6728 are weighted equally for each AFE hazard level, and for both HF and LF. For frequencies below 0.5 Hz, the spectral shape is extrapolated from the value at 0.5 Hz assuming a constant spectral velocity (i.e., spectral accelerations are assumed to scale linearly with frequency) down to 0.167 Hz (6 sec period). From 0.167 Hz to 0.1 Hz, spectral accelerations are assumed to scale as the square of the frequency. This follows the recommendation of FEMA 450 (Reference 2.5.2-21) for long periods. Some smoothing of the $10^{-4}$ and $10^{-5}$ AFE LF spectrum is applied between 0.6 Hz and 2 Hz to avoid bumps in this frequency range that are apparent if no smoothing is applied.

Figures 2.5.2-31 through 2.5.2-33 present the horizontal HF and LF spectra calculated in this way for $10^{-4}$, $10^{-5}$, and $10^{-6}$ annual frequencies of exceedance, respectively. As mentioned previously, these spectra accurately reflect the rock UHRS amplitudes in Table 2.5.2-32 that are calculated for the seven spectral frequencies. For each AFE hazard level, the envelope spectrum (smooth mean rock UHRS) is also calculated. Figure 2.5.2-76 shows the smooth mean rock $10^{-4}$, $10^{-5}$, and $10^{-6}$ AFE UHRS for the PSEG Site.

### 2.5.2.5 Seismic Wave Transmission Characteristics of the Site

The subsurface conditions necessary to predict and model the seismic wave transmission characteristics for the PSEG Site are determined from both site-specific and regional data. This data included both stratigraphic and representative shear-wave measurements, degradation properties of the soils, and the uncertainties associated with these parameters. A detailed presentation of these parameters, as well as a discussion of the data and methodology for developing them, are provided in Subsections 2.5.4.2 through 2.5.4.7.

The profile is divided into the shallow profile (surface to about 400 ft.) and the deep profile (about 400 ft. to “basement”). The shallow profile represents depth to which extensive characterization has been performed. The lateral and vertical control on the subsurface strata (layering) is defined primarily on lithology and material properties. The GMRS is developed for the top of the Competent Layer (Layer 1) (Figure 2.5.4.7-8a), following the guidance of RG

1.208, which has a mean elevation of -67 feet. Soils above this elevation are considered only for the purposes of calculating confining stresses.

2.5.2.5.1 Aleatory and Epistemic Uncertainty

The uncertainties in most of the site-characterization parameters are developed in Subsection 2.5.4.7 and are summarized here. Other necessary parameters not described in Subsection 2.5.4.7 are developed in this subsection.

Uncertainty in shear-wave velocities is specified by means of its Coefficient of Variation (COV). This COV takes a value of 0.25 for the top 160 ft. of the shallow profile, 0.30 for the deeper portion of the shallow profile, and 0.35 for the deep profile.

Uncertainty in the stratigraphy is also described in Subsections 2.5.4.1, 2.5.4.7.2, and 2.5.4.7.4, including uncertainty in the depth to basement rock. These uncertainties are specified as standard deviations or ranges for the elevation of the top of each layer.

Uncertainties in the degradation properties for soils in the shallow profile are discussed in Subsection 2.5.4.7.5. These values are roughly comparable to those recommended by Costantino (Reference 2.5.2-28) and by EPRI (Reference 2.5.2-38). For the deep profile and bedrock, which have strain-independent properties, the uncertainty in damping is characterized by a COV of 0.35 based on the recommendations in EPRI (Reference 2.5.2-38).

2.5.2.5.2 Description of Site Response Analysis

The site response analysis is conducted in three steps that are common to analyses of this type. First, the site geology and geotechnical properties in Subsections 2.5.4.1, 2.5.4.2, and 2.5.4.7, and the assessments of uncertainty described in Subsection 2.5.2.5.1 are reviewed and used to generate multiple synthetic profiles of site characteristics. Second, sets of rock spectra are selected to represent rock ground motions corresponding to mean annual exceedance frequencies of $10^{-4}$, $10^{-5}$, and $10^{-6}$. Finally, site response is calculated using an equivalent-linear technique, using the multiple synthetic profile and the sets of rock spectra representing input motions. These three steps are described in detail in the following subsections.

2.5.2.5.2.1 Generation of Synthetic Profiles

To account for the epistemic and aleatory uncertainties in the site's dynamic properties, 60 synthetic profiles are generated using the stochastic model developed by Toro (Reference 2.5.2-84), with some modifications to account for the conditions at the PSEG Site. These synthetic profiles represent the site column from the top of the bedrock to the top of the Competent Layer, where the GMRS is defined. Bedrock is defined as having a shear-wave velocity of 9,200 ft/sec, in order to achieve consistency with the EPRI attenuation equations used for the rock hazard calculations (Reference 2.5.2-39). This stochastic model uses as inputs the following quantities, provided from Subsections 2.5.2.5.1 or 2.5.4.2, 2.5.4.4, and 2.5.4.7: (1) the median shear-wave velocity profile, provided in Table 2.5.2-17; (2) the standard deviation of ln(Vs) (the natural logarithm of the shear-wave velocity) as a function of depth below the top of the Competent Layer, provided in Table 2.5.2-17 and is taken as identical to the COV values given in Subsection 2.5.2.5.1; (3) the correlation coefficient between ln(Vs) in adjacent layers, from generic results in Toro (Reference 2.5.2-84); and (4) the uncertainties in the depths to the top of the various layers, provided in Table 2.5.2-18 (note that the standard deviations for the shallow profile take into account that the elevation of the top of Competent Layer is itself uncertain).

The correlation coefficient between ln(Vs) in adjacent layers is estimated using the inter-layer correlation model from Toro (Reference 2.5.2-84) for USGS category A+B, which corresponds to Vs30 values of 360 m/s (~1,180 ft./s) or greater. This correlation model predicts fairly high correlation coefficients, except for the very top of the profile. For instance, the correlation coefficient is approximately 75 percent at a depth of 50 ft. and higher values at greater depths.

Figures 2.5.2-34 and 2.5.2-35 present the Vs values of the 60 synthetic profiles for the entire profile and shallow profile, respectively. Figures 2.5.2-36 and 2.5.2-37 compare the logarithmic means of these 60 Vs profiles to the Vs ± Variability values provided in Table 2.5.2-17, indicating excellent agreement. The difference near the bottom of the profile occurs because the values in Table 2.5.2-17 do not take into account the depth to bedrock and its uncertainty.

For the randomization of the degradation properties, the standard deviations given in Subsection 2.5.4.7.5 are read at a strain of 3.16E-2, converted to logarithmic standard deviations and used as input to the randomization calculations. To account for a possible range in the Overconsolidation Ratio (OCR) of Layers 1 through 9B in Table 2.5.2-17 (varying from 2 to 6), idealized G/Gmax and damping curves are developed whose median and standard deviations bound the respective curves for the range of OCRs as shown in Figures 2.5.2-77 through 2.5.2-80. The randomization software extends these uncertainty values to other strains, tapering them near the ends to achieve physically reasonable curves for the synthetic G/Gmax and damping curves. The correlation coefficient between ln(G/Gmax) and ln(damping) in the fill is specified as -0.75. This implies that in synthetic profiles where the fill has higher than average G/Gmax, the fill tends to have lower than average damping. The degradation and damping properties are treated as fully correlated among layers with the same soil type, but independent between different soil types. In this analysis, damping values are truncated at 15 percent as is standard practice.

Figures 2.5.2-77 through 2.5.2-80 illustrate the modulus-degradation and damping curves for layers 1, 2-5, 6-8, and 9A/9B, respectively used in the 60 synthetic profiles..

Each set of 60 synthetic profiles, consisting of Vs and unit weight vs. depth, depth to bedrock, stiffness, and damping curves, is used to calculate and quantify site response and its uncertainty, as described below.

2.5.2.5.2.2 Selection of Rock Input Motions

Rock input motions are selected for input to the site response calculations using the seismic hazard and deaggregation results. Six separate input motions are considered, corresponding to HF and LF motions at $10^{-4}$, $10^{-5}$, and $10^{-6}$. The development of spectra for these motions is presented in Subsection 2.5.2.4.4 and illustrated in Figures 2.5.2-59 through 2.5.2-61.

2.5.2.5.2.2.1 Site Response Calculations

The site response calculations for the PSEG Site are performed using the Random Vibration Theory (RVT) approach. In many respects, the inputs and assumptions are the same for an

RVT analysis and for a time-history based analysis (e.g., an analysis with the program SHAKE (Reference 2.5.2-47)). Both the RVT and SHAKE procedures use a horizontally layered half-space representation of the site and use an equivalent-linear representation of dynamic response to vertically propagating shear waves. Starting from the same inputs (in the form of response spectra), both procedures result in similar estimates of site response (Reference 2.5.2-73). The main advantage of the RVT approach is that it does not require the spectral matching of multiple time histories to a given rock response spectrum. Instead, the RVT approach uses a probabilistic representation of the ensemble of all input motions corresponding to that given response spectrum and then calculates the response spectrum of the ensemble of dynamic responses.

Site-response calculations are performed for the six bedrock motions as described in the previous subsection.

In addition to the rock response spectra, the RVT site-response calculations require the following inputs: (1) the strong-motion duration (T) associated with each rock spectrum; and (2) the equivalent-strain ratio to use in the equivalent-linear calculations (this input is required for both the time-history and RVT approaches and depends on magnitude). The duration is calculated from the deaggregation results in Subsection 2.5.2.4.4 (Table 2.5.2-34), using standard seismological relations between magnitude, seismic moment, corner frequency (fc), and duration (Reference 2.5.2-73), and stress-drop and crustal Vs values typical of the eastern United States. The effective strain ratio is calculated using the expression (**M**-1)/10 (Reference 2.5.2-47), where **M** is moment magnitude. Values smaller than 0.5 or greater than 0.65 are brought into the 0.5-0.65 range, which is the range recommended by Kramer (Reference 2.5.2-54). The calculated values of duration and effective strain ratio are given in Table 2.5.2-19.

For each rock-motion input, separate site response calculations are performed for the corresponding 60 synthetic profiles, and these results are used to calculate the logarithmic mean and standard deviation of the amplification factor. Figures 2.5.2-40 and 2.5.2-41 present the amplification factors computed for the 60 synthetic profiles, for the $10^{-4}$ HF and LF motions, and the resulting logarithmic mean and standard deviation. Figures 2.5.2-42 and 2.5.2-43 present the logarithmic mean and standard deviation of the amplification factor for all three exceedance frequencies considered. Tables 2.5.2-20 and 2.5.2-21 present these results in Tabular form.

Figures 2.5.2-44 and 2.5.2-45 provide the peak strains as a function of depth for the 60 synthetic profiles, for the $10^{-4}$ HF and LF rock motions. Results are shown only for the shallow portion of the profile because the properties of the deep profile are independent of strain.

### 2.5.2.6 Ground Motion and Site Response Analysis

#### 2.5.2.6.1 Ground Motion Response Spectrum (GMRS)

With the site-specific amplification described in Subsection 2.5.2.5, the seismic hazard model described in Subsection 2.5.2.4 is reanalyzed incorporating the site amplifications into the hazard calculations. For ground motions below the $10^{-4}$ amplitudes, site amplification is assumed to be the same as for the $10^{-4}$ amplitudes (Tables 2.5.2-20 and 2.5.2-21). For ground motions greater than the $10^{-6}$ amplitudes, site amplification is assumed to be the same as for the $10^{-6}$ amplitudes (Tables 2.5.2-20 and 2.5.2-21). The logarithmic standard deviations in Tables

2.5.2-20 and 2.5.2-21 are used to represent uncertainties in site response. A minimum moment magnitude (**M**) of 5.0 is used in the calculations (no CAV filter was applied), using Vs30m for surface conditions for the PSEG Site - 730 m/s (2395 ft/sec) and using amplitudes at the surface after site effects have been taken into account.

The amplification factors for the HF input spectra are used for hazard calculations at 5, 10, 25 and 100 Hz (peak ground acceleration; PGA), and the amplification factors for the LF input spectra are used for hazard calculations at 0.5, 1, and 2.5 Hz. Figures 2.5.2-59 through 2.5.2-61 illustrate that the HF rock spectra dominate the high frequencies and the LF rock spectra dominate the low frequencies.

Figures 2.5.2-46 through 2.5.2-52 present seismic hazard curves for the seven spectral frequencies at which ground motion equations are available for the GMRS elevation. These figures cover a frequency range from PGA (100 hz) in Figure 2.5.2-46 to 0.5 hz (Figure 2.5.2-52). Seismic hazard data for the GMRS elevation are provided in Table 2.5.2-22. Table 2.5.2-23 provides mean and median amplitudes for annual frequencies of $10^{-4}$, $10^{-5}$, and $10^{-6}$. The mean and median soil UHRS for $10^{-4}$, $10^{-5}$, and $10^{-6}$ are presented in Figure 2.5.2-53.

2.5.2.6.1.1 Horizontal GMRS Spectrum

The horizontal Ground Motion Response Spectra (GMRS) is developed from the horizontal soil UHRS using the approach described in ASCE/SEI Standard 43-05 (Reference 2.5.2-4) and RG 1.208**.**

The ASCE/SEI Standard 43-05 (Reference 2.5.2-4) approach defines the GMRS using the site-specific UHRS, which is defined for Seismic Design Category SDC-5 at a mean $10^{-4}$ annual frequency of exceedance. The procedure for computing the GMRS is as follows:

For each spectral frequency at which the UHRS is defined, a slope factor $A_R$ is determined from:

$$A_R = SA(10^{-5})/SA(10^{-4}) \quad \text{(Equation 2.5.2-2)}$$

where $SA(10^{-4})$ is the spectral acceleration SA at a mean UHRS exceedance frequency of $10^{-4}$/yr (and similarly for $SA(10^{-5})$). A Design Factor "DF" is defined based on $A_R$, which reflects the slope of the mean hazard curve between $10^{-4}$ and $10^{-5}$ mean annual frequencies of exceedance. The DF at each spectral frequency is given by:

$$DF = 0.6(A_R)^{0.80} \quad \text{(Equation 2.5.2-3)}$$

and

$$GMRS = \max[SA(10^{-4}) \times \max(1, DF), 0.45 \times SA(10^{-5})] \quad \text{(Equation 2.5.2-4)}$$

The derivation of DF is described in detail in Reference 2.5.2-4 and in RG 1.208. Table 2.5.2-24 tabulates the horizontal GMRS. The horizontal GMRS is plotted in Figure 2.5.2-54.

2.5.2.6.1.2 Vertical GMRS Spectrum

The vertical GMRS is developed using vertical-to-horizontal (V/H) ratios. NRC RG 1.60 and NUREG/CR-6728 provide proposed V/H ratios for design spectra for nuclear facilities, and these V/H ratios are plotted in Figure 2.5.2-55. The V/H ratios in the portion of Figure 2.5.2-55 labeled "NUREG/CR-6728 CEUS rock" are from Table 4-5 in NUREG/CR-6728. The values are those recommended for rock sites in the CEUS when the horizontal PGA ranges from 0.2g to 0.5g, which is the case for the horizontal GMRS at the PSEG Site. These V/H ratios are shown for background information only. For soil conditions, two ground motion prediction equations are used based on empirical data from the Western United States (WUS), Campbell and Bozorgnia (Reference 2.5.2-112) and Gülerce and Abrahamson (Reference 2.5.2-113) because these studies enable prediction of V/H ratios as a function of **M** and R. Two earthquakes are used for this calculation, corresponding to the **M** and R values presented in Table 2.5.2-34 for HF $10^{-4}$ and $10^{-5}$ spectra: **M**=5.9 and R=27 km (16.7 mi.), and **M**=6.0 and R=12 km (7.5 mi.). The GMRS is between the $10^{-4}$ and $10^{-5}$ UHRS as shown in Figure 2.5.2-81 but these **M** and R values are indicative of the magnitudes and distances that cause the GMRS ground motion.

Two sets of V/H ratios are presented on Figure 2.5.2-55 for each of the two WUS ground motion prediction equations. The first set is labeled "unshifted" and is taken directly from each respective ground motion prediction equation for the corresponding HF controlling earthquake. The second set of V/H ratios, labeled "shifted" recognizes that CEUS earthquake ground motions tend to have more high-frequency content than their WUS counterparts. To approximate what might be a V/H ratio for soil conditions in the CEUS, the WUS soil V/H ratios are shifted by scaling the frequency by a factor of 3, which shifts the peak V/H ratio to higher frequencies. The locations of the peak for the "shifted" V/H ratios are consistent with the peak in the "NUREG/CR-6728 CEUS rock" V/H ratio.

Based on these comparisons, the recommended V/H ratios for the PSEG Site are 1.15 at spectral frequencies between 40 Hz and 100 Hz, 0.75 for frequencies from 0.1 Hz to 5 Hz. Between the frequencies of 5 and 40 Hz the V/H ratio is assumed to vary linearly from 0.75 at 5 Hz up to 1.15 at 40 Hz. The recommended V/H ratios are depicted on Figure 2.5.2-55 as a solid black line. These recommended V/H ratios bound the V/H ratios described above, except the RG 1.60 ratio, which is considered obsolete because it is based on a small number of ground motions recorded prior to 1973.

Vertical spectra are scaled from the horizontal spectra using the V/H ratios. The vertical GMRS is calculated by multiplying the horizontal GMRS at each frequency by the V/H ratio depicted by the solid black line in Figure 2.5.2-55. Figure 2.5.2-54 illustrates the horizontal GMRS and the vertical GMRS calculated using this method. The V/H ratios and vertical GMRS values are provided in Table 2.5.2-24.

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**Table 2.5.2-17**
**Base-Case Soil Profile**
**Mean Shear Wave Velocity**

| Formation | Soil Curve Number | Soil Curve Description | Thickness (ft.) | Vs (ft/sec) | Unit Weight (pcf)[a] | Sigma (In Vs) | Depth to Top of layer – best estimate (ft.)[c] |
|---|---|---|---|---|---|---|---|
| Layer 1 (Tvt, Tht and Knv) - Competent Layer for GMRS[b] | 1 | Layer 1 | 84.5 | 2250 | 121 | 0.25 | 0 |
| Layer 2 (Kml) | 2 | Layers 2-5 | 18.5 | 3920 | 131 | 0.25 | 84.5 |
| Layer 3 (Kml) | 2 | Layers 2-5 | 21.5 | 2490 | 131 | 0.25 | 103 |
| Layer 4 (Kml) | 2 | Layers 2-5 | 34.5 | 3020 | 131 | 0.25 | 124.5 |
| Layer 5 (Kml, Kwn, Kmt) | 2 | Layers 2-5 | 62.0 | 2490 | 128 | 0.25 | 159 |
| Layer 6 (Ket, Kwb) | 3 | Layers 6-8 | 84.0 | 1710 | 125 | 0.30 | 221 |
| Layer 7 ( Kmv) | 3 | Layers 6-8 | 26.0 | 2290 | 130 | 0.30 | 305 |
| Layer 8 (Kmg) | 3 | Layers 6-8 | 25.0 | 1780 | 130 | 0.30 | 331 |
| Layer 9A (Kmg) | 4 | Layers 9a-9b | 31.0 | 2490 | 130 | 0.30 | 356 |
| Layer 9B (Kp) | 4 | Layers 9a-9b | 51.0 | 2490 | 130 | 0.30 | 387 |
| Upper Potomac | 5 | Deep Profile | 365.0 | 2200 | 135 | 0.35 | 438 |
| Middle Potomac | 5 | Deep Profile | 430.0 | 2630 | 135 | 0.35 | 803 |
| Lower Potomac | 5 | Deep Profile | 450.0 | 3060 | 135 | 0.35 | 1233 |

a) pcf = pounds per cubic foot
b) Layer definitions are shown on Figure 2.5.4.7-8a
c) Depths are referenced to top of Competent Layer

**Table 2.5.2-18**
**Parameters for Layer-Depth Randomization**

| Formation (top of) | Distribution Type | Depth 1 (ft.)[a] | Depth 2 (ft.)[a] |
|---|---|---|---|
| Layer 2 (Kml) | Normal | 84.5 | 4.27 |
| Layer 3 (Kml) | Normal | 103 | 4.27 |
| Layer 4 (Kml) | Normal | 124.5 | 4.27 |
| Layer 5 (Kml, Kwn, Kmt) | Normal | 159 | 4.27 |
| Layer 6 (Ket, Kwb) | Normal | 221 | 4.27 |
| Layer 7 ( Kmv) | Normal | 305 | 6.40 |
| Layer 8 (Kmg) | Normal | 331 | 6.40 |
| Layer 9A (Kmg) | Normal | 356 | 6.40 |
| Layer 9B (Kp) | Normal | 387 | 20.40 |
| Upper Potomac | Uniform | 433 | 443 |
| Middle Potomac | Uniform | 603 | 1003 |
| Lower Potomac | Uniform | 1033 | 1433 |
| Bedrock | Uniform | 1483 | 1883 |

a) For normal distributions, Depth1 is the mean depth below competent layer and Depth2 is the standard deviation of depth; for uniform distributions, Depth1 is the minimum depth to the top of the layer below top of competent layer and Depth2 is the maximum depth to the top of the layer below top of competent layer.

## Table 2.5.2-19

## Calculation of Durations and Effective Strain Ratios for Input Rock Motions

| Event | M | Distance (R) km (mi) | Mo (dyn-cm)[a] | fc (Hz) | T (seconds) | Effective Strain Ratio |
|---|---|---|---|---|---|---|
| 1E-4 HF | 5.9 | 27 (16.7) | 7.94E+24 | 0.42 | 3.71 | 0.5 |
| 1E-4 LF | 7.3 | 540 (335.5) | 1.00E+27 | 0.08 | 38.82 | 0.63 |
| 1E-5 HF | 6.0 | 12 (7.5) | 1.21E+25 | 0.38 | 3.25 | 0.5 |
| 1E-5 LF | 7.6 | 570 (354) | 2.82E+27 | 0.06 | 45.20 | 0.65 |
| 1E-6 HF | 6.3 | 9 (5.6) | 3.16E+25 | 0.27 | 4.19 | 0.53 |
| 1E-6 LF | 7.7 | 420 (261) | 3.98E+27 | 0.05 | 39.74 | 0.65 |

a) Mo = seismic moment; dyn-cm = Dyne-centimeters

**Table 2.5.2-20**

**Amplification Factors for High Frequency (HF) Motions**

| Frequency (Hz) | Logarithmic Mean Amplification Factors | | | Logarithmic Standard Deviations | | |
|---|---|---|---|---|---|---|
| | 1E-4 | 1E-5 | 1E-6 | 1E-4 | 1E-5 | 1E-6 |
| 100 | 1.07 | 0.77 | 0.48 | 0.21 | 0.23 | 0.30 |
| 90 | 0.97 | 0.70 | 0.43 | 0.21 | 0.23 | 0.30 |
| 80 | 0.85 | 0.60 | 0.37 | 0.22 | 0.24 | 0.30 |
| 70 | 0.72 | 0.51 | 0.30 | 0.23 | 0.24 | 0.31 |
| 60 | 0.62 | 0.42 | 0.25 | 0.25 | 0.26 | 0.31 |
| 50 | 0.57 | 0.38 | 0.21 | 0.28 | 0.28 | 0.32 |
| 45 | 0.57 | 0.37 | 0.20 | 0.29 | 0.30 | 0.33 |
| 40 | 0.59 | 0.37 | 0.19 | 0.30 | 0.32 | 0.34 |
| 35 | 0.63 | 0.38 | 0.19 | 0.31 | 0.34 | 0.36 |
| 30 | 0.67 | 0.41 | 0.19 | 0.31 | 0.36 | 0.39 |
| 25 | 0.76 | 0.46 | 0.21 | 0.30 | 0.36 | 0.43 |
| 20 | 0.89 | 0.57 | 0.25 | 0.30 | 0.36 | 0.46 |
| 15 | 1.06 | 0.73 | 0.33 | 0.27 | 0.33 | 0.48 |
| 12.5 | 1.14 | 0.84 | 0.42 | 0.23 | 0.29 | 0.47 |
| 10 | 1.27 | 0.97 | 0.52 | 0.22 | 0.27 | 0.43 |
| 9 | 1.38 | 1.07 | 0.59 | 0.22 | 0.27 | 0.43 |
| 8 | 1.51 | 1.19 | 0.69 | 0.21 | 0.26 | 0.43 |
| 7 | 1.63 | 1.31 | 0.80 | 0.22 | 0.26 | 0.40 |
| 6 | 1.74 | 1.43 | 0.92 | 0.19 | 0.22 | 0.37 |
| 5 | 1.80 | 1.53 | 1.03 | 0.28 | 0.25 | 0.32 |
| 4 | 1.64 | 1.50 | 1.10 | 0.32 | 0.31 | 0.33 |
| 3 | 1.42 | 1.37 | 1.17 | 0.22 | 0.25 | 0.34 |
| 2.5 | 1.47 | 1.39 | 1.22 | 0.26 | 0.27 | 0.35 |
| 2 | 1.69 | 1.57 | 1.35 | 0.23 | 0.26 | 0.33 |
| 1.5 | 1.93 | 1.83 | 1.57 | 0.23 | 0.25 | 0.31 |
| 1.25 | 2.05 | 1.96 | 1.70 | 0.24 | 0.25 | 0.34 |
| 1 | 2.18 | 2.17 | 1.98 | 0.26 | 0.23 | 0.24 |
| 0.9 | 2.06 | 2.10 | 2.03 | 0.26 | 0.25 | 0.23 |
| 0.8 | 1.97 | 2.02 | 2.02 | 0.23 | 0.23 | 0.23 |
| 0.7 | 2.00 | 2.05 | 2.08 | 0.24 | 0.23 | 0.21 |
| 0.6 | 2.16 | 2.22 | 2.29 | 0.23 | 0.23 | 0.21 |
| 0.5 | 2.44 | 2.49 | 2.57 | 0.23 | 0.23 | 0.22 |
| 0.4 | 2.75 | 2.82 | 2.89 | 0.30 | 0.30 | 0.30 |
| 0.3 | 2.34 | 2.41 | 2.48 | 0.38 | 0.39 | 0.39 |
| 0.2 | 1.60 | 1.64 | 1.69 | 0.32 | 0.33 | 0.35 |
| 0.15 | 1.36 | 1.39 | 1.41 | 0.18 | 0.19 | 0.21 |
| 0.125 | 1.31 | 1.33 | 1.34 | 0.14 | 0.15 | 0.16 |
| 0.1 | 1.29 | 1.31 | 1.30 | 0.11 | 0.12 | 0.13 |

**Table 2.5.2-21**

**Amplification Factors for Low Frequency (LF) Motions**

| Frequency (Hz) | Logarithmic Mean Amplification Factors | | | Logarithmic Standard Deviations | | |
|---|---|---|---|---|---|---|
| | 1E-4 | 1E-5 | 1E-6 | 1E-4 | 1E-5 | 1E-6 |
| 100 | 1.13 | 0.93 | 0.63 | 0.18 | 0.21 | 0.28 |
| 90 | 1.05 | 0.86 | 0.58 | 0.18 | 0.21 | 0.28 |
| 80 | 0.93 | 0.76 | 0.51 | 0.19 | 0.21 | 0.28 |
| 70 | 0.80 | 0.64 | 0.43 | 0.20 | 0.21 | 0.28 |
| 60 | 0.69 | 0.54 | 0.36 | 0.21 | 0.22 | 0.28 |
| 50 | 0.64 | 0.48 | 0.31 | 0.23 | 0.23 | 0.29 |
| 45 | 0.63 | 0.47 | 0.30 | 0.25 | 0.25 | 0.29 |
| 40 | 0.64 | 0.46 | 0.29 | 0.26 | 0.26 | 0.30 |
| 35 | 0.67 | 0.47 | 0.29 | 0.27 | 0.27 | 0.30 |
| 30 | 0.71 | 0.49 | 0.29 | 0.28 | 0.29 | 0.32 |
| 25 | 0.77 | 0.53 | 0.30 | 0.28 | 0.31 | 0.34 |
| 20 | 0.89 | 0.60 | 0.33 | 0.28 | 0.33 | 0.37 |
| 15 | 1.04 | 0.72 | 0.37 | 0.27 | 0.33 | 0.42 |
| 12.5 | 1.12 | 0.82 | 0.43 | 0.24 | 0.32 | 0.44 |
| 10 | 1.26 | 0.94 | 0.51 | 0.23 | 0.30 | 0.45 |
| 9 | 1.36 | 1.03 | 0.56 | 0.22 | 0.30 | 0.46 |
| 8 | 1.47 | 1.14 | 0.63 | 0.22 | 0.29 | 0.47 |
| 7 | 1.59 | 1.25 | 0.73 | 0.22 | 0.28 | 0.45 |
| 6 | 1.69 | 1.36 | 0.83 | 0.20 | 0.25 | 0.43 |
| 5 | 1.74 | 1.43 | 0.91 | 0.28 | 0.27 | 0.39 |
| 4 | 1.62 | 1.43 | 0.99 | 0.32 | 0.31 | 0.38 |
| 3 | 1.42 | 1.34 | 1.07 | 0.21 | 0.26 | 0.36 |
| 2.5 | 1.47 | 1.38 | 1.16 | 0.25 | 0.28 | 0.38 |
| 2 | 1.66 | 1.51 | 1.26 | 0.22 | 0.26 | 0.37 |
| 1.5 | 1.93 | 1.79 | 1.48 | 0.22 | 0.26 | 0.35 |
| 1.25 | 2.03 | 1.91 | 1.60 | 0.23 | 0.25 | 0.39 |
| 1 | 2.10 | 2.02 | 1.77 | 0.23 | 0.18 | 0.26 |
| 0.9 | 2.06 | 2.08 | 1.94 | 0.24 | 0.22 | 0.25 |
| 0.8 | 2.00 | 2.04 | 2.00 | 0.22 | 0.21 | 0.26 |
| 0.7 | 2.03 | 2.07 | 2.07 | 0.23 | 0.21 | 0.24 |
| 0.6 | 2.20 | 2.26 | 2.28 | 0.24 | 0.23 | 0.23 |
| 0.5 | 2.51 | 2.54 | 2.63 | 0.27 | 0.26 | 0.24 |
| 0.4 | 2.73 | 2.77 | 2.85 | 0.30 | 0.30 | 0.29 |
| 0.3 | 2.30 | 2.33 | 2.42 | 0.37 | 0.38 | 0.37 |
| 0.2 | 1.55 | 1.57 | 1.62 | 0.31 | 0.31 | 0.34 |
| 0.15 | 1.30 | 1.31 | 1.34 | 0.17 | 0.18 | 0.19 |
| 0.125 | 1.23 | 1.23 | 1.25 | 0.13 | 0.13 | 0.14 |
| 0.1 | 1.17 | 1.18 | 1.19 | 0.09 | 0.09 | 0.10 |

## Table 2.5.2-22 (Sheet 1 of 7)

## Mean and Fractile Soil Seismic Hazard Curves at GMRS Elevation

| **100 Hz (PGA) Hazard Curves** | | | | | | |
|---|---|---|---|---|---|---|
| **Amplitude [(a)]** | **MEAN** | **0.05[(b)]** | **0.16** | **0.5[(c)]** | **0.84** | **0.95** |
| 0.0005 | 6.08E-02 | 2.10E-02 | 2.83E-02 | 4.76E-02 | 1.04E-01 | 1.41E-01 |
| 0.0007 | 4.73E-02 | 1.70E-02 | 2.14E-02 | 3.41E-02 | 8.22E-02 | 1.16E-01 |
| 0.001 | 3.56E-02 | 1.29E-02 | 1.62E-02 | 2.44E-02 | 6.12E-02 | 8.97E-02 |
| 0.0015 | 2.54E-02 | 9.12E-03 | 1.13E-02 | 1.71E-02 | 4.45E-02 | 6.52E-02 |
| 0.002 | 1.98E-02 | 6.92E-03 | 8.56E-03 | 1.28E-02 | 3.43E-02 | 5.09E-02 |
| 0.003 | 1.36E-02 | 4.90E-03 | 6.04E-03 | 8.85E-03 | 2.29E-02 | 3.59E-02 |
| 0.005 | 8.29E-03 | 2.82E-03 | 3.72E-03 | 5.33E-03 | 1.37E-02 | 2.16E-02 |
| 0.007 | 5.86E-03 | 1.86E-03 | 2.63E-03 | 4.00E-03 | 8.85E-03 | 1.49E-02 |
| 0.01 | 3.98E-03 | 1.23E-03 | 1.74E-03 | 2.82E-03 | 5.97E-03 | 1.00E-02 |
| 0.015 | 2.50E-03 | 7.08E-04 | 1.07E-03 | 1.86E-03 | 3.80E-03 | 5.78E-03 |
| 0.02 | 1.76E-03 | 4.68E-04 | 7.08E-04 | 1.32E-03 | 2.65E-03 | 4.04E-03 |
| 0.03 | 1.04E-03 | 2.69E-04 | 4.07E-04 | 7.59E-04 | 1.52E-03 | 2.33E-03 |
| 0.05 | 5.06E-04 | 1.35E-04 | 1.91E-04 | 3.80E-04 | 7.59E-04 | 1.23E-03 |
| 0.07 | 3.09E-04 | 7.76E-05 | 1.10E-04 | 2.34E-04 | 4.68E-04 | 7.59E-04 |
| 0.1 | 1.82E-04 | 4.17E-05 | 6.31E-05 | 1.35E-04 | 2.88E-04 | 4.68E-04 |
| 0.15 | 9.89E-05 | 2.16E-05 | 3.16E-05 | 7.76E-05 | 1.66E-04 | 2.51E-04 |
| 0.2 | 6.35E-05 | 1.29E-05 | 1.95E-05 | 5.13E-05 | 1.02E-04 | 1.55E-04 |
| 0.3 | 3.33E-05 | 6.46E-06 | 1.08E-05 | 2.75E-05 | 5.89E-05 | 8.32E-05 |
| 0.5 | 1.38E-05 | 2.14E-06 | 3.98E-06 | 1.05E-05 | 2.57E-05 | 3.89E-05 |
| 0.7 | 7.23E-06 | 9.33E-07 | 1.86E-06 | 5.25E-06 | 1.38E-05 | 2.24E-05 |
| 1 | 3.41E-06 | 3.20E-07 | 7.08E-07 | 2.29E-06 | 6.46E-06 | 1.05E-05 |
| 1.5 | 1.29E-06 | 7.24E-08 | 2.04E-07 | 7.08E-07 | 2.29E-06 | 4.27E-06 |
| 2 | 5.93E-07 | 2.09E-08 | 6.53E-08 | 3.09E-07 | 1.00E-06 | 2.29E-06 |
| 3 | 1.71E-07 | 2.37E-09 | 1.05E-08 | 7.24E-08 | 2.88E-07 | 7.33E-07 |
| 5 | 2.69E-08 | 3.59E-15 | 4.68E-10 | 8.51E-09 | 4.79E-08 | 1.30E-07 |
| 7 | 6.55E-09 | 5.19E-29 | 4.73E-15 | 1.68E-09 | 1.12E-08 | 3.27E-08 |
| 10 | 1.24E-09 | 4.20E-29 | 6.31E-17 | 2.34E-10 | 2.00E-09 | 6.03E-09 |

a) Spectral acceleration in g
b) Percentile
c) 0.5 fractile = median

## Table 2.5.2-22 (Sheet 2 of 7)

## Mean and Fractile Soil Seismic Hazard Curves at GMRS Elevation

| 25 Hz Hazard Curves | | | | | | |
|---|---|---|---|---|---|---|
| Amplitude [(a)] | MEAN | 0.05[(b)] | 0.16 | 0.5 [(c)] | 0.84 | 0.95 |
| 0.0005 | 7.69E-02 | 1.82E-02 | 3.02E-02 | 7.55E-02 | 1.11E-01 | 1.71E-01 |
| 0.0007 | 6.18E-02 | 1.48E-02 | 2.44E-02 | 5.75E-02 | 9.10E-02 | 1.32E-01 |
| 0.001 | 4.84E-02 | 1.29E-02 | 1.84E-02 | 4.38E-02 | 7.00E-02 | 1.02E-01 |
| 0.0015 | 3.62E-02 | 1.05E-02 | 1.49E-02 | 2.91E-02 | 5.38E-02 | 7.49E-02 |
| 0.002 | 2.92E-02 | 9.12E-03 | 1.20E-02 | 2.21E-02 | 4.19E-02 | 5.86E-02 |
| 0.003 | 2.14E-02 | 7.41E-03 | 9.13E-03 | 1.45E-02 | 3.01E-02 | 4.57E-02 |
| 0.005 | 1.43E-02 | 4.90E-03 | 6.46E-03 | 9.39E-03 | 1.98E-02 | 3.01E-02 |
| 0.007 | 1.08E-02 | 3.98E-03 | 4.90E-03 | 7.05E-03 | 1.46E-02 | 2.29E-02 |
| 0.01 | 7.99E-03 | 2.82E-03 | 3.47E-03 | 5.30E-03 | 1.06E-02 | 1.72E-02 |
| 0.015 | 5.62E-03 | 1.86E-03 | 2.46E-03 | 3.73E-03 | 7.24E-03 | 1.16E-02 |
| 0.02 | 4.34E-03 | 1.32E-03 | 1.86E-03 | 3.02E-03 | 5.76E-03 | 8.97E-03 |
| 0.03 | 2.96E-03 | 8.13E-04 | 1.23E-03 | 2.14E-03 | 4.02E-03 | 6.00E-03 |
| 0.05 | 1.74E-03 | 4.22E-04 | 6.61E-04 | 1.23E-03 | 2.46E-03 | 3.55E-03 |
| 0.07 | 1.18E-03 | 2.69E-04 | 4.37E-04 | 8.13E-04 | 1.68E-03 | 2.48E-03 |
| 0.1 | 7.54E-04 | 1.66E-04 | 2.51E-04 | 5.37E-04 | 1.07E-03 | 1.74E-03 |
| 0.15 | 4.39E-04 | 8.91E-05 | 1.40E-04 | 3.09E-04 | 6.17E-04 | 1.07E-03 |
| 0.2 | 2.93E-04 | 5.89E-05 | 8.91E-05 | 2.04E-04 | 4.07E-04 | 7.08E-04 |
| 0.3 | 1.62E-04 | 3.16E-05 | 4.79E-05 | 1.18E-04 | 2.34E-04 | 4.07E-04 |
| 0.5 | 7.40E-05 | 1.29E-05 | 2.24E-05 | 5.50E-05 | 1.18E-04 | 1.97E-04 |
| 0.7 | 4.31E-05 | 6.92E-06 | 1.29E-05 | 3.16E-05 | 7.24E-05 | 1.22E-04 |
| 1 | 2.37E-05 | 3.47E-06 | 6.03E-06 | 1.70E-05 | 4.47E-05 | 6.31E-05 |
| 1.5 | 1.15E-05 | 1.41E-06 | 2.82E-06 | 8.22E-06 | 2.24E-05 | 3.39E-05 |
| 2 | 6.61E-06 | 6.38E-07 | 1.41E-06 | 4.42E-06 | 1.20E-05 | 2.09E-05 |
| 3 | 2.85E-06 | 1.91E-07 | 4.37E-07 | 1.62E-06 | 4.90E-06 | 9.77E-06 |
| 5 | 8.61E-07 | 3.06E-08 | 8.32E-08 | 3.80E-07 | 1.41E-06 | 3.02E-06 |
| 7 | 3.53E-07 | 6.24E-09 | 2.24E-08 | 1.26E-07 | 5.75E-07 | 1.32E-06 |
| 10 | 1.23E-07 | 5.56E-10 | 4.57E-09 | 3.63E-08 | 1.91E-07 | 5.01E-07 |

a) Spectral acceleration in g
b) Percentile
c) 0.5 fractile = median

## Table 2.5.2-22 (Sheet 3 of 7)

## Mean and Fractile Soil Seismic Hazard Curves at GMRS Elevation

| 10 Hz Hazard Curves | | | | | | |
|---|---|---|---|---|---|---|
| **Amplitude [(a)]** | **MEAN** | **0.05[(b)]** | **0.16** | **0.5[(c)]** | **0.84** | **0.95** |
| 0.0005 | 9.89E-02 | 3.91E-02 | 5.62E-02 | 9.32E-02 | 1.45E-01 | 1.84E-01 |
| 0.0007 | 7.94E-02 | 3.18E-02 | 4.27E-02 | 7.12E-02 | 1.19E-01 | 1.52E-01 |
| 0.001 | 6.15E-02 | 2.41E-02 | 3.24E-02 | 5.08E-02 | 9.14E-02 | 1.17E-01 |
| 0.0015 | 4.50E-02 | 1.82E-02 | 2.29E-02 | 3.63E-02 | 6.58E-02 | 9.03E-02 |
| 0.002 | 3.56E-02 | 1.48E-02 | 1.85E-02 | 2.76E-02 | 5.09E-02 | 7.07E-02 |
| 0.003 | 2.52E-02 | 9.78E-03 | 1.30E-02 | 1.82E-02 | 3.70E-02 | 5.21E-02 |
| 0.005 | 1.60E-02 | 6.46E-03 | 7.98E-03 | 1.10E-02 | 2.34E-02 | 3.45E-02 |
| 0.007 | 1.17E-02 | 4.57E-03 | 5.63E-03 | 8.21E-03 | 1.65E-02 | 2.54E-02 |
| 0.01 | 8.20E-03 | 3.02E-03 | 3.98E-03 | 5.73E-03 | 1.14E-02 | 1.76E-02 |
| 0.015 | 5.39E-03 | 2.00E-03 | 2.63E-03 | 4.01E-03 | 7.20E-03 | 1.16E-02 |
| 0.02 | 3.95E-03 | 1.41E-03 | 2.00E-03 | 3.03E-03 | 5.25E-03 | 7.90E-03 |
| 0.03 | 2.48E-03 | 8.13E-04 | 1.23E-03 | 2.00E-03 | 3.33E-03 | 4.86E-03 |
| 0.05 | 1.31E-03 | 4.07E-04 | 6.17E-04 | 1.07E-03 | 1.75E-03 | 2.59E-03 |
| 0.07 | 8.27E-04 | 2.51E-04 | 3.80E-04 | 6.61E-04 | 1.08E-03 | 1.66E-03 |
| 0.1 | 4.94E-04 | 1.45E-04 | 2.19E-04 | 4.07E-04 | 7.08E-04 | 1.01E-03 |
| 0.15 | 2.69E-04 | 7.76E-05 | 1.10E-04 | 2.19E-04 | 4.07E-04 | 5.77E-04 |
| 0.2 | 1.74E-04 | 4.79E-05 | 6.76E-05 | 1.45E-04 | 2.88E-04 | 3.81E-04 |
| 0.3 | 9.23E-05 | 2.32E-05 | 3.39E-05 | 7.76E-05 | 1.55E-04 | 2.04E-04 |
| 0.5 | 4.02E-05 | 8.51E-06 | 1.38E-05 | 3.39E-05 | 7.24E-05 | 9.55E-05 |
| 0.7 | 2.24E-05 | 4.57E-06 | 7.41E-06 | 1.82E-05 | 3.89E-05 | 5.50E-05 |
| 1 | 1.15E-05 | 2.21E-06 | 3.47E-06 | 9.12E-06 | 2.09E-05 | 3.16E-05 |
| 1.5 | 5.02E-06 | 8.71E-07 | 1.32E-06 | 3.47E-06 | 9.12E-06 | 1.38E-05 |
| 2 | 2.62E-06 | 3.80E-07 | 6.38E-07 | 1.86E-06 | 4.90E-06 | 7.41E-06 |
| 3 | 9.49E-07 | 1.02E-07 | 2.04E-07 | 6.17E-07 | 1.74E-06 | 2.82E-06 |
| 5 | 2.18E-07 | 1.20E-08 | 3.16E-08 | 1.35E-07 | 3.80E-07 | 6.61E-07 |
| 7 | 7.28E-08 | 1.57E-09 | 6.92E-09 | 3.89E-08 | 1.26E-07 | 2.34E-07 |
| 10 | 2.02E-08 | 7.50E-11 | 9.33E-10 | 9.12E-09 | 3.89E-08 | 7.24E-08 |

a) Spectral acceleration in g
b) Percentile
c) 0.5 fractile = median

## Table 2.5.2-22 (Sheet 4 of 7)

## Mean and Fractile Soil Seismic Hazard Curves at GMRS Elevation

| 5 Hz Hazard Curves | | | | | | |
|---|---|---|---|---|---|---|
| **Amplitude [(a)]** | **MEAN** | **0.05[(b)]** | **0.16** | **0.5[(c)]** | **0.84** | **0.95** |
| 0.0005 | 1.12E-01 | 5.91E-02 | 7.38E-02 | 9.97E-02 | 1.66E-01 | 2.04E-01 |
| 0.0007 | 8.95E-02 | 4.19E-02 | 5.62E-02 | 7.63E-02 | 1.36E-01 | 1.75E-01 |
| 0.001 | 6.88E-02 | 2.96E-02 | 4.27E-02 | 5.50E-02 | 1.05E-01 | 1.44E-01 |
| 0.0015 | 4.96E-02 | 2.09E-02 | 2.82E-02 | 3.94E-02 | 7.62E-02 | 1.11E-01 |
| 0.002 | 3.87E-02 | 1.48E-02 | 2.00E-02 | 3.03E-02 | 6.25E-02 | 8.58E-02 |
| 0.003 | 2.67E-02 | 9.78E-03 | 1.31E-02 | 2.02E-02 | 4.22E-02 | 6.24E-02 |
| 0.005 | 1.61E-02 | 5.62E-03 | 7.48E-03 | 1.23E-02 | 2.55E-02 | 3.84E-02 |
| 0.007 | 1.13E-02 | 3.72E-03 | 4.92E-03 | 8.01E-03 | 1.80E-02 | 2.77E-02 |
| 0.01 | 7.55E-03 | 2.46E-03 | 3.24E-03 | 5.50E-03 | 1.20E-02 | 1.87E-02 |
| 0.015 | 4.64E-03 | 1.46E-03 | 2.00E-03 | 3.32E-03 | 7.06E-03 | 1.12E-02 |
| 0.02 | 3.21E-03 | 1.00E-03 | 1.41E-03 | 2.32E-03 | 4.79E-03 | 7.60E-03 |
| 0.03 | 1.85E-03 | 5.37E-04 | 8.13E-04 | 1.42E-03 | 2.62E-03 | 4.28E-03 |
| 0.05 | 8.87E-04 | 2.51E-04 | 3.80E-04 | 6.84E-04 | 1.21E-03 | 1.91E-03 |
| 0.07 | 5.31E-04 | 1.55E-04 | 2.19E-04 | 4.07E-04 | 7.14E-04 | 1.13E-03 |
| 0.1 | 3.01E-04 | 8.32E-05 | 1.26E-04 | 2.34E-04 | 4.37E-04 | 6.29E-04 |
| 0.15 | 1.56E-04 | 4.17E-05 | 6.31E-05 | 1.18E-04 | 2.51E-04 | 3.56E-04 |
| 0.2 | 9.65E-05 | 2.40E-05 | 3.63E-05 | 7.24E-05 | 1.55E-04 | 2.19E-04 |
| 0.3 | 4.83E-05 | 1.12E-05 | 1.70E-05 | 3.63E-05 | 7.76E-05 | 1.10E-04 |
| 0.5 | 1.92E-05 | 3.98E-06 | 6.03E-06 | 1.48E-05 | 3.16E-05 | 4.79E-05 |
| 0.7 | 1.00E-05 | 1.86E-06 | 2.82E-06 | 7.94E-06 | 1.70E-05 | 2.57E-05 |
| 1 | 4.74E-06 | 7.59E-07 | 1.23E-06 | 3.72E-06 | 8.51E-06 | 1.29E-05 |
| 1.5 | 1.86E-06 | 2.51E-07 | 4.37E-07 | 1.41E-06 | 3.47E-06 | 5.25E-06 |
| 2 | 9.05E-07 | 1.02E-07 | 1.78E-07 | 6.61E-07 | 1.74E-06 | 2.63E-06 |
| 3 | 2.95E-07 | 1.82E-08 | 4.17E-08 | 2.04E-07 | 5.75E-07 | 9.33E-07 |
| 5 | 5.97E-08 | 5.07E-12 | 4.27E-09 | 3.16E-08 | 1.18E-07 | 2.19E-07 |
| 7 | 1.84E-08 | 7.50E-14 | 4.52E-10 | 7.67E-09 | 3.63E-08 | 7.24E-08 |
| 10 | 4.70E-09 | 9.66E-19 | 2.75E-14 | 1.51E-09 | 9.12E-09 | 2.09E-08 |

a) Spectral acceleration in g
b) Percentile
c) 0.5 fractile = median

## Table 2.5.2-22 (Sheet 5 of 7)

## Mean and Fractile Soil Seismic Hazard Curves at GMRS Elevation

| 2.5 Hz Hazard Curves | | | | | | |
|---|---|---|---|---|---|---|
| Amplitude [(a)] | MEAN | 0.05[(b)] | 0.16 | 0.5[(c)] | 0.84 | 0.95 |
| 0.0005 | 1.03E-01 | 1.59E-02 | 6.44E-02 | 4.19E-02 | 1.56E-01 | 1.98E-01 |
| 0.0007 | 8.06E-02 | 1.13E-02 | 4.58E-02 | 3.07E-02 | 1.28E-01 | 1.70E-01 |
| 0.001 | 6.06E-02 | 7.17E-03 | 3.24E-02 | 2.10E-02 | 9.86E-02 | 1.36E-01 |
| 0.0015 | 4.26E-02 | 4.27E-03 | 2.01E-02 | 1.38E-02 | 7.20E-02 | 9.89E-02 |
| 0.002 | 3.26E-02 | 2.92E-03 | 1.42E-02 | 9.78E-03 | 5.60E-02 | 8.01E-02 |
| 0.003 | 2.18E-02 | 1.62E-03 | 8.68E-03 | 6.46E-03 | 3.81E-02 | 5.50E-02 |
| 0.005 | 1.25E-02 | 7.85E-04 | 4.61E-03 | 3.47E-03 | 2.18E-02 | 3.30E-02 |
| 0.007 | 8.34E-03 | 4.68E-04 | 3.03E-03 | 2.14E-03 | 1.40E-02 | 2.28E-02 |
| 0.01 | 5.25E-03 | 2.51E-04 | 1.87E-03 | 1.32E-03 | 8.61E-03 | 1.49E-02 |
| 0.015 | 2.97E-03 | 1.18E-04 | 1.07E-03 | 7.59E-04 | 4.76E-03 | 8.52E-03 |
| 0.02 | 1.93E-03 | 7.24E-05 | 6.61E-04 | 5.01E-04 | 2.82E-03 | 5.72E-03 |
| 0.03 | 1.02E-03 | 3.16E-05 | 3.55E-04 | 2.69E-04 | 1.39E-03 | 2.76E-03 |
| 0.05 | 4.35E-04 | 1.05E-05 | 1.45E-04 | 1.10E-04 | 5.59E-04 | 1.05E-03 |
| 0.07 | 2.42E-04 | 4.57E-06 | 7.76E-05 | 5.89E-05 | 3.36E-04 | 5.59E-04 |
| 0.1 | 1.27E-04 | 1.86E-06 | 4.17E-05 | 2.75E-05 | 1.79E-04 | 2.90E-04 |
| 0.15 | 5.98E-05 | 5.75E-07 | 1.95E-05 | 1.29E-05 | 9.56E-05 | 1.38E-04 |
| 0.2 | 3.45E-05 | 2.19E-07 | 1.12E-05 | 6.92E-06 | 5.89E-05 | 8.10E-05 |
| 0.3 | 1.56E-05 | 4.79E-08 | 4.90E-06 | 2.82E-06 | 2.75E-05 | 3.64E-05 |
| 0.5 | 5.47E-06 | 2.27E-10 | 1.41E-06 | 8.71E-07 | 9.77E-06 | 1.38E-05 |
| 0.7 | 2.61E-06 | 1.80E-12 | 5.75E-07 | 3.31E-07 | 4.90E-06 | 6.92E-06 |
| 1 | 1.13E-06 | 7.00E-14 | 2.04E-07 | 8.91E-08 | 2.14E-06 | 3.24E-06 |
| 1.5 | 3.99E-07 | 1.15E-15 | 4.79E-08 | 1.59E-08 | 8.13E-07 | 1.15E-06 |
| 2 | 1.78E-07 | 1.46E-18 | 1.25E-08 | 7.24E-11 | 3.80E-07 | 5.37E-07 |
| 3 | 5.15E-08 | 4.04E-29 | 8.91E-11 | 1.88E-14 | 1.10E-07 | 1.66E-07 |
| 5 | 8.85E-09 | 4.20E-29 | 2.07E-15 | 5.07E-29 | 1.82E-08 | 3.16E-08 |
| 7 | 2.44E-09 | 4.20E-29 | 4.32E-17 | 4.28E-29 | 4.90E-09 | 9.77E-09 |
| 10 | 5.53E-10 | 4.20E-29 | 3.55E-19 | 4.20E-29 | 1.07E-09 | 2.46E-09 |

a) Spectral acceleration in g
b) Percentile
c) 0.5 fractile = median

**Table 2.5.2-22 (Sheet 6 of 7)**

**Mean and Fractile Soil Seismic Hazard Curves at GMRS Elevation**

| **1 Hz Hazard Curves** | | | | | | |
|---|---|---|---|---|---|---|
| **Amplitude [(a)]** | **MEAN** | **0.05[(b)]** | **0.16** | **0.5[(c)]** | **0.84** | **0.95** |
| 0.0005 | 5.94E-02 | 1.59E-02 | 3.04E-02 | 4.27E-02 | 1.05E-01 | 1.29E-01 |
| 0.0007 | 4.44E-02 | 1.13E-02 | 2.01E-02 | 3.12E-02 | 8.21E-02 | 1.07E-01 |
| 0.001 | 3.19E-02 | 7.17E-03 | 1.32E-02 | 2.16E-02 | 5.70E-02 | 7.91E-02 |
| 0.0015 | 2.14E-02 | 4.27E-03 | 8.10E-03 | 1.41E-02 | 3.94E-02 | 5.71E-02 |
| 0.002 | 1.59E-02 | 2.92E-03 | 5.32E-03 | 1.03E-02 | 2.93E-02 | 4.43E-02 |
| 0.003 | 1.02E-02 | 1.62E-03 | 2.84E-03 | 6.22E-03 | 1.87E-02 | 2.93E-02 |
| 0.005 | 5.47E-03 | 7.85E-04 | 1.32E-03 | 3.09E-03 | 1.02E-02 | 1.78E-02 |
| 0.007 | 3.49E-03 | 4.68E-04 | 7.09E-04 | 1.80E-03 | 6.12E-03 | 1.19E-02 |
| 0.01 | 2.08E-03 | 2.51E-04 | 4.08E-04 | 9.62E-04 | 3.57E-03 | 7.64E-03 |
| 0.015 | 1.10E-03 | 1.18E-04 | 2.04E-04 | 4.76E-04 | 1.66E-03 | 4.33E-03 |
| 0.02 | 6.84E-04 | 7.24E-05 | 1.18E-04 | 2.82E-04 | 9.18E-04 | 2.69E-03 |
| 0.03 | 3.35E-04 | 3.16E-05 | 5.31E-05 | 1.37E-04 | 3.79E-04 | 1.22E-03 |
| 0.05 | 1.27E-04 | 1.05E-05 | 1.82E-05 | 5.14E-05 | 1.44E-04 | 3.88E-04 |
| 0.07 | 6.41E-05 | 4.57E-06 | 9.12E-06 | 2.76E-05 | 7.94E-05 | 1.70E-04 |
| 0.1 | 2.96E-05 | 1.86E-06 | 4.27E-06 | 1.38E-05 | 4.20E-05 | 7.31E-05 |
| 0.15 | 1.18E-05 | 5.75E-07 | 1.51E-06 | 6.03E-06 | 1.95E-05 | 2.93E-05 |
| 0.2 | 6.09E-06 | 2.19E-07 | 6.61E-07 | 3.24E-06 | 1.12E-05 | 1.63E-05 |
| 0.3 | 2.40E-06 | 4.79E-08 | 1.91E-07 | 1.32E-06 | 4.90E-06 | 7.45E-06 |
| 0.5 | 7.30E-07 | 2.27E-10 | 2.02E-08 | 3.55E-07 | 1.62E-06 | 2.46E-06 |
| 0.7 | 3.21E-07 | 1.80E-12 | 1.78E-10 | 1.26E-07 | 7.59E-07 | 1.15E-06 |
| 1 | 1.27E-07 | 7.00E-14 | 1.48E-11 | 3.89E-08 | 2.88E-07 | 5.01E-07 |
| 1.5 | 4.01E-08 | 1.15E-15 | 1.97E-13 | 1.05E-08 | 8.61E-08 | 1.78E-07 |
| 2 | 1.65E-08 | 1.46E-18 | 9.44E-15 | 3.24E-09 | 3.39E-08 | 7.76E-08 |
| 3 | 4.26E-09 | 4.04E-29 | 1.45E-16 | 4.07E-10 | 8.51E-09 | 2.16E-08 |
| 5 | 6.28E-10 | 4.20E-29 | 2.88E-19 | 2.85E-11 | 1.15E-09 | 3.47E-09 |
| 7 | 1.55E-10 | 4.20E-29 | 5.28E-29 | 4.27E-12 | 2.51E-10 | 8.71E-10 |
| 10 | 3.12E-11 | 4.20E-29 | 5.28E-29 | 5.75E-13 | 4.47E-11 | 1.66E-10 |

a) Spectral acceleration in g
b) Percentile
c) 0.5 fractile = median

## Table 2.5.2-22 (Sheet 7 of 7)

## Mean and Fractile Soil Seismic Hazard Curves at GMRS Elevation

| 0.5 Hz Hazard Curves | | | | | | |
|---|---|---|---|---|---|---|
| Amplitude [(a)] | MEAN | 0.05[(b)] | 0.16 | 0.5 [(c)] | 0.84 | 0.95 |
| 0.0005 | 3.34E-02 | 6.96E-03 | 1.28E-02 | 2.31E-02 | 6.08E-02 | 8.54E-02 |
| 0.0007 | 2.43E-02 | 4.59E-03 | 7.86E-03 | 1.72E-02 | 4.53E-02 | 6.67E-02 |
| 0.001 | 1.71E-02 | 2.82E-03 | 4.79E-03 | 1.23E-02 | 3.16E-02 | 4.92E-02 |
| 0.0015 | 1.12E-02 | 1.57E-03 | 2.54E-03 | 7.75E-03 | 2.11E-02 | 3.41E-02 |
| 0.002 | 8.24E-03 | 1.00E-03 | 1.55E-03 | 5.26E-03 | 1.57E-02 | 2.59E-02 |
| 0.003 | 5.17E-03 | 4.68E-04 | 7.68E-04 | 2.71E-03 | 9.97E-03 | 1.76E-02 |
| 0.005 | 2.73E-03 | 1.66E-04 | 2.89E-04 | 1.12E-03 | 5.27E-03 | 1.04E-02 |
| 0.007 | 1.74E-03 | 8.32E-05 | 1.55E-04 | 5.86E-04 | 3.17E-03 | 6.89E-03 |
| 0.01 | 1.04E-03 | 3.89E-05 | 7.25E-05 | 2.87E-04 | 1.71E-03 | 4.39E-03 |
| 0.015 | 5.56E-04 | 1.59E-05 | 2. 95E-05 | 1.33E-04 | 7.20E-04 | 2.44E-03 |
| 0.02 | 3.47E-04 | 8.51E-06 | 1.59E-05 | 7.44E-05 | 3.64E-04 | 1.51E-03 |
| 0.03 | 1.74E-04 | 3.02E-06 | 6.03E-06 | 3.41E-05 | 1.48E-04 | 6.21E-04 |
| 0.05 | 7.08E-05 | 7.08E-07 | 1.74E-06 | 1.20E-05 | 5.47E-05 | 1.68E-04 |
| 0.07 | 3.70E-05 | 2.19E-07 | 6.61E-07 | 5.62E-06 | 2.82E-05 | 7.02E-05 |
| 0.1 | 1.70E-05 | 5.69E-08 | 2.19E-07 | 2.46E-06 | 1.39E-05 | 2.86E-05 |
| 0.15 | 6.24E-06 | 5.43E-09 | 4.79E-08 | 7.59E-07 | 6.03E-06 | 1.05E-05 |
| 0.2 | 2.86E-06 | 9.55E-11 | 1.05E-08 | 3.55E-07 | 3.47E-06 | 5.77E-06 |
| 0.3 | 9.03E-07 | 1.27E-12 | 1.10E-10 | 1.18E-07 | 1.32E-06 | 2.83E-06 |
| 0.5 | 2.11E-07 | 8.22E-15 | 3.98E-12 | 1.95E-08 | 4.07E-07 | 9.34E-07 |
| 0.7 | 8.32E-08 | 5.56E-16 | 1.84E-13 | 3.47E-09 | 1.91E-07 | 4.22E-07 |
| 1 | 3.09E-08 | 4.04E-29 | 4.42E-15 | 3.67E-10 | 7.76E-08 | 1.78E-07 |
| 1.5 | 9.53E-09 | 4.04E-29 | 8.61E-17 | 4.17E-11 | 2.40E-08 | 5.50E-08 |
| 2 | 3.88E-09 | 4.04E-29 | 4.73E-18 | 8.51E-12 | 9.77E-09 | 2.40E-08 |
| 3 | 9.81E-10 | 4.20E-29 | 5.28E-29 | 1.00E-12 | 2.29E-09 | 6.03E-09 |
| 5 | 1.41E-10 | 4.20E-29 | 5.28E-29 | 4.17E-14 | 2.51E-10 | 9.33E-10 |
| 7 | 3.43E-11 | 4.20E-29 | 4.47E-29 | 4.12E-15 | 4.79E-11 | 2.19E-10 |
| 10 | 6.76E-12 | 4.20E-29 | 4.47E-29 | 2.19E-16 | 7.41E-12 | 4.17E-11 |

a) Spectral acceleration in g
b) Percentile
c) 0.5 fractile = median

## Table 2.5.2-23

### Mean and Median UHRS Values for Soil Seismic Hazard (SA in g)

| **Frequency, Hz** | **Mean $10^{-4}$** | **Mean $10^{-5}$** | **Mean $10^{-6}$** |
|---|---|---|---|
| 100 (PGA) | 0.158 | 0.465 | 0.958 |
| 25 | 0.313 | 0.836 | 1.59 |
| 10 | 0.360 | 1.07 | 2.17 |
| 5.0 | 0.366 | 1.12 | 2.48 |
| 2.5 | 0.174 | 0.543 | 1.42 |
| 1.0 | 0.122 | 0.341 | 0.853 |
| 0.5 | 0.110 | 0.341 | 0.823 |
| **Frequency, Hz** | **Median $10^{-4}$** | **Median $10^{-5}$** | **Median $10^{-6}$** |
| 100 (PGA) | 0.133 | 0.415 | 0.837 |
| 25 | 0.254 | 0.756 | 1.42 |
| 10 | 0.317 | 0.991 | 1.96 |
| 5.0 | 0.316 | 1.02 | 2.29 |
| 2.5 | 0.146 | 0.479 | 1.21 |
| 1.0 | 0.0767 | 0.251 | 0.665 |
| 0.5 | 0.0465 | 0.144 | 0.378 |

## Table 2.5.2-24

## Calculation of Horizontal and Vertical GMRS

| Frequency (Hz) | Horizontal GMRS (g) | V/H Ratio | Vertical GMRS (g) |
|---|---|---|---|
| 0.1 | 9.14E-03 | 0.75 | 6.86E-03 |
| 0.125 | 1.49E-02 | 0.75 | 1.12E-02 |
| 0.15 | 2.28E-02 | 0.75 | 1.71E-02 |
| 0.2 | 4.04E-02 | 0.75 | 3.03E-02 |
| 0.3 | 8.98E-02 | 0.75 | 6.74E-02 |
| 0.4 | 1.42E-01 | 0.75 | 1.07E-01 |
| 0.5 | 1.60E-01 | 0.75 | 1.20E-01 |
| 0.6 | 1.54E-01 | 0.75 | 1.16E-01 |
| 0.7 | 1.50E-01 | 0.75 | 1.12E-01 |
| 0.8 | 1.53E-01 | 0.75 | 1.15E-01 |
| 0.9 | 1.60E-01 | 0.75 | 1.20E-01 |
| 1 | 1.72E-01 | 0.75 | 1.29E-01 |
| 1.25 | 1.97E-01 | 0.75 | 1.48E-01 |
| 1.5 | 2.20E-01 | 0.75 | 1.65E-01 |
| 2 | 2.45E-01 | 0.75 | 1.84E-01 |
| 2.5 | 2.59E-01 | 0.75 | 1.94E-01 |
| 3 | 2.84E-01 | 0.75 | 2.13E-01 |
| 4 | 4.17E-01 | 0.75 | 3.13E-01 |
| 5 | 5.26E-01 | 0.75 | 3.95E-01 |
| 6 | 5.67E-01 | 0.79 | 4.45E-01 |
| 7 | 5.72E-01 | 0.81 | 4.66E-01 |
| 8 | 5.59E-01 | 0.84 | 4.70E-01 |
| 9 | 5.39E-01 | 0.86 | 4.65E-01 |
| 10 | 5.23E-01 | 0.88 | 4.62E-01 |
| 12.5 | 5.17E-01 | 0.93 | 4.79E-01 |
| 15 | 5.11E-01 | 0.96 | 4.91E-01 |
| 20 | 4.63E-01 | 1.02 | 4.71E-01 |
| 25 | 4.13E-01 | 1.06 | 4.37E-01 |
| 30 | 3.66E-01 | 1.09 | 4.01E-01 |
| 35 | 3.32E-01 | 1.12 | 3.73E-01 |
| 40 | 3.02E-01 | 1.15 | 3.47E-01 |
| 45 | 2.81E-01 | 1.15 | 3.23E-01 |
| 50 | 2.67E-01 | 1.15 | 3.07E-01 |
| 60 | 2.45E-01 | 1.15 | 2.81E-01 |
| 70 | 2.33E-01 | 1.15 | 2.68E-01 |
| 80 | 2.28E-01 | 1.15 | 2.62E-01 |
| 90 | 2.26E-01 | 1.15 | 2.60E-01 |
| 100 | 2.25E-01 | 1.15 | 2.59E-01 |