[Site] [Year] Seismic Hazard Report

Background

In response to the March 11, 2011, Great East Japan Earthquake and tsunami, which triggered an accident at the Fukushima Dai-ichi nuclear power plant, the U.S. Nuclear Regulatory Commission (NRC) established the Near-Term Task Force (NTTF) to conduct a systematic and methodical review of NRC processes and regulations and determine whether the agency should make additional improvements to its regulatory system. In SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 (NRC, 2011), the NRC staff recommended a set of actions to clarify and strengthen the regulatory framework for protection against natural hazards. In particular, NTTF Recommendation 2.1 (NTTF R2.1) instructed the NRC staff to issue requests for information to all power reactor licensees pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) ("50.54(f) letter"). Enclosure 1 to the 50.54(f) letter requested that addresses reevaluate the seismic hazards at their sites, using present-day NRC requirements and guidance to perform a probabilistic seismic hazard analysis (PSHA) and develop a site-specific ground motion response spectrum (GMRS). To comply with the 50.54(f) request, the Nuclear Energy Institute submitted Electric Power Research Institute (EPRI) Report 1025287, "Seismic Evaluation Guidance: Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima NTTF Recommendation 2.1 Seismic," dated November 27, 2012 (EPRI, 2012). Recipients of the 50.54(f) letter committed to following the SPID to develop seismic hazard and screening reports (SHSRs). By December 2017, the NRC staff had finished assessing the SHSRs for all operating U.S. nuclear power plants.

Under the process for the ongoing assessment of natural hazard information (POANHI), described in SECY-16-0144, "Proposed Resolution of Remaining Tier 2 and 3 Recommendations Resulting from the Fukushima Dai-ichi Accident," dated December 26, 2016 (NRC, 2016), the NRC staff continuously seeks out and integrates new natural hazard information for operating plants in the United States. The Office of Nuclear Reactor Regulation's Office Instruction LIC-208, "Process for the Ongoing Assessment of Natural Hazards Information," issued November 2019 (NRC, 2019), provides guidance to the staff on how to collect, integrate, and evaluate new information for consideration in its regulatory decision-making. This report presents the NRC staff's latest understanding of seismic hazards at the [Site name] site under the POANHI framework.

[Paragraph describing the site location, physiographic province and high level summary of site geology and subsurface profile.]

Motivation

After evaluating the SHSR submittals, the NRC staff captured in NUREG/KM-0017, "Seismic Hazards Evaluations for U.S. Nuclear Power Plants: Near-Term Task Force Recommendation 2.1 Results," issued December 2021 (Munson et al., 2021), the information used to develop the GMRS at each of the U.S. nuclear power plants. This includes a compilation and synthesis of (1) information provided by licensees in their SHSRs, (2) information collected by the NRC staff during its reviews of the SHSRs, and (3) information subsequently collected by the NRC staff from the scientific and engineering literature pertaining to several of the nuclear power plant sites. In addition, NUREG/KM-017 includes updated approaches and relationships, relative to those recommended by the SPID, that the NRC staff used to perform its analyses.

After the development of NUREG/KM-0017, a new ground motion model (GMM) for Eastern North America called NGA-East was published by Goulet et al. (2018), and the NRC staff also participated in a Senior Seismic Hazard Analysis Committee (SSHAC) Level 2 study, documented in Research Information Letter (RIL) 2021-15, "Documentation Report for SSHAC Level 2: Site Response," issued November 2021 (Rodriguez-Marek et al., 2021). This SSHAC Level 2 study implemented the SSHAC approach to performing site response analyses (SRAs). The SSHAC process, described most recently in NUREG-2213, "Updated Implementation Guidelines for SSHAC Hazard Studies," issued October 2018 (Ake et al., 2018), provides a structured and logical framework for the systematic evaluation of alternative data, models, and methods. This seismic hazard report for the [site name] site incorporates the NGA-East GMM in place of the EPRI (2013) GMM and lessons learned from the SSHAC Level 2 SRA study (RIL 2021-15) into a PSHA to develop updated seismic hazard curves and a GMRS for the site.

Methods

Reference Rock Hazard

For the reference rock PSHA, the NRC staff used the distributed seismicity zones (DSZs) from the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities (CEUS-SSC) model in NUREG-2115, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities, issued January 2012 (NRC, 2012). Specifically, the NRC staff selected the DSZs that are located within 500 kilometers of the site. In addition to the nearby [RLME name] CEUS-SSC repeated large-magnitude earthquake (RLME) source, the NRC staff selected additional RLME sources that are within 1,000 kilometers of the site. To develop the reference rock seismic hazard curves for the site, the NRC staff used the NGA-East GMM (2018) to compute the median and logarithmic standard deviation of the spectral accelerations. Because the NGA-East GMM implements the rupture distance parameter, the NRC staff developed virtual rupture planes for each of the distributed source zones surrounding the site. For each virtual rupture, the NRC staff used the CEUS-SSC hazard input document (NRC, 2012) to specify the size of the rupture plane and the orientation of the rupture plane in terms of the strike and dip angles, dip direction, and rupture type (e.g., reverse and strike slip). In contrast, to develop the hazard curves for NUREG/KM-0017, the NRC staff used point source approximations for the CEUS-SSC and EPRI GMM (EPRI, 2013) combination.

Figure 1 shows the distribution of the virtual ruptures for one of the four alternative CEUS-SSC seismotectonic DSZ configurations along with the resulting 10-Hertz (Hz) mean hazard curves developed using the NGA-East GMM. In particular, figure 1 shows the distribution of the surface projection of the updip segments of the virtual rupture planes for each of the five seismotectonic DSZs within 500 kilometers of the site. As expected, the [name of specific source zone] source zone, which surrounds the site, is the largest contributor to the 10 Hz reference rock mean hazard curves at the 10^{-4} annual frequency of exceedance (AFE) level. Similarly, figure 2 shows the distribution of the virtual ruptures for one of the three alternative CEUS-SSC maximum-magnitude DSZ configurations along with the resulting 10 Hz mean hazard curves developed using the NGA-East GMM. The [name of specific source zone] source zone, which surrounds the site, is the largest contributor to the 10 Hz reference rock mean hazard curves at the 10^{-4} AFE level. Figure 3 shows the RLME sources within 1,000 kilometers of the site, and their contribution to the 1 Hz reference rock mean hazard, from using the NGA-East GMM. The [name of nearest RLME source to site] RLME source, which is closest to the site, is the largest contributor to the 1 Hz reference rock mean hazard curves at the 10^{-4} AFE level. Figure 4 shows the contribution from all of the DSZs relative to the RLMEs, as well as the total mean hazard for the 1 and 10 Hz mean reference rock hazard curves, from using the NGA-East GMM. For both the 1 and 10 Hz mean reference rock hazard curves, the RLME sources provide the largest contribution at the 10^{-4} AFE level. Finally, figure 5 shows the mean 1,000-, 10,000-, and 100,000-year return period mean reference rock uniform hazard response spectra for the [site name] site from using the EPRI GMM (blue) and the NGA-East GMM (red). As shown in figure 5, the spectral accelerations from using the NGA-East GMM are moderately higher than those from using the EPRI GMM, up to the spectral frequency of about 25 Hz.

Site Response Analysis

SRAs, which are used to develop site adjustment (or amplification) factors ($SAFs$), depend on several factors, including the site strata (material type, stiffness, and thickness) and their response to dynamic loading. Because this information is site specific, the ability to accurately model the site response depends on the quantity and quality of site-specific geologic and geotechnical data available, and on the interpretation and use of these data to develop input models for assessing amplification (or deamplification) of ground motions. The resulting $SAFs$ are assessed for a wide range of input ground motions as part of understanding the changes in the soil and rock response as input ground motions increase.

The NRC staff followed the linear one-dimensional site response approach described in RIL 2021-15, which uses a logic tree for systematically identifying and propagating epistemic uncertainties in the SRA. As described in RIL 2021-15, to produce a truly probabilistic estimate of the seismic hazard at the control point elevation, it is necessary to estimate both the epistemic uncertainties and the aleatory variability of the soil and or rock dynamic response, and to propagate these through the SRA and the calculation of the site hazard curves.

Site Exploration. As described in the NTTF R2.1 SHSR submitted by [Name of licensee and reference to SHSR submittal] and summarized in section 2.3.[XX] of NUREG/KM-017, the field investigations for [summary of site-specific field investigations, including initial licensing, ISFSI or ESP/COL activities. Will include summary of geophysical profiles, crosshole methods, suspension logging, etc. and nearby geophysical investigations]

Basecase Profiles. [Description of licensee's NTTF R2.1 basecase profile including depth to control point elevation and summary of profile geology by thickness and Vs]

[Description of NRC staff's basecase profile, including rationale for differences from licensee's NTTF R2.1 basecase profile]

To capture the uncertainty in its basecase profile, the NRC staff developed lower and upper profiles by multiplying its best estimate basecase profile by scale factors of X and Y, respectively, which corresponds to an epistemic logarithmic standard deviation of Z. The weights for the lower, best estimate, and upper basecase profiles are 0.3, 0.4, and 0.3, respectively. Figure 6 shows the lower, best estimate, and upper basecase profiles used by the NRC staff.

Site Kappa. To estimate the site kappa (κ_0), which captures the overall attenuation (i.e., intrinsic and scattering attenuation) of the geologic profile, the NRC staff used five empirical relationships: the four Q_{ef}-V_S models from Campbell (2009), where Q_{ef} is the effective quality factor of shear waves, which captures both the frequency-independent component of intrinsic attenuation and small-scale scattering; and the V_{S30}-$Z_{2.5}$-κ_0 correlation model of Xu et al. (2020), where V_{S30} is the average shear-wave velocity over the top 30 meters of a profile, and $Z_{2.5}$ is the depth to the $V_S = 2.5$ kilometers per second horizon. For each of the four Q_{ef}-V_S models, the NRC staff estimated a Q_{ef} for each layer in the three basecase profiles, then used the estimated Q_{ef}, V_S, and layer thickness to determine a κ_0 for each layer. Summing these κ_0 values for each layer and adding the reference value of 6 milliseconds (msec) provides an estimate of the total κ_0. The NRC staff used a weight of 0.125 for each of the four Q_{ef}-V_S models and a weight of 0.5 for the V_{S30}-$Z_{2.5}$-κ_0 correlation model. Assuming a lognormal distribution for κ_0 with a logarithmic standard deviation of 0.2 from Xu et al. (2020), the NRC staff developed a nine-point discrete distribution. This results in 45 κ_0 values and associated weights for each of the three basecase profiles, which the NRC staff then resampled using the approach from Miller and Rice (1983) to reduce the distribution to five representative values and associated weights. These five κ_0 values and weights, which are listed in table 1, range from X msec to Y msec for the three basecase profiles.

Nonlinear Dynamic Properties. For the equivalent linear (EQL) SRA, nonlinearity is incorporated using strain-compatible site properties (i.e., shear modulus and damping ratio) for each layer. The strain-compatible properties model both the shear modulus reduction and the increased damping that are expected as the intensity of shaking increases. To model the nonlinear response [description of MRD curves and their weighting] The NRC staff used multiple MRD curves to better capture the epistemic uncertainty in the nonlinear response of the soil to higher dynamic loading.

Table 2 provides the layer depths, lithologies, V_S, unit weights, and dynamic properties for the NRC staff's three profiles. It is important to note that the NRC staff has adjusted the critical damping ratio values [statement on any adjustments] so that the profile as a whole has the appropriate κ_0 value. Figure 7, which shows tornado plots for the reference rock peak ground acceleration value of 0.8g, shows which site response logic tree nodes contribute to the variance of the SAF. Each tornado plot in figure 7 is associated with one of the four oscillator frequencies of 1, 5, 10, and 100 Hz. [Statement on uncertainty that contributes most to variance in SAF]

Input Motions. Input motions used for the SRA were generated as outcrop motions at the reference rock horizon, located at the bottom of the basecase profiles. The NRC staff used random vibration theory to generate the input motions after first developing an input Fourier amplitude spectrum (FAS) using seismological source theory (i.e., single-corner frequency Brune source spectrum). To develop the FAS, the NRC staff used the source and regional attenuation parameters recommended in the SPID for Eastern North American rock sites and then used random vibration theory to develop corresponding 5 percent damped acceleration response spectra. The NRC staff developed 12 input FAS assuming a magnitude ($\boldsymbol{M}$) of 6.5 and 12 different source-to-site distances, as recommended in the SPID.

Analysis Methodology. To develop $SAFs$ for the [Site name] site, the NRC staff used traditional EQL analysis and the recently developed kappa-corrected EQL analysis, which adjusts the high-frequency control point (e.g., surface) FAS from the EQL SRA to be consistent with the target κ_0 value. In particular, the NRC staff used the kappa2-corrected EQL analysis methodology (NCREE, 2021), in which the EQL control point FAS remains unmodified below a specified transition frequency, and then a slope equal to the target κ_0 value is imposed at frequencies above the transition frequency. To capture the uncertainty in the transition frequency value, the NRC staff selected three frequencies for which the FAS amplitude equals 5 percent, 11 percent, and 17 percent of its peak value, with weights of 0.2, 0.6, and 0.2, respectively.

To capture the spatial variability in site properties across the site, the NRC staff generated randomized V_S profiles around the three basecase profiles using the Toro (1995) model, which quantifies the aleatory variability through a depth-dependent standard deviation of the natural log of the velocities. The logarithmic standard deviation value used by the NRC staff for each layer of the profile are based on the guidance in the SPID as well as site-specific data and are shown in table 2. In addition to randomizing the V_S profiles, the NRC staff also randomized the MRD curves following the logit function approach used in the SPID and described in RIL 2021-15.

For each terminal branch of the site response logic tree, the NRC staff developed 60 randomized profiles and then determined the SAF by dividing the computed control point response spectrum by the outcrop response spectrum for the reference condition. Next, the NRC staff computed a median and logarithmic standard deviation for the SAF, using the 60 $SAFs$ from the randomized profiles, for each terminal branch of the logic tree. To facilitate implementing the SAF medians and logarithmic standard deviations into the PSHA seismic hazard integral, the NRC staff reduced the median SAFs from the over 200 logic tree terminal branches to seven discrete fractiles using the resampling procedure outlined by Miller and Rice (1983). As recommended by Rodriguez-Marek et al. (2021), to ensure that estimates of the SRA capture enough epistemic uncertainty in the median SAF, the NRC staff implemented a minimum logarithmic standard deviation value of 0.15, which causes the seven median SAF fractiles to spread apart if necessary.

Finally, because the SAF logarithmic standard deviation for each spectral frequency does not vary significantly across the terminal branches of the logic tree, the NRC staff used a single mean value for each frequency. In addition, to avoid double-counting the aleatory variability already captured by the GMM, the NRC staff adjusted the SAF logarithmic standard deviation to include only the portion of the standard deviation associated with the nonlinear site response.

Figure 8 shows the seven median SAF values (top) and the average logarithmic standard deviation (bottom) as a function of input reference rock spectral acceleration for the 1 and 10 Hz spectral frequencies. [More on what Figure 8 shows] The lower half of figure 8 shows both the total and the nonlinear values of the SAF logarithmic standard deviation, the latter of which are implemented into the PSHA hazard integral. Figure 9 shows the seven median SAF values versus frequency at the 10^{-4} AFE spectral acceleration value for each of the 23 NGA-East GMM spectral frequencies. [More on what Figure 9 shows]

Control Point Hazard and Ground Motion Response Spectra

The NRC staff calculated the mean control point hazard for the [site name] site using Convolution Approach 3 from NUREG/CR-6728, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines," issued October 2001 (McGuire et al., 2001), which convolves the predetermined mean reference condition hazard with the $SAFs$. For each NGA-East GMM spectral frequency, the NRC staff convolved the mean reference condition hazard curve with the seven $SAFs$ to determine the final mean control point hazard. Using the mean control point hazard curves, the NRC staff then determined the 10^{-4} and 10^{-5} uniform hazard response spectra in order to calculate the final GMRS. Figure 10 shows this final GMRS (red curve) compared to the GMRS (black curve) developed for NUREG/KM-017 and the GMRS (blue curve) in [licensee and site] SHSR ([reference to SHSR submittal]). Based on a sensitivity analysis, the NRC staff found that the primary difference between the updated GMRS developed by this study and the previous GMRS is due to [cause of differences for GMRS]

Data Tables

Appendix A provides the data tables for the [site name] site. Tables A-1, A-2, and A-3 give the reference rock mean hazard curves for 23 spectral frequencies ranging from 0.100 to 100.00 Hz. Tables A-4 through A-26 give the SAF medians and logarithmic standard deviations for the 23 spectral frequencies. Tables A-27, A-28, and A-29 give the control point hazard mean hazard curves for the 23 spectral frequencies.

References

Table 1 Site Kappa (κ_0) Values for Each Basecase Profile

Profile Kappa Distribution					
Lower Range		Basecase		Upper Range	
κ_0 (s)	Weight	κ_0 (s)	Weight	κ_0 (s)	Weight

Table 2 Layer Depths, Shear Wave Velocities (V_S), Unit Weights, and Dynamic Properties for [Site]

Layer #	Depth (m)	V_S (m/s)			V_S Sigma (ln)	Unit Weight (kN/m^3)	Dynamic Properties				
		LR (0.3)	BC (0.4)	UR (0.3)			Alt. 1 (0.5)	Alt. 2 (0.125)	Alt. 3 (0.125)	Alt. 4 (0.125)	Alt. 5 (0.125)

Figure 1 Distribution of virtual ruptures (left) for CEUS-SSC Seismotectonic Configuration 1 DSZs, and associated mean 10 Hz reference rock hazard curves (right) for [Site]

Figure 2 Distribution of virtual ruptures (left) for CEUS-SSC maximum-magnitude narrow-configuration DSZs, and associated mean 10 Hz reference rock hazard curves (right) for [site]

Figure 3 CEUS-SSC RLME sources (left), and associated mean 1 Hz reference rock hazard curves (right) for [site]

Figure 4 DSZ, RLME, and total mean reference rock hazard curves for 1 Hz (right) and 10 Hz (left) for [site]

Figure 5 1,000-, 10,000-, and 100,000-year return period mean reference rock UHRS for CEUS-SSC and EPRI GMM (blue curves) and CEUS-SSC and NGA-East GMM (red curves)

Figure 6 Shear wave velocity (V_S) basecase profiles for [site name]; best estimate basecase profile shown as solid line; lower and upper range basecase profiles shown as dashed lines

Figure 7 Seven median SAFs (above) and mean log standard deviations of SAF (below) as functions of input acceleration for 1 Hz (left) and 10 Hz (right)

Figure 8 Seven median SAFs (above) and mean log standard deviations of SAF (below) as functions of input acceleration for 1 Hz (left) and 10 Hz (right)

Figure 9 Seven median SAFs as functions of spectral frequency for spectral accelerations at the 10^{-4} AFE level

Figure 10 GMRS for the [site name] site

Appendix A—Data Tables

Table A-1 Reference Rock Total Mean Hazard Curves for F=0.100 to 0.667 Hz							
SA (g)	F0.100Hz	F0.133Hz	F0.200Hz	F0.250Hz	F0.333Hz	F0.500Hz	F0.667Hz

Table A-2 Reference Rock Total Mean Hazard Curves for F=1.000 to 6.667 Hz								
SA (g)	F1.000Hz	F1.333Hz	F2.000Hz	F2.500Hz	F3.333Hz	F4.000Hz	F5.000Hz	F6.667Hz

Table A-3 Reference Rock Total Mean Hazard Curves for F=10.000 to 100.000 Hz								
SA (g)	F10.000Hz	F13.333Hz	F20.000Hz	F25.000Hz	F33.333Hz	F40.000	F50.000Hz	F100.000Hz

Table A-4 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=0.100 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-5 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=0.133 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-6 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=0.200 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-7 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=0.250 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-8 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=0.333 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-9 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=0.500 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-10 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=0.667 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-11 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=1.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-12 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=1.333 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-13 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=2.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-14 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=2.500 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-15 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=3.333 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-16 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=4.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-17 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=5.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-18 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=6.667 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-19 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=10.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-20 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=13.333 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-21 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=20.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-22 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=25.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-23 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=33.333 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-24 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=40.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-25 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=50.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-26 Site Adjustment Factor Medians and Logarithmic Standard Deviation for F=100.000 Hz								
SA (g)	SAF-M1	SAF-M2	SAF-M3	SAF-M4	SAF-M5	SAF-M6	SAF-M7	LNSTDEV

Table A-27 Control Point Total Mean Hazard Curves for F=0.100 to 0.667 Hz							
SA (g)	F0.100Hz	F0.133Hz	F0.200Hz	F0.250Hz	F0.333Hz	F0.500Hz	F0.667Hz

Table A-28 Control Point Total Mean Hazard Curves for F=1.000 to 6.667 Hz								
SA (g)	F1.000Hz	F1.333Hz	F2.000Hz	F2.500Hz	F3.333Hz	F4.000Hz	F5.000Hz	F6.667Hz

Table A-29 Control Point Total Mean Hazard Curves for F=10.000 to 100.000 Hz								
SA (g)	F10.000Hz	F13.333Hz	F20.000Hz	F25.000Hz	F33.333Hz	F40.000	F50.000Hz	F100.000Hz