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CHAPTER 8 DEMONSTRATION HAZARD CALCULATIONS

8.1 Background on Demonstration Hazard Calculations

The Updated EPRI (2004, 2006) Ground-Motion Model (GMM; herein called the “Updated GMM”) as developed under this project was used to calculate hazard at the seven test sites examined under the CEUS SSC Project (EPRI/DOE/NRC, 2012). In addition, comparisons with hazard results from the CEUS SSC Project illustrate differences in hazard between the Updated GMM and the EPRI (2004, 2006) GMM, which were the equations used in the CEUS SSC Project. All of the calculations described here were made for demonstration purposes only and should not be used for design or analysis decisions for any engineered facility.

The seven test sites are shown on the map on Figure 8.1-1. The location of each site and the reason for its selection (taken from the CEUS SSC Project) are given in Table 8.1-1. Seismic hazard was calculated for CEUS reference rock and a kappa of 0.006 seconds for illustration purposes. CEUS reference rock is defined as rock with a shear-wave velocity (V_s) of 2,800 m/s (9,200 ft/s). All the seismic hazard results presented in this section are for CEUS reference rock conditions.

When the geometry of the earthquake rupture is defined, the Updated GMM uses distance to the surface projection of the rupture (“Joyner-Boore distance”) and closest distance to the rupture (depending on the specific equation within the model). When (for seismic hazard calculations) the rupture geometry is unknown and the earthquake is represented as a point, the EPRI (2004) report includes correction terms for the distance measures and the aleatory standard deviation, which are used to modify these parameters for point-source conditions. These modifications were implemented within the seismic hazard calculations for both the EPRI (2004, 2006) GMM and the Updated GMM.

The seismic hazard calculations reported in this section were made with the LCI THAZ software code. This software is different from the software used to calculate and report results in the CEUS SSC Project, but it gives seismic hazard results that are very close to those in the CEUS SSC Project. Any differences in results shown in this section are attributable to differences in the ground-motion equations.

8.2 Demonstration Hazard Calculations

This section presents demonstration hazard calculations for the seven test sites. Figures with hazard results are presented for CEUS reference rock conditions (labeled “rock” below) in the order outlined below for each site. Additionally, hazard plots are presented for the Chattanooga site showing hazard for individual ground-motion equations, for both the EPRI (2004, 2006) GMM and the Updated GMM.

Test Sites

Hazard curves and uniform hazard response spectra (UHRs) are presented for the following test sites:

- Figures 8.2-1a–1h: Central Illinois
- Figures 8.2-2a–2h: Chattanooga
- Figures 8.2-3a–3h: Houston
- Figures 8.2-4a–4h: Jackson
- Figures 8.2-5a–5h: Manchester
- Figures 8.2-6a–6h: Savannah
- Figures 8.2-7a–7h: Topeka

In all these figures, the EPRI (2004, 2006) GMM results are shown as dashed curves and the Updated GMM results are shown as solid curves. Total hazard results are plotted as red curves, total background results are plotted as orange curves, and hazard results for individual repeated large-magnitude earthquake (RLME) sources are plotted in other colors, as indicated in each figure’s legend. In particular, hazards from the New Madrid fault source (NMFS) are plotted as black curves, and hazards from the Charleston source are plotted as green curves.

Also, the following sensitivity plots are included:

- Figures 8.2-8–8.2-10: Sensitivity to ground-motion equations for Chattanooga
- Figure 8.2-11: Sensitivity to ground-motion aleatory uncertainty

Hazard Curves

Figures a–g: Show total mean rock hazard and contribution by source, for PGA, 25 Hz, 10 Hz, 5 Hz, 2.5 Hz, 1 Hz, and 0.5 Hz, respectively. Curves are included for both the EPRI (2004, 2006) GMM and the Updated GMM.

Hazard Spectra

Figure h: Shows mean rock UHRs for an annual frequency of exceedance of 10^{-4} and 10^{-5} for both the EPRI (2004, 2006) GMM and the Updated GMM.

Sensitivity to Individual Equations

Figures 8.2-8–8.2-10: Show comparisons of mean rock hazard at the Chattanooga site for PGA, 10 Hz SA, and 1 Hz SA, respectively, conditional on each of the nine equations used for general, nonrift sources. These comparisons are shown for the EPRI (2004, 2006) GMM and the Updated GMM.

Sensitivity to Ground-Motion Aleatory Uncertainty

Figure 8.2-11: Shows the sensitivity of hazard to changes in aleatory uncertainty (quantified by logarithmic standard deviation, or logarithmic “sigma”) as ratios of annual frequency (for a fixed ground-motion amplitude) and ratios of ground-motion amplitude (for a fixed annual frequency), using logarithmic sigma = 0.6 as a base.

8.2.1 Central Illinois Site

Hazard results are shown on Figures 8.2-1a through 8.2-1g for the Central Illinois site. At high spectral frequencies (5 Hz and above), seismic hazard is dominated by contributions from background sources, but at lower spectral frequencies, the dominant contributor to seismic hazard at some amplitudes is the NMFS. Figure 8.2-1a shows that seismic hazard for PGA is similar for the EPRI (2004, 2006) GMM and the Updated GMM. However, for the other six spectral frequencies, Figures 8.2-1b through 8.2-1g show that seismic hazard is lower with the Updated GMM. This observation is summarized on Figure 8.2-1h, which plots the 10^{-4} and 10^{-5} rock UHRS for the EPRI (2004, 2006) GMM and the Updated GMM.

8.2.2 Chattanooga Site

Hazard results are shown on Figures 8.2-2a through 8.2-2g for the Chattanooga site. At high spectral frequencies (5 Hz and above), seismic hazard is dominated by contributions from background sources, but at lower spectral frequencies, the NMFS is an important contributor to seismic hazard. Figure 8.2-2a shows that seismic hazard for PGA is similar for the EPRI (2004, 2006) GMM and the Updated GMM. However, for the other six spectral frequencies, Figures 8.2-2b through 8.2-2g show that seismic hazard is lower with the Updated GMM. This observation is summarized on Figure 8.2-2h, which plots the 10^{-4} and 10^{-5} rock UHRS for the EPRI (2004, 2006) GMM and the Updated GMM.

8.2.3 Houston Site

Hazard results are shown on Figures 8.2-3a through 8.2-3g for the Houston site. At high spectral frequencies (5 Hz and above), seismic hazard is dominated by contributions from background sources, but at lower spectral frequencies (2.5 Hz and below), the NMFS is an important contributor to seismic hazard. Figure 8.2-3a shows that seismic hazard for PGA increases with the Updated GMM for background sources; this is expected because the Gulf equations are used for background sources at Houston, and ground motions from Gulf equations increase (as compared to Gulf equations from the EPRI [2004, 2006] GMM, as shown in other comparisons

in this report). PGA hazard at Houston *decreases dramatically* for the NMFS, however, because the Gulf region was redefined for the Updated GMM, and the travel path for seismic waves from the NMFS to Houston is entirely within the Gulf region (see Figure 8.1-1). In the CEUS SSC report, the Midcontinent equations were used for the NMFS at Houston, and changing equations from Midcontinent to Gulf decreases the PGA hazard. As a result of the increase in PGA hazard from background sources and decrease in PGA hazard from the NMFS, the total PGA hazard decreases at 10^{-4} , and is about the same at 10^{-5} .

Similar trends are seen at lower spectral frequencies, as shown on Figures 8.2-3b through 8.2-3g, except that at low spectral frequencies, the NMFS is the dominant contributor to hazard. The large decrease in hazard from the NMFS, for the reasons discussed above, lead to a decrease in total hazard that is greater than the decrease observed at high spectral frequencies.

These trends across the spectral frequency range are summarized on Figure 8.2-3h, which plots the 10^{-4} and 10^{-5} rock UHRS for the EPRI (2004, 2006) GMM and the Updated EPRI (2004, 2006) GMM.

8.2.4 Jackson Site

Hazard results are shown on Figures 8.2-4a through 8.2-4g for the Jackson site. For ground motions corresponding to 10^{-4} annual frequency of exceedance, the NMFS is the dominant contributor to hazard. For ground motions corresponding to 10^{-5} annual frequency of exceedance, and for spectral frequencies of 10 Hz and higher, background sources are the dominant contributor to hazard, but the NMFS has a significant contribution because of its proximity to Jackson. For lower spectral frequencies, the NMFS is the dominant contributor to hazard for ground motions corresponding to annual frequencies of 10^{-4} and 10^{-5} .

Figure 8.2-4h indicates that the 10^{-4} and 10^{-5} rock UHRS for Jackson using the Updated GMM generally is lower than the rock UHRS using the EPRI (2004, 2006) GMM, except for PGA, where the rock UHRS are about the same for the two models.

8.2.5 Manchester Site

Hazard results for the Manchester site are shown on Figures 8.2-5a through 8.2-5g. This is a site where the hazard is dominated by background sources, with a small contribution from the distant Charlevoix source. PGA hazard from the background sources is about the same for the EPRI (2004, 2006) GMM and the Updated GMM. For other spectral frequencies, the hazard is lower for the Updated GMM. Note in the high-frequency hazard plots that the total hazard (red curves) are overlain by the background hazard (brown curves) for both ground-motion models, so only the background hazard curves show on the plots. Figure 8.2-5h indicates that the 10^{-4} and 10^{-5} rock UHRS is about the same for PGA but is lower for the Updated GMM than for the EPRI (2004, 2006) GMM.

8.2.6 Savannah Site

Hazard results for the Savannah site are shown on Figures 8.2-6a through 8.2-6g. This site is located close to the Charleston seismic source, and seismic hazard at all spectral frequencies is dominated by that source. For PGA, seismic hazards increase very slightly between annual frequencies of 10^{-4} and 10^{-5} using the Updated GMM compared to the EPRI (2004, 2006) GMM. For other spectral frequencies, seismic hazards are lower for the Updated GMM than for the EPRI (2004, 2006) GMM. This difference is summarized on Figure 8.2-6h, which shows the 10^{-4} and 10^{-5} rock UHRS for the two models.

8.2.7 Topeka Site

Hazard results are shown on Figures 8.2-7a through 8.2-7g for the Topeka site. This is a site where the hazard at high spectral frequencies (5 Hz and above) is dominated by background sources, with a small contribution from the NMFS. At low spectral frequencies (2.5 Hz and lower), the hazard is generally dominated by the NMFS, with some contribution from background sources, particularly at higher ground-motion amplitudes. Comparing seismic hazards from the two ground-motion models, hazards are about the same for PGA; for other spectral frequencies (25 Hz and lower), the Updated GMM indicates lower seismic hazards than does the EPRI (2004, 2006) GMM. This difference is summarized on Figure 8.2-7h, which shows the 10^{-4} and 10^{-5} rock UHRS for the two ground-motion models.

8.2.8 Comparison of Hazard by Equation

It is instructive to compare seismic hazard by equation for the two ground-motion models. Figures 8.2-8, 8.2-9, and 8.2-10 illustrate this comparison for the Chattanooga site, for PGA, 10 Hz, and 1 Hz, respectively. The hazard is shown for the 9 ground-motion equations used for background sources (general, nonrift sources) in both the EPRI (2004, 2006) GMM and the Updated GMM. Equation designations are as follows:

- C1L: Cluster 1 Low equation
- C1M: Cluster 1 Median equation
- C1H: Cluster 1 High equation
- C2L: Cluster 2 Low equation
- C2M: Cluster 2 Median equation
- C2H: Cluster 2 High equation
- C3L: Cluster 3 Low equation
- C3M: Cluster 3 Median equation
- C3H: Cluster 3 High equation

Note that nongeneral, rift sources (“RLME sources,” in the designation of the CEUS SSC report) use 12 equations, but they are correlated with the 9 equations above, as indicated in Appendix G, Figure G.3.3-1.

Note also that each equation listed above has an associated weight attached, and weights for the Updated GMM are different from those for the EPRI (2004, 2006) GMM. These weights are taken into account in calculating the overall hazard and UHRS for each of the seven test sites. In addition, the criteria used to define Clusters 2 and 3 changed between the EPRI (2004, 2006) GMM and the Updated GMM, so one should be careful when comparing original versus updated results for one of these clusters.

Figure 8.2-8 (for PGA) shows that equations for the Updated GMM indicate a range of seismic hazards that is similar to the range of seismic hazards for the EPRI (2004, 2006) GMM. Figure 8.2-9 (for 10 Hz spectral acceleration) and Figure 8.2-10 (for 1 Hz spectral acceleration) show that equations for the Updated GMM indicate a range of seismic hazards that is somewhat lower than the range of seismic hazards for the EPRI (2004, 2006) GMM. This observation is consistent with the comparison of hazards between the EPRI (2004, 2006) GMM and the Updated GMM made for Chattanooga and other sites in this chapter.

These results, and the results shown earlier in this chapter, can generally be explained in terms of the comparisons in GMPE space presented in Section 7.12.1. For PGA (Figure 8.2-8), the curve that produces the highest hazard is the Cluster 2 high curve in the Updated GMM, which is consistent with the values on Figure 7.12.1-1 for the magnitude-distance combinations that dominate hazard (i.e., M near 6 and approximately 20 km, in the background zone). The mean hazard for PGA is roughly the same for EPRI (2004, 2006) and for the Updated GMM, which is consistent with the observation on Figure 7.12.1-8 for the dominant magnitude-distance combination, for which the mean and 84th percentile curves are comparable between EPRI (2004, 2006) and the Updated GMM.

For 10 Hz, which is dominated by the same magnitude-distance combinations as PGA, the curve that produces the highest hazard is the EPRI (2004, 2006) GMM Cluster 3 high curve, followed closely by the Updated Cluster 2 high curve. Again, this is consistent with Figure 7.12.1-2. The mean hazard is lower for the Updated GMM than for the EPRI (2004, 2006) GMM, which is also consistent with Figure 7.12.1-9, which shows that the mean and 84th percentile curves are roughly 20% higher for the EPRI (2004, 2006) GMM than for the Updated GMM. It is also worth noting that none of the GMPEs in the EPRI (2004, 2006) GMM Cluster 3 are currently supported by their developers.

For 1 Hz, these comparisons are somewhat more difficult because both the New Madrid RLME (approximately 400 km away) and the background zone contribute to the hazard, and because the former is affected by differences in Q for the Gulf region portion of the travel path. The curve that produces the highest hazard is the EPRI (2004, 2006) GMM Cluster 3 high curve, and the next highest hazard curve is lower by approximately a factor of three. This is consistent with Figure 7.12.1-6, which shows that the EPRI (2004, 2006) GMM Cluster 3 high curve is much higher than other curves for M 7.5 and distances of several hundred kilometers. As mentioned earlier, none of the GMPEs in the EPRI (2004, 2006) GMM Cluster 3 are currently supported by

their developers. In terms of the contribution from the background at 1 Hz, Figure 7.12.1-6, Cluster 1 of the Updated GMM has the highest amplitudes, but is followed closely by Clusters 1 and 3 of the EPRI (2004, 2006) GMM. It is also worth noting that Cluster 1 gets lower weight in the Updated GMM than in the EPRI (2004, 2006) GMM.

In summary, the results obtained here can be explained in terms of the comparisons in Section 7.12.1. These comparisons suggest that the main causes for the observed differences in hazard are the removal of EPRI (2004, 2006) GMM Cluster 3 (which consists of GMPEs that are no longer supported by their developers) and the reduction of the weight for Cluster 1 (which receives lower weight because it is less consistent with the recordings).

Comparisons of this kind are useful, but they have limitations because many elements of the GMM have changed. Other issues that are not considered in the above comparisons are changes in the Gulf coastal region and changes in the model for aleatory variability:

- *Changes in the Gulf coastal region.* The geographic extent of the Gulf coastal region has been expanded, the differences between the Midcontinent and Gulf GMPEs at long distances have diminished because the Midcontinent and Gulf anelastic-attenuation models are more similar than they were in the EPRI (2004, 2006) GMM, and there are essentially no differences between the Midcontinent and Gulf GMMs at short distance. The combined effect of these changes is site-specific, as shown earlier in this chapter.
- *Changes in the model for aleatory variability.* The Updated GMM (see Section 7.10) makes sigma amplitude dependent, with higher values for M 5, slightly lower values for M 6, and lower values for M 7 (except for 0.5 Hz, for which the updated values are nearly magnitude independent, but slightly higher than for the EPRI (2004, 2006) GMM). One can quantify the effects of these changes in an approximate manner by using the approach developed in Appendix I of EPRI (2004), even though the approach applies only to constant sigma. Figure 8.2-11 is constructed using that approach, assuming a typical value of 3 for the logarithmic slope of the hazard curve. For 10 Hz and PGA, the differences in sigma between the EPRI (2004, 2006) GMM and the Updated GMM for M 6 are 0.25 or less, which indicates a less than 10 percent effect on amplitude for a given hazard. For 1 Hz, the differences are even smaller, which indicates a smaller event. In summary, the effect of changes in the aleatory uncertainty model are smaller than the effect of changes in the GMPEs that comprise the GMM.

Table 8.1-1
Description of Seven Test Sites

Test Site Name	N. Latitude	W. Longitude	Reason for Selection
Central Illinois	40.000	-90.000	Hazard from New Madrid seismic zone and paleo-earthquake zones in central Illinois
Chattanooga	35.064	-85.255	Hazard from Eastern Tennessee seismic zone
Houston	29.760	-95.363	Hazard in Gulf Coast region
Jackson	32.312	-90.178	Hazard from New Madrid seismic zone
Manchester	42.991	-71.463	Hazard in New England
Savannah	32.082	-81.097	Hazard from Charleston source
Topeka	39.047	-95.682	Hazard in central plains region

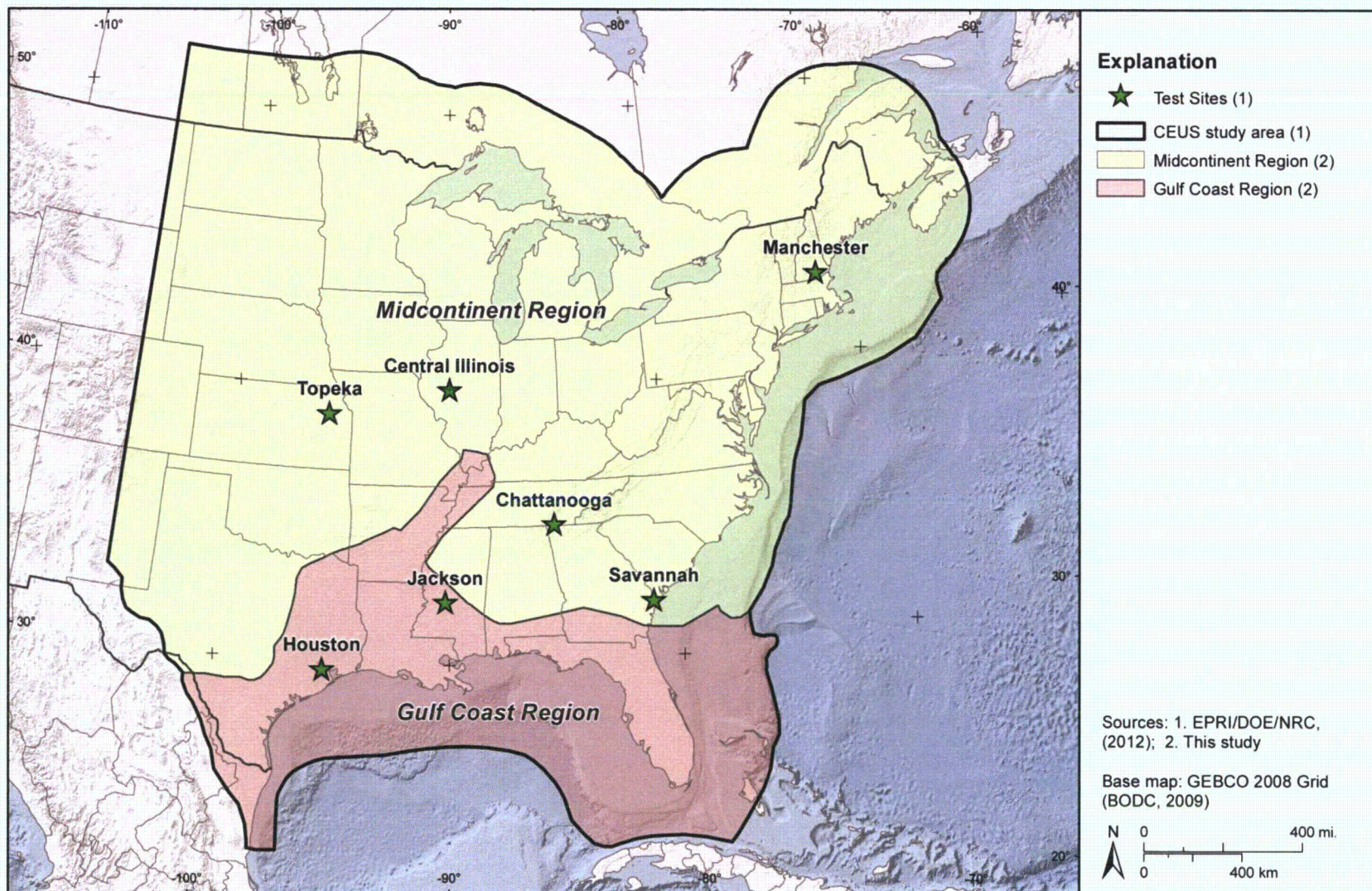


Figure 8.1-1
Project study region showing sub-regions for the Updated EPRI (2004, 2006) Ground-Motion Model and 7 test site locations for seismic hazard calculations

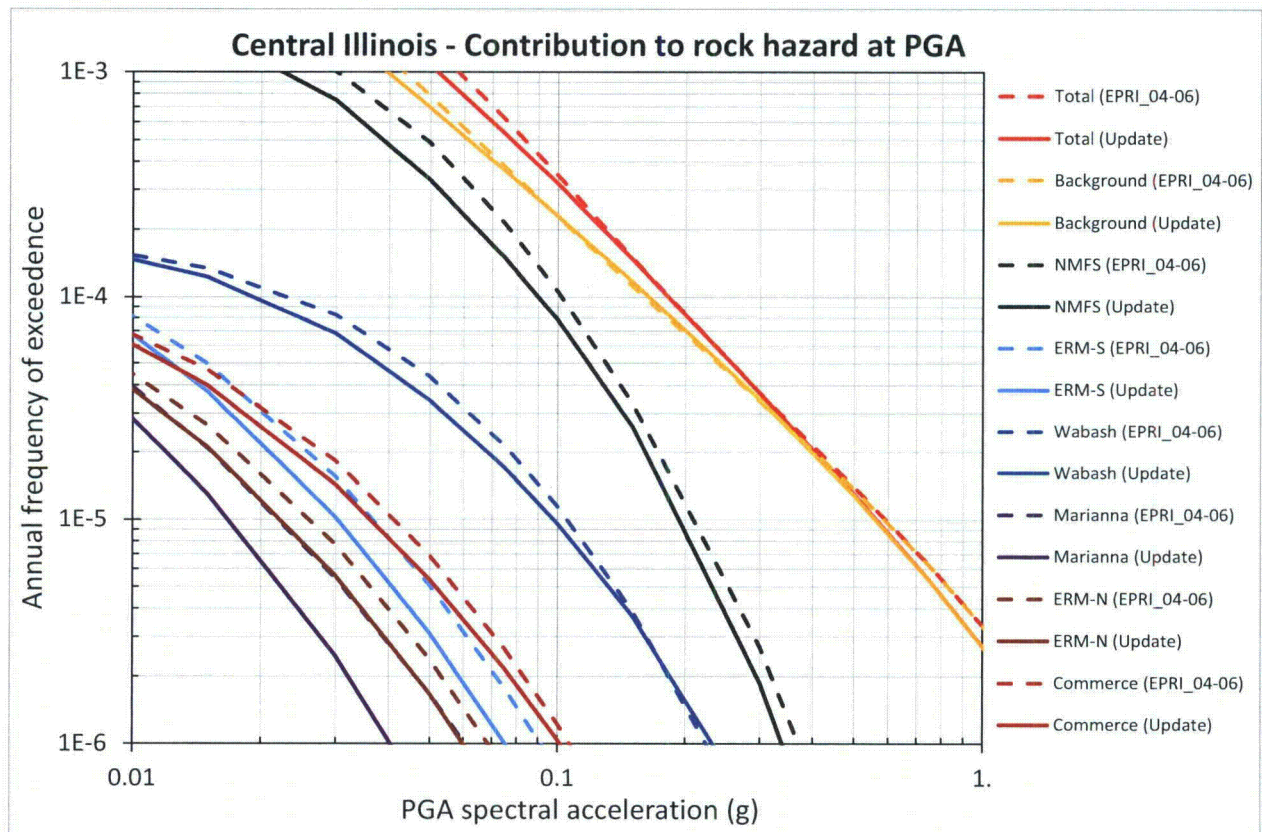


Figure 8.2-1a
Central Illinois site, contribution to rock PGA hazard by seismic source

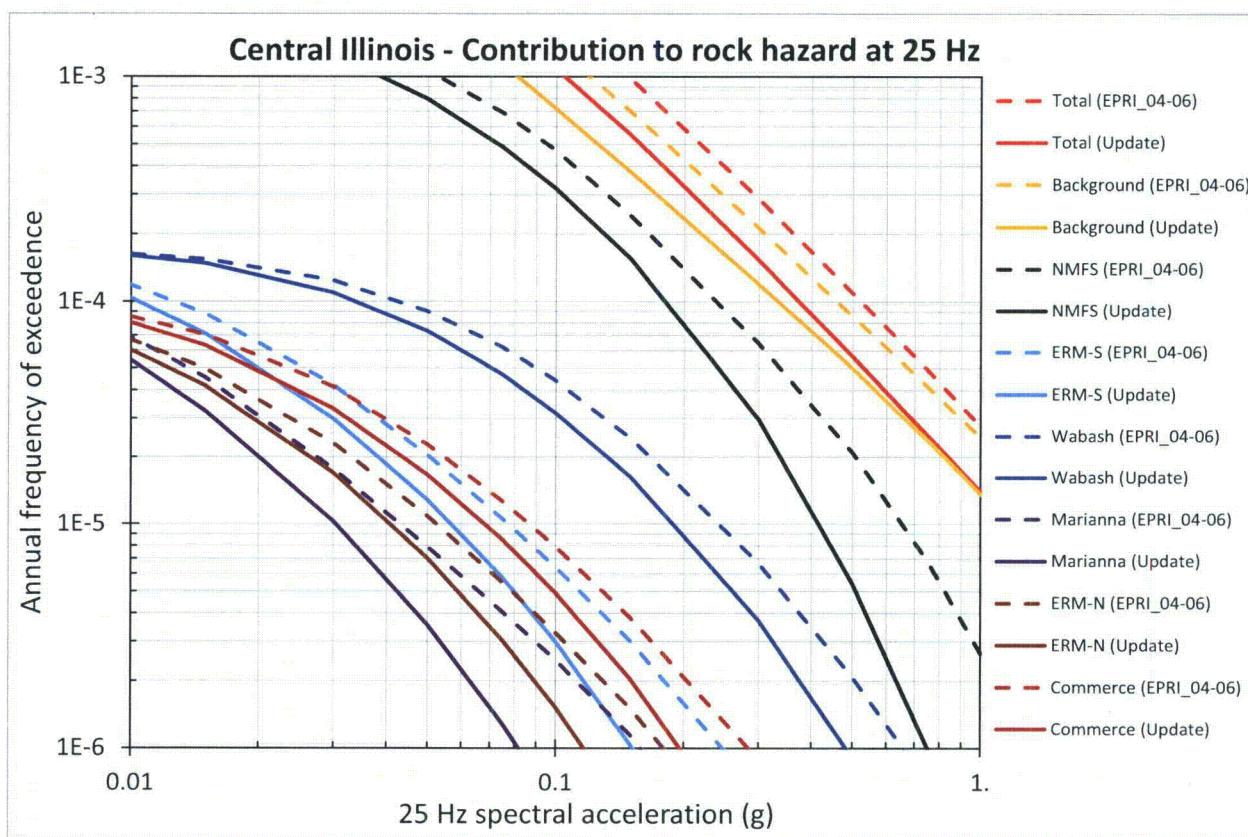


Figure 8.2-1b
Central Illinois site, contribution to rock 25 Hz hazard by seismic source

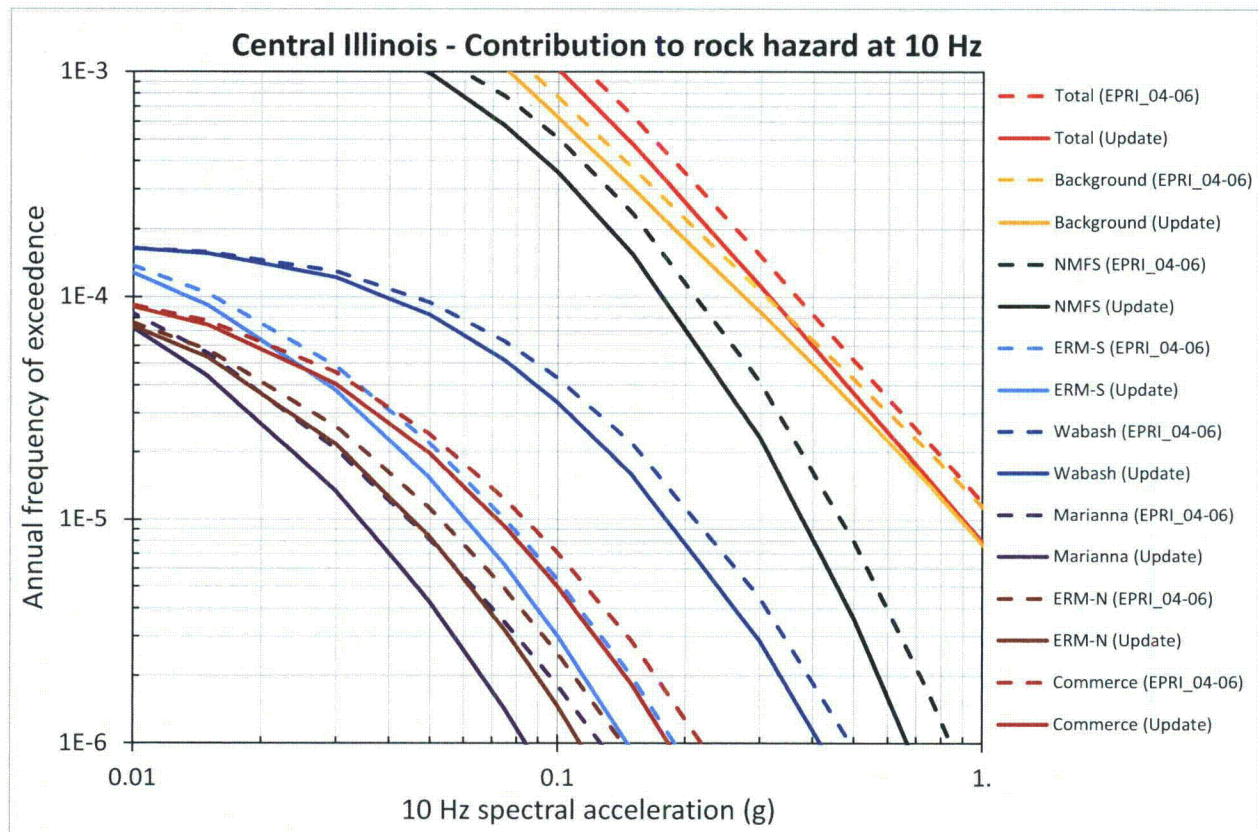


Figure 8.2-1c
Central Illinois site, contribution to rock 10 Hz hazard by seismic source

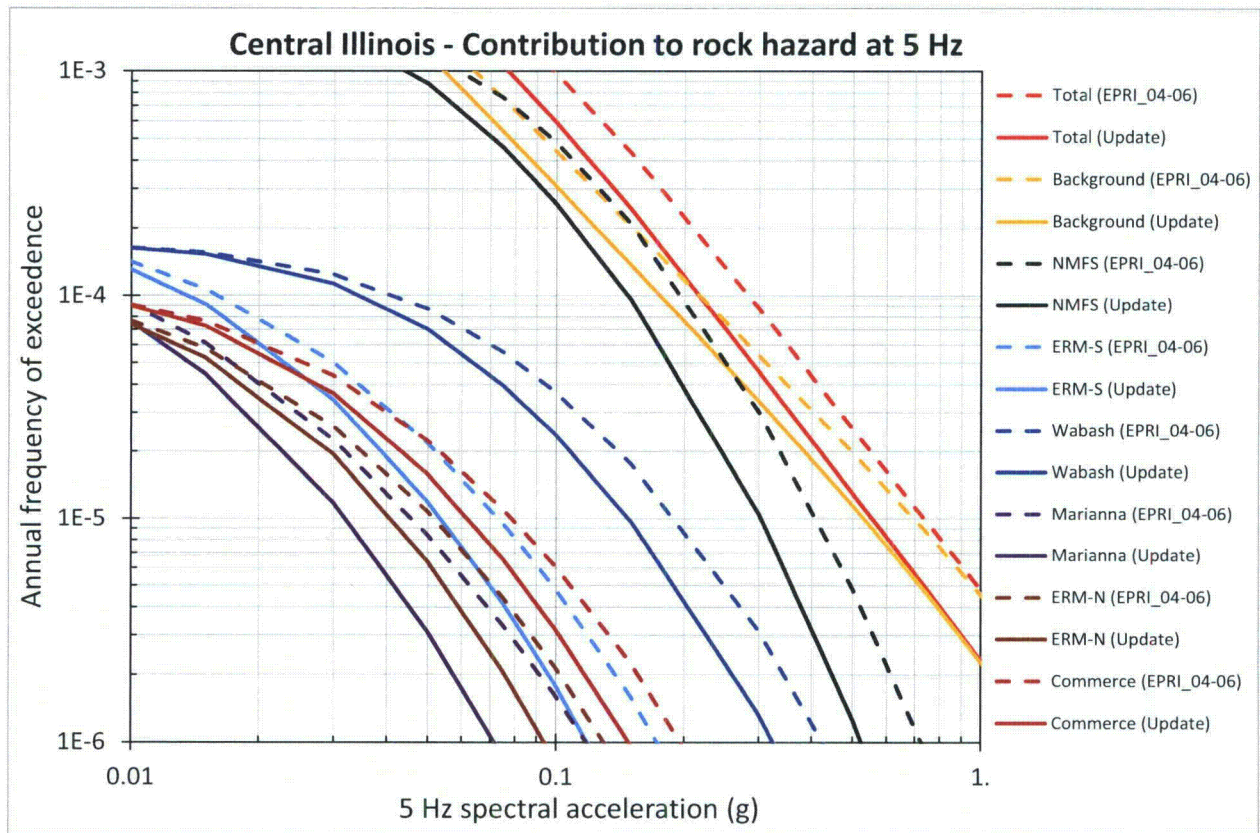


Figure 8.2-1d
Central Illinois site, contribution to rock 5 Hz hazard by seismic source

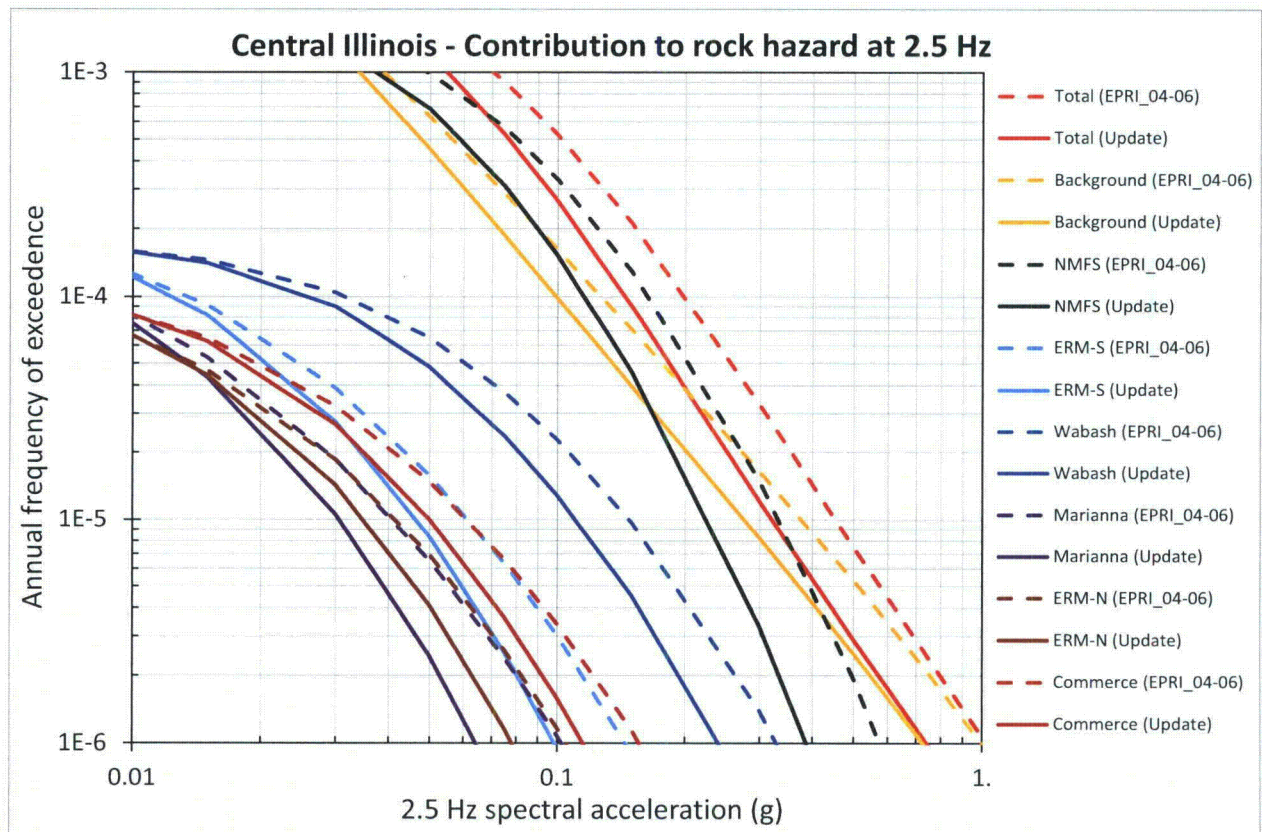


Figure 8.2-1e
Central Illinois site, contribution to rock 2.5 Hz hazard by seismic source

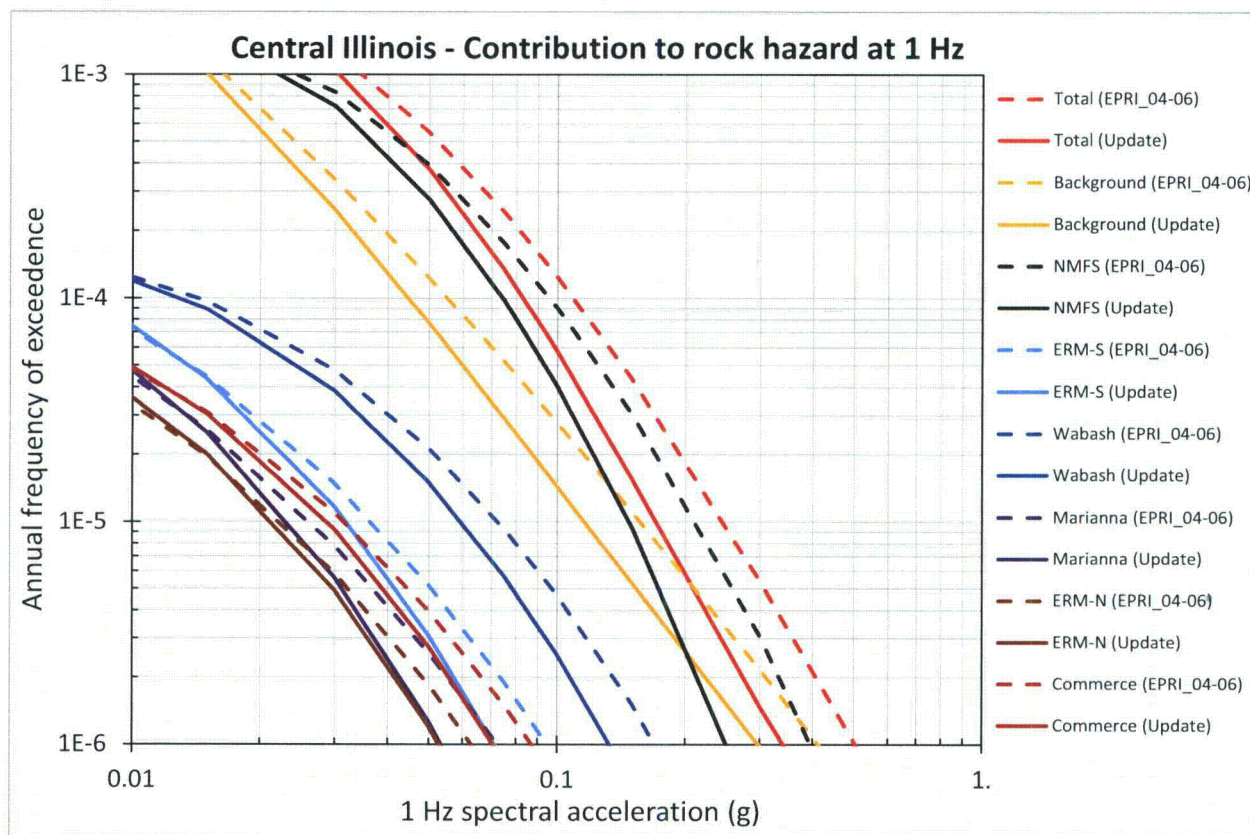


Figure 8.2-1f
Central Illinois site, contribution to rock 1 Hz hazard by seismic source

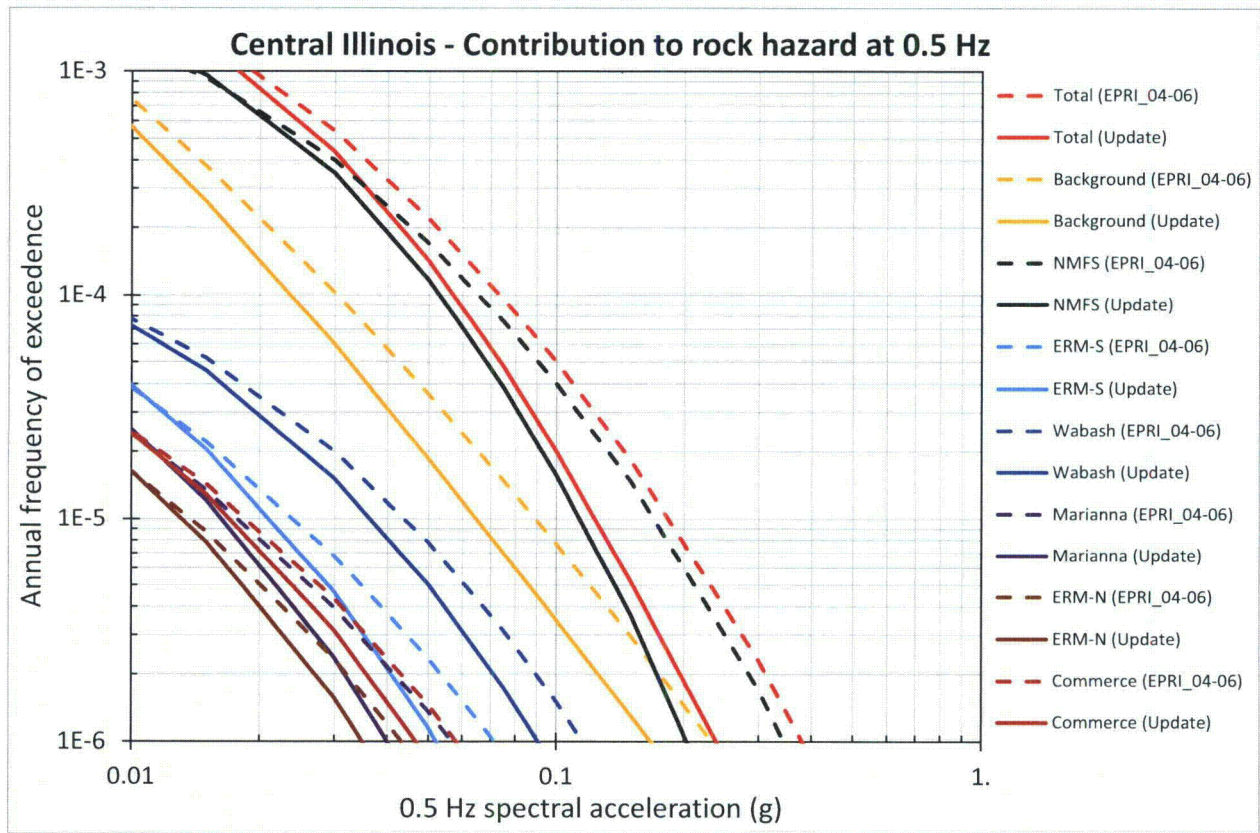


Figure 8.2-1g
Central Illinois site, contribution to rock 0.5 Hz hazard by seismic source

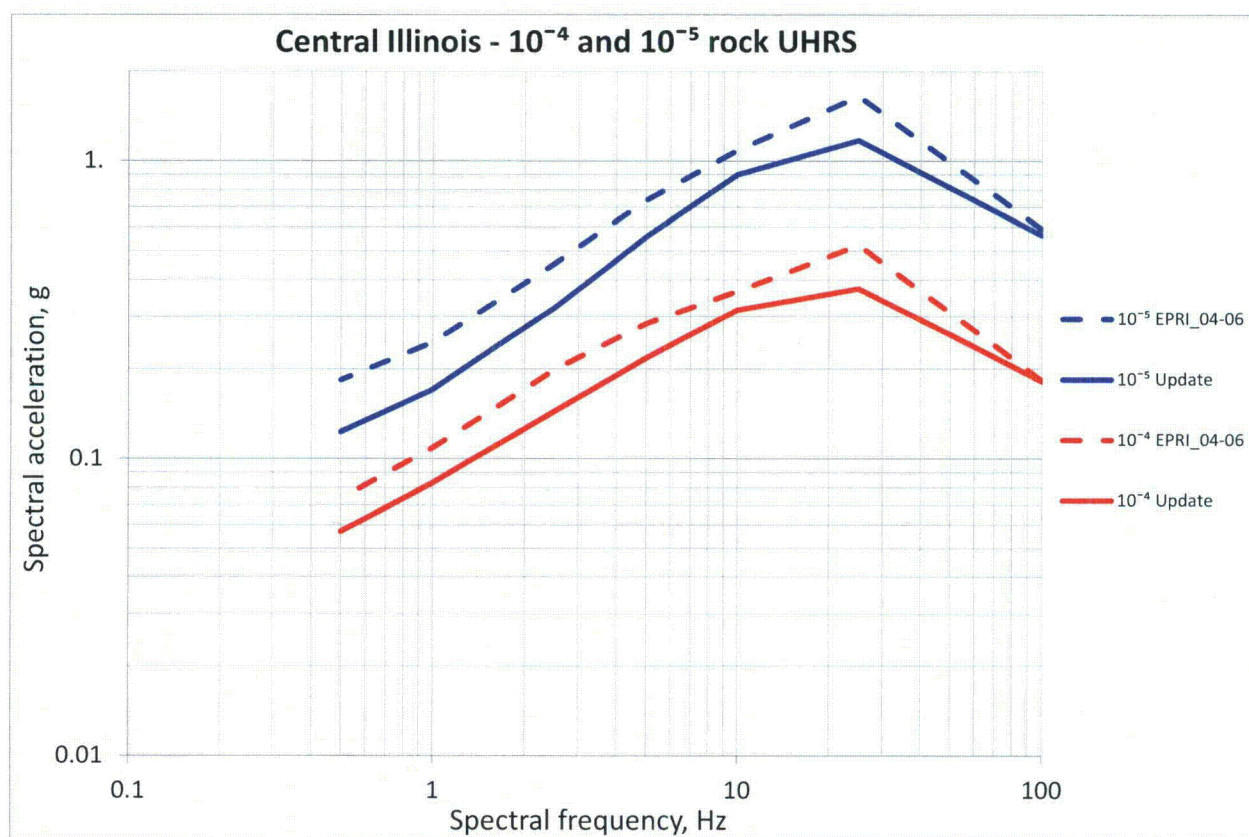


Figure 8.2-1h
Central Illinois site, 10^{-4} and 10^{-5} rock UHRs

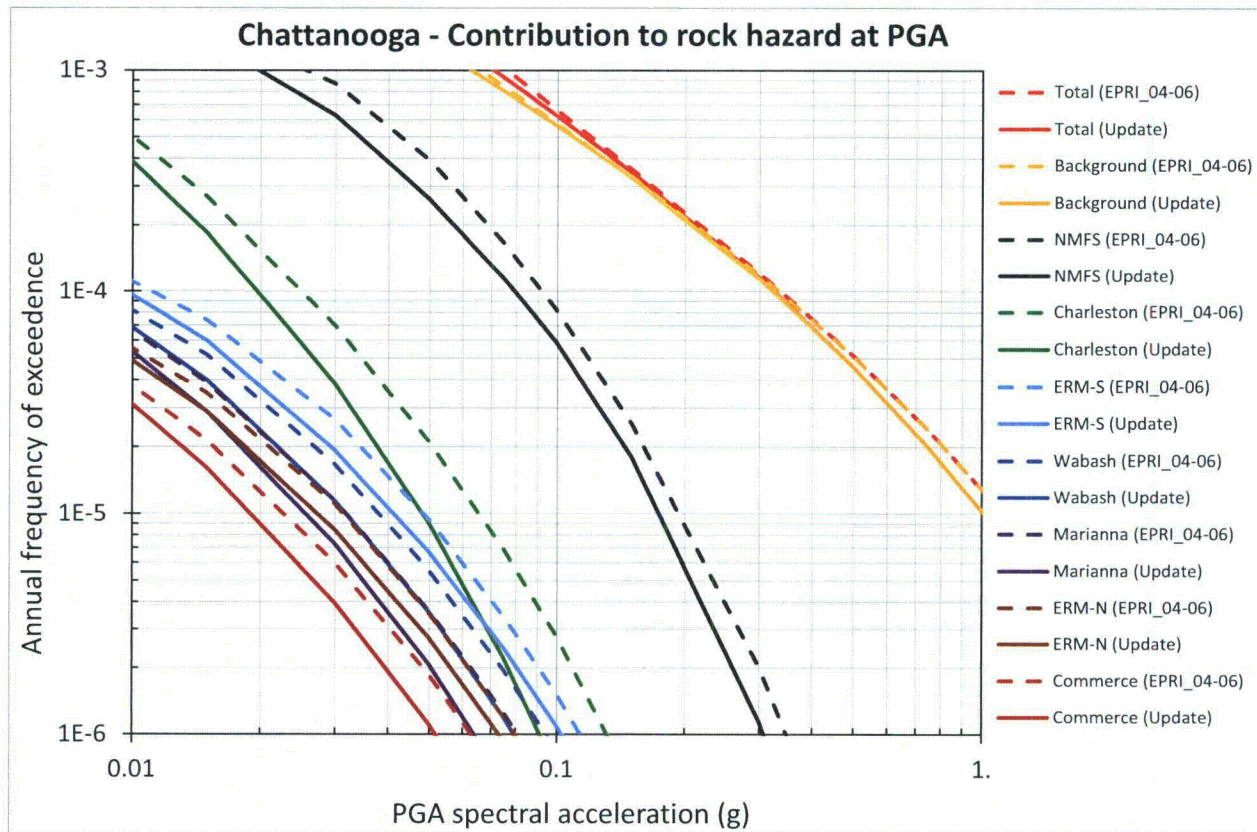


Figure 8.2-2a
Chattanooga site, contribution to rock PGA hazard by seismic source

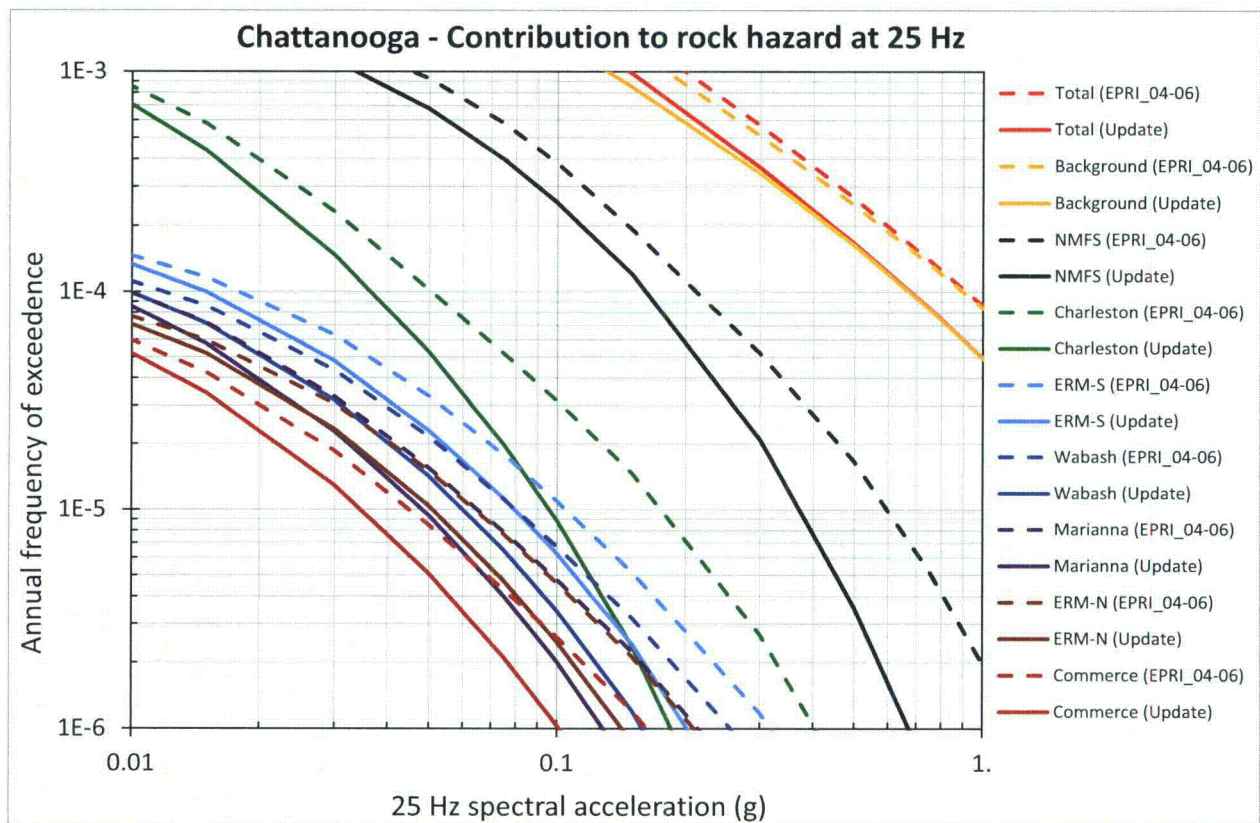


Figure 8.2-2b
Chattanooga site, contribution to rock 25 Hz hazard by seismic source

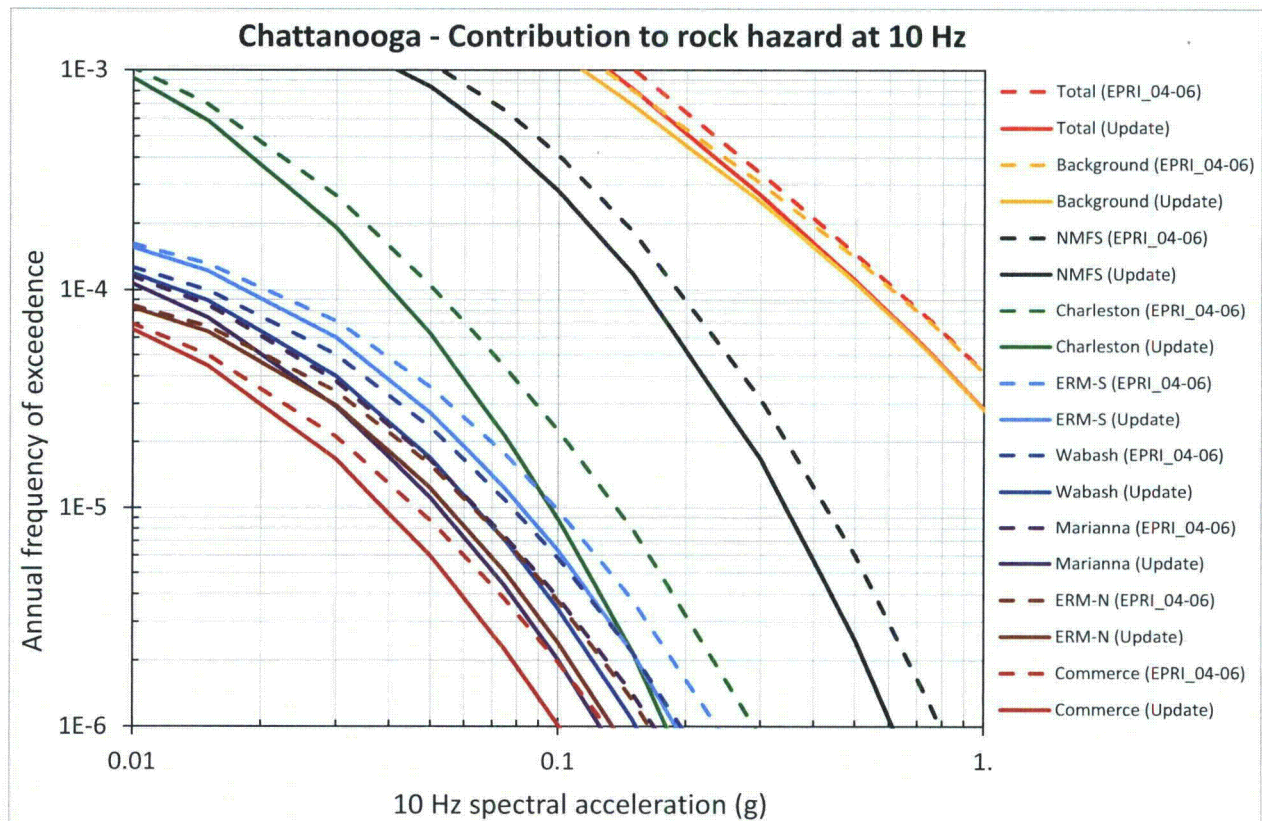


Figure 8.2-2c
Chattanooga site, contribution to rock 10 Hz hazard by seismic source

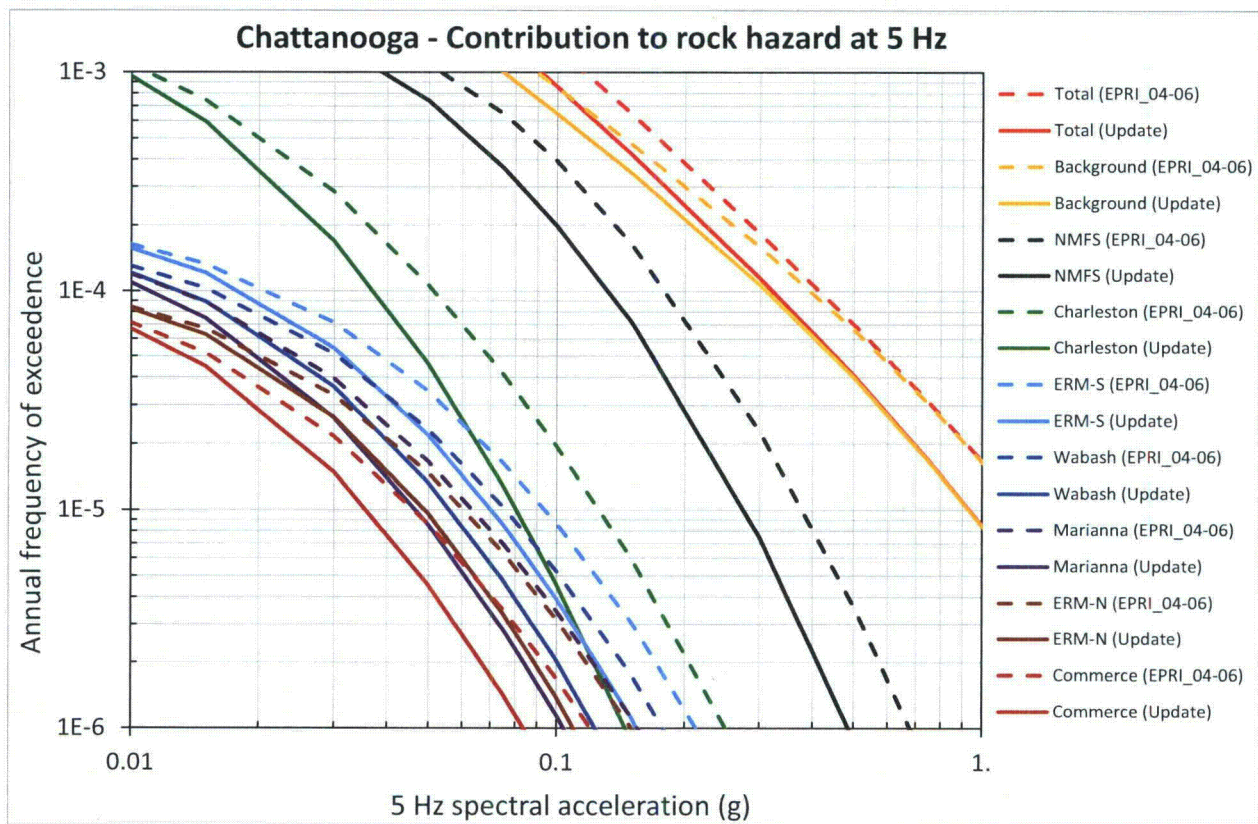


Figure 8.2-2d
Chattanooga site, contribution to rock 5 Hz hazard by seismic source

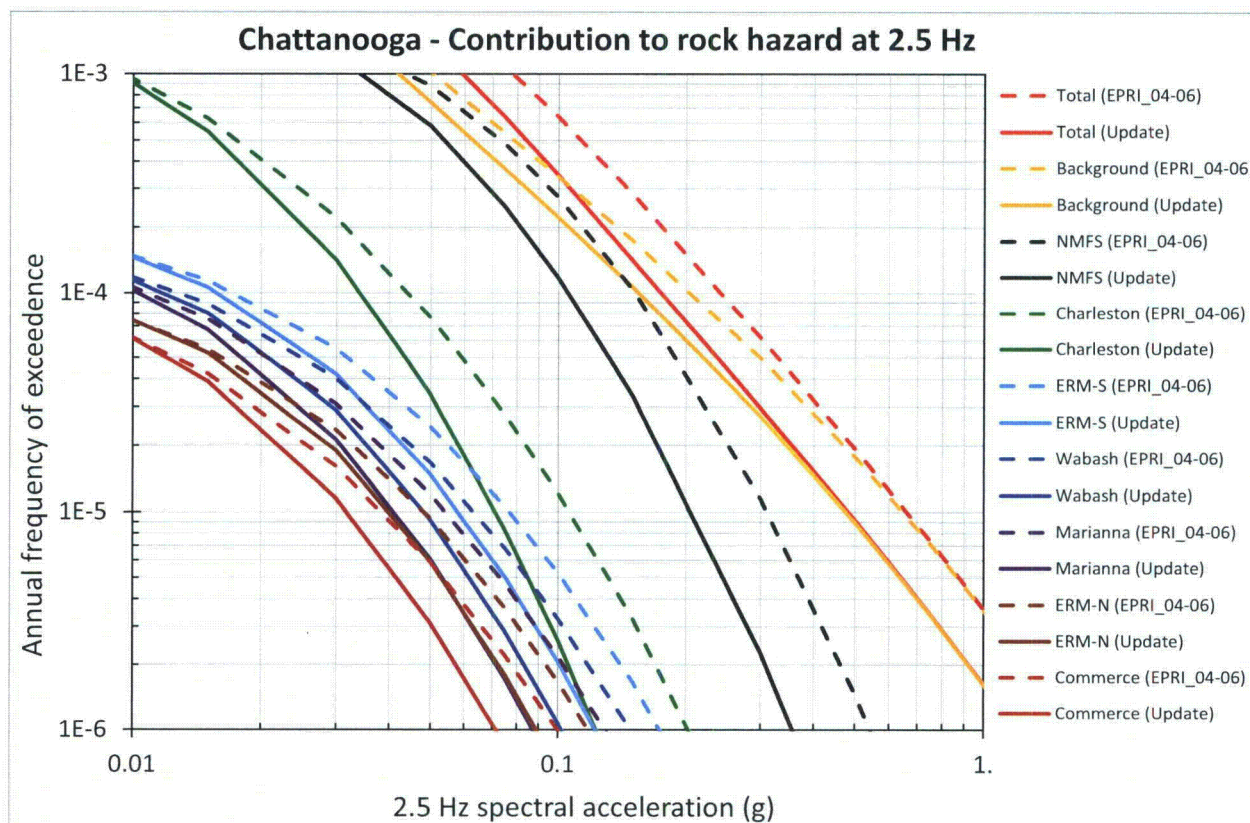


Figure 8.2-2e
Chattanooga site, contribution to rock 2.5 Hz hazard by seismic source

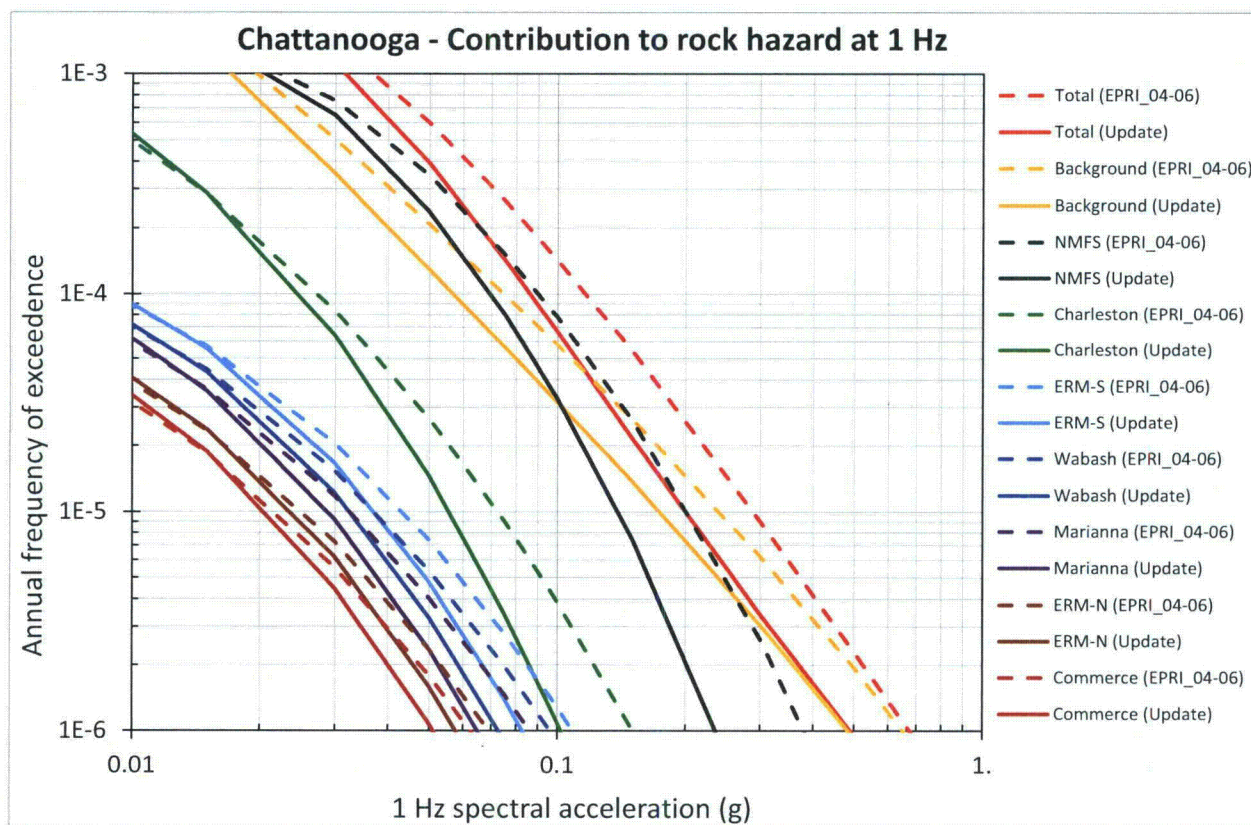


Figure 8.2-2f
Chattanooga site, contribution to rock 1 Hz hazard by seismic source

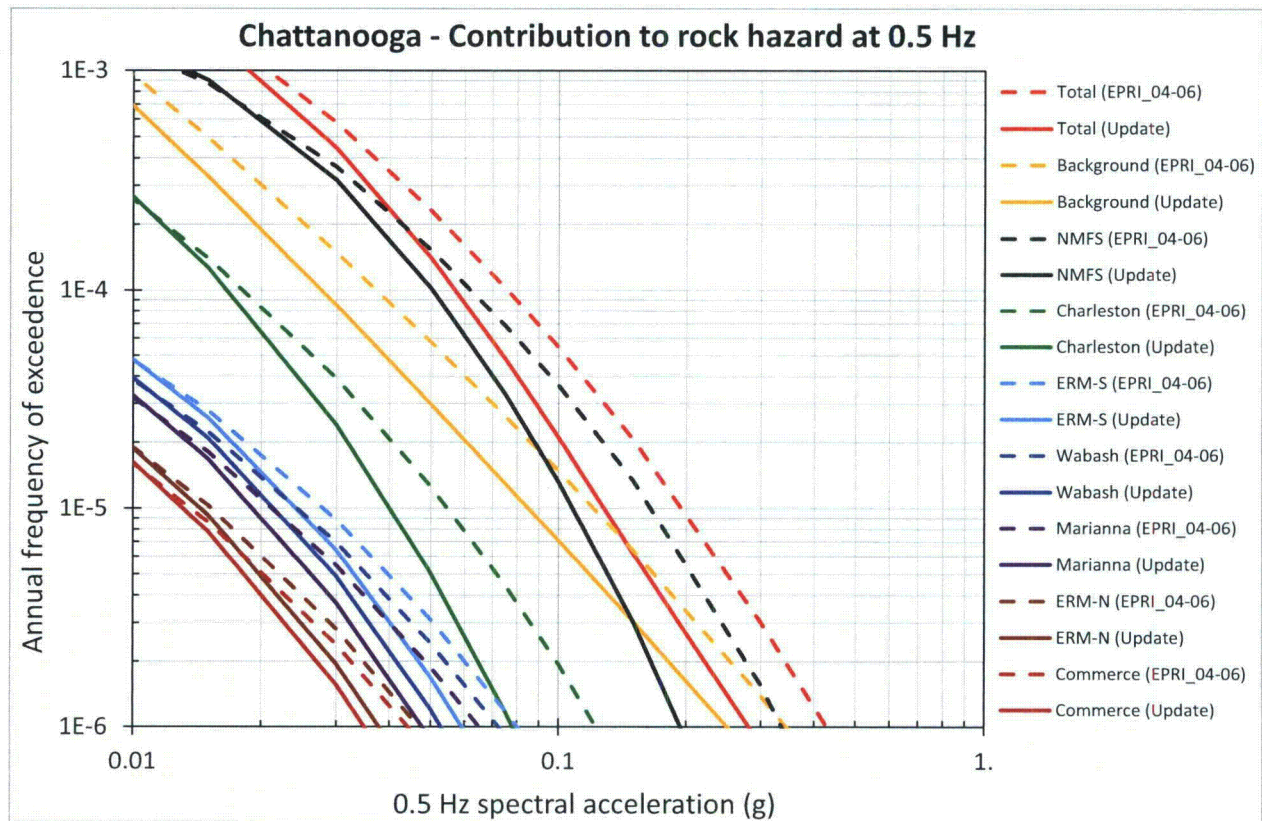


Figure 8.2-2g
Chattanooga site, contribution to rock 0.5 Hz hazard by seismic source

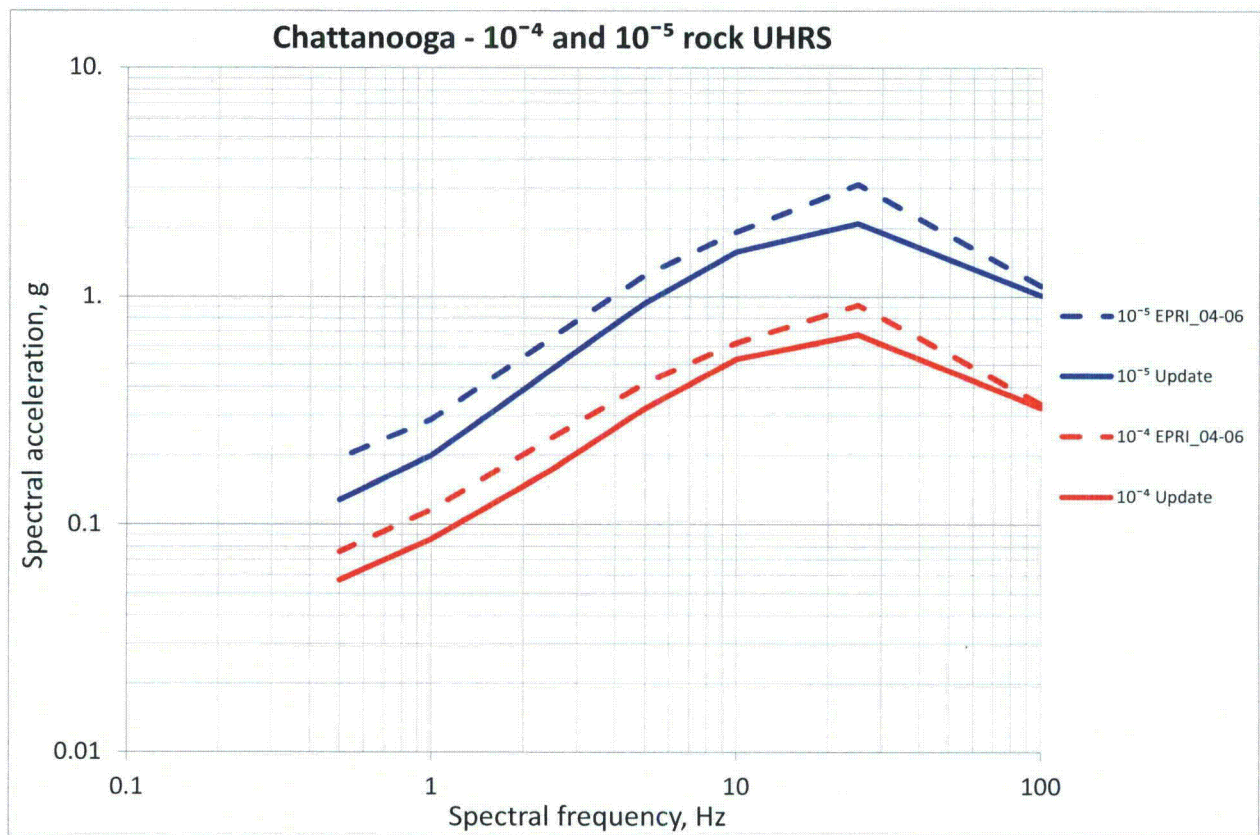


Figure 8.2-2h
Chattanooga site, 10^{-4} and 10^{-5} rock UHRS

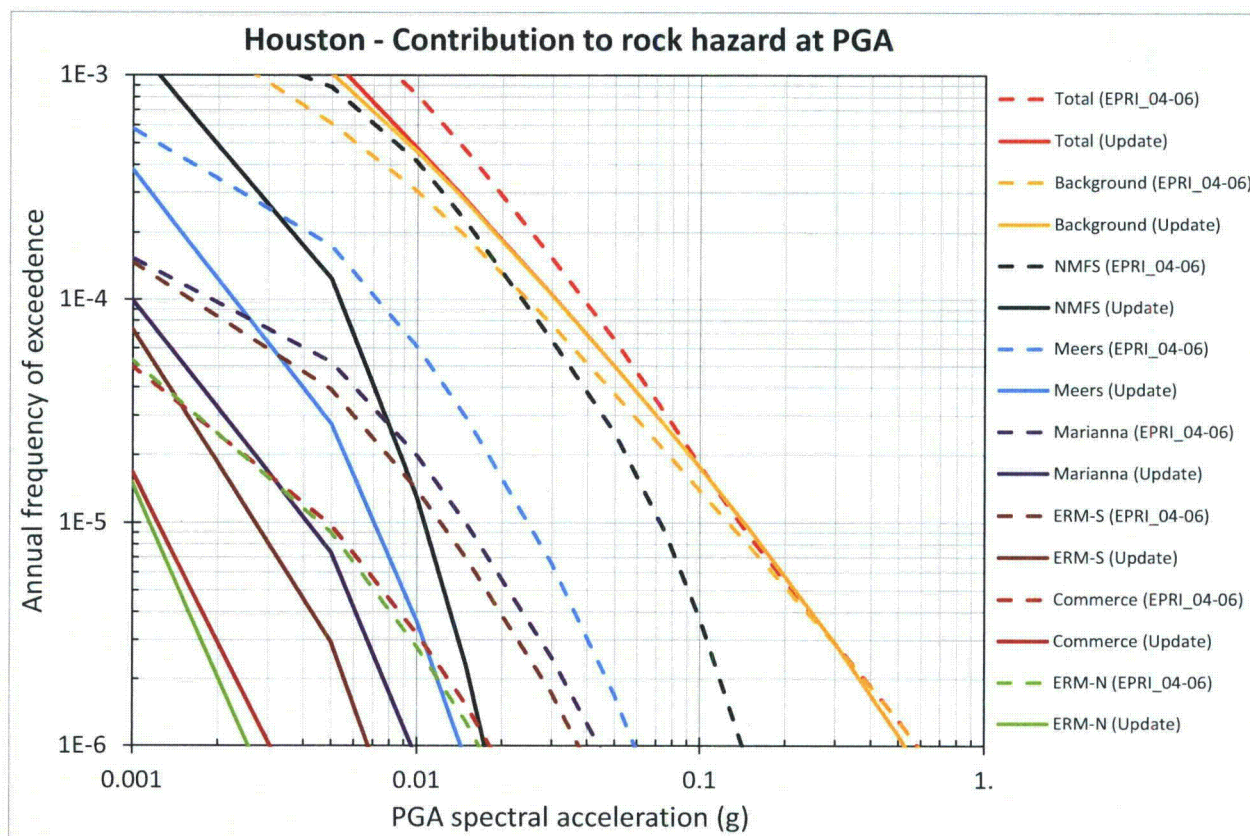


Figure 8.2-3a
Houston site, contribution to rock PGA hazard by seismic source

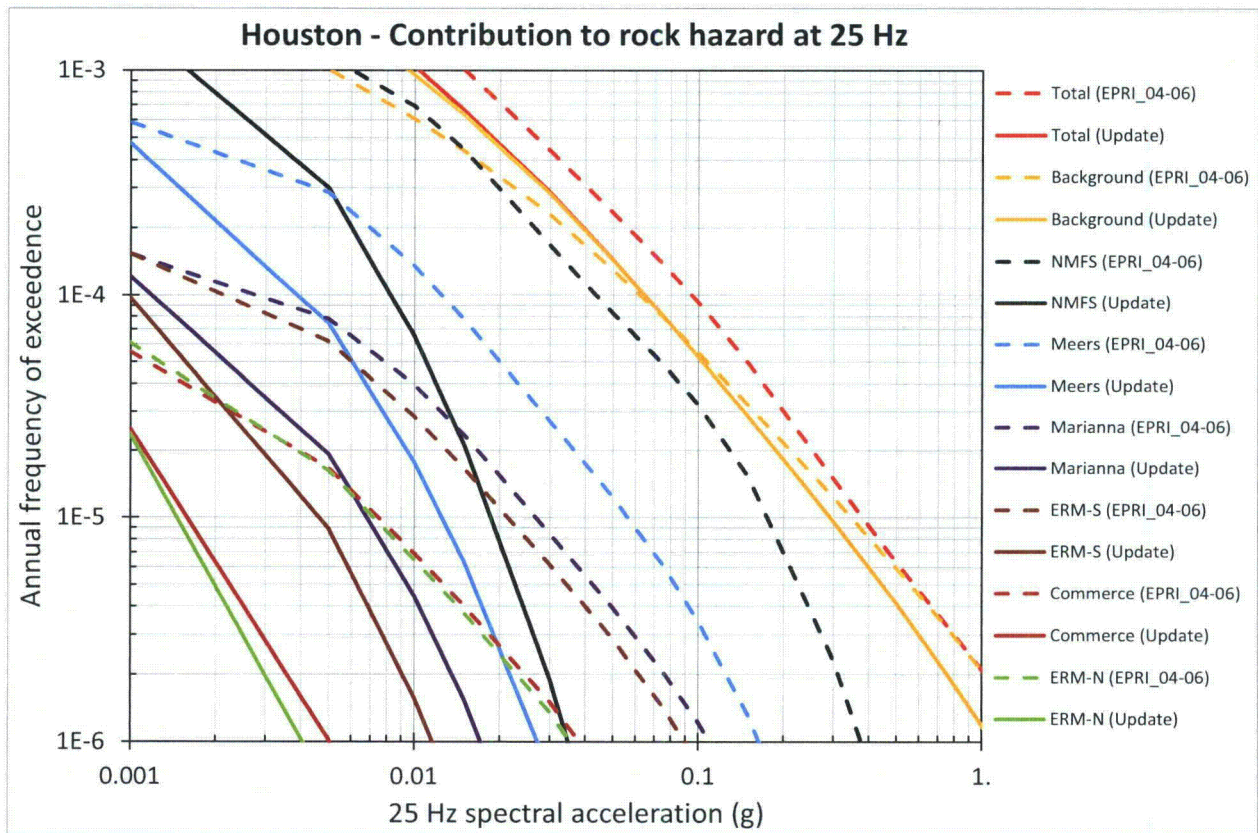


Figure 8.2-3b
Houston site, contribution to rock 25 Hz hazard by seismic source

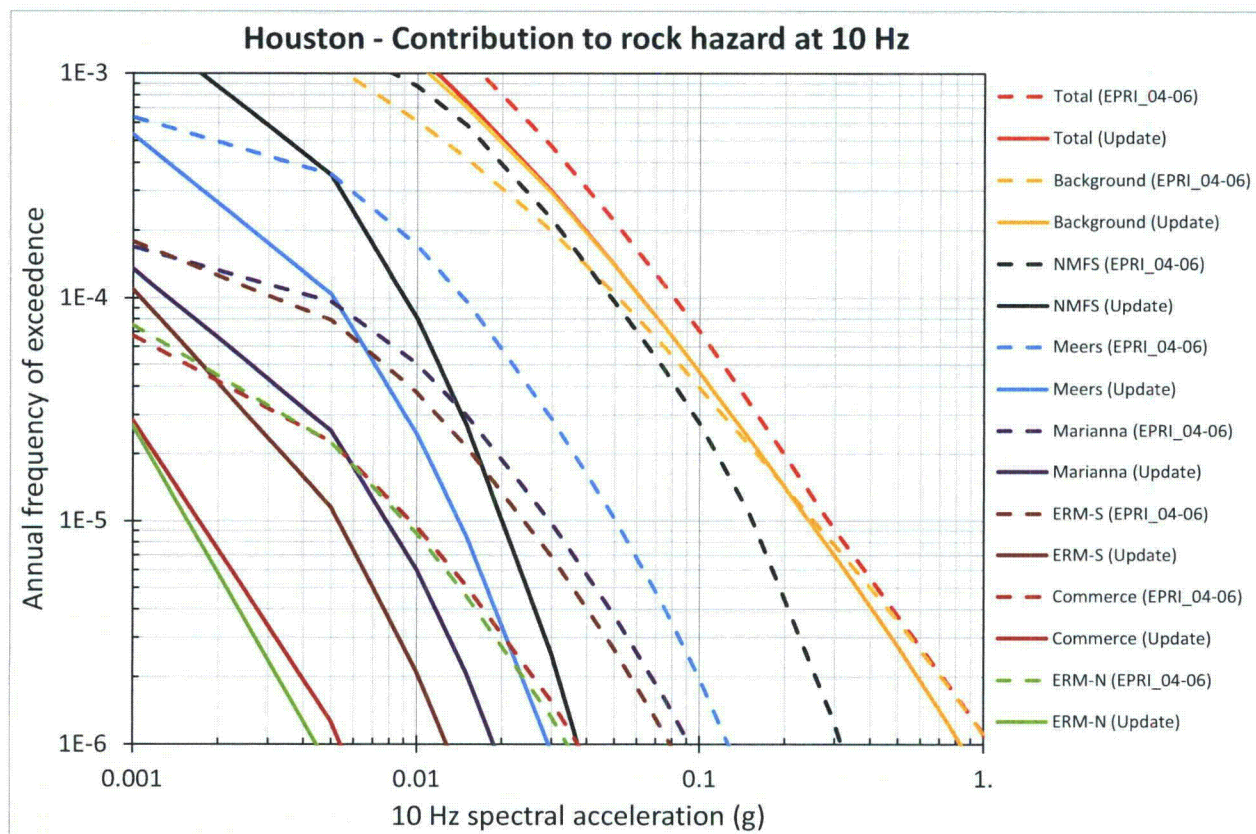


Figure 8.2-3c
Houston site, contribution to rock 10 Hz hazard by seismic source

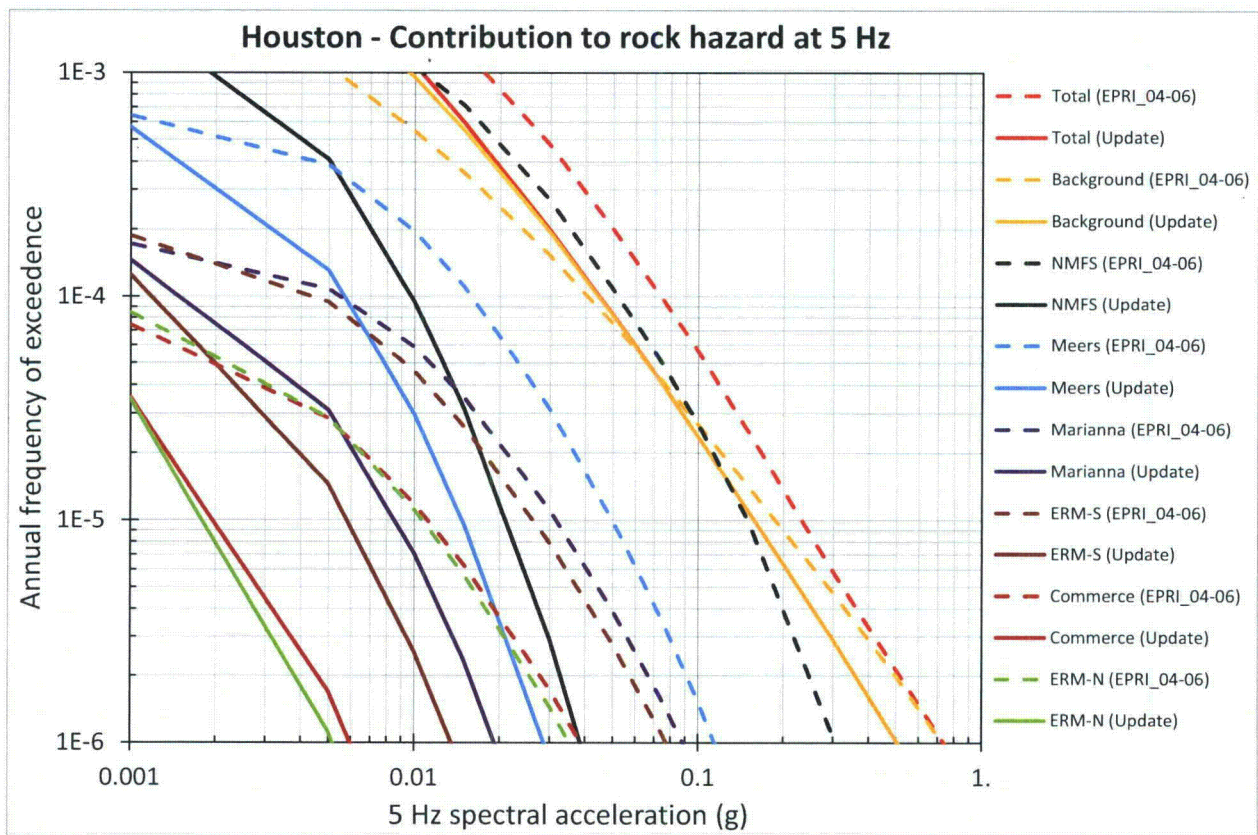


Figure 8.2-3d
Houston site, contribution to rock 5 Hz hazard by seismic source

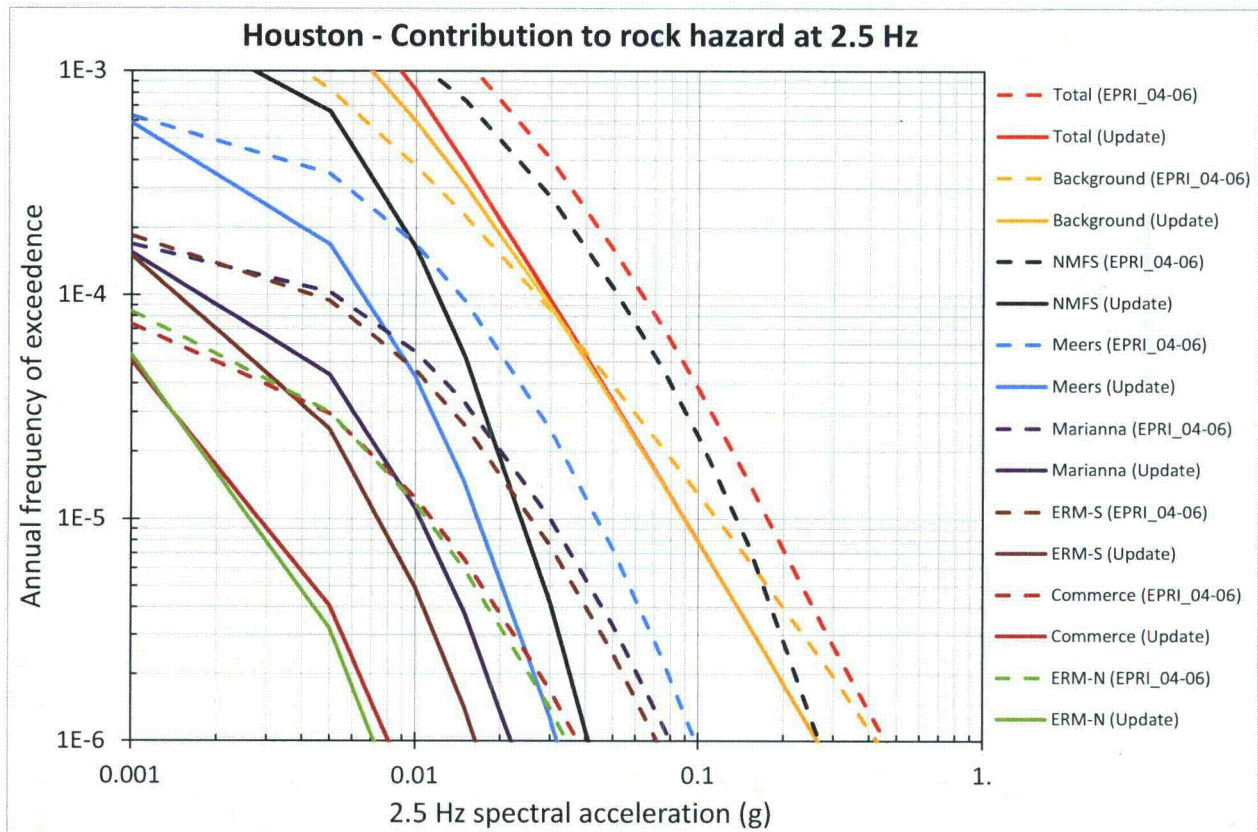


Figure 8.2-3e
Houston site, contribution to rock 2.5 Hz hazard by seismic source

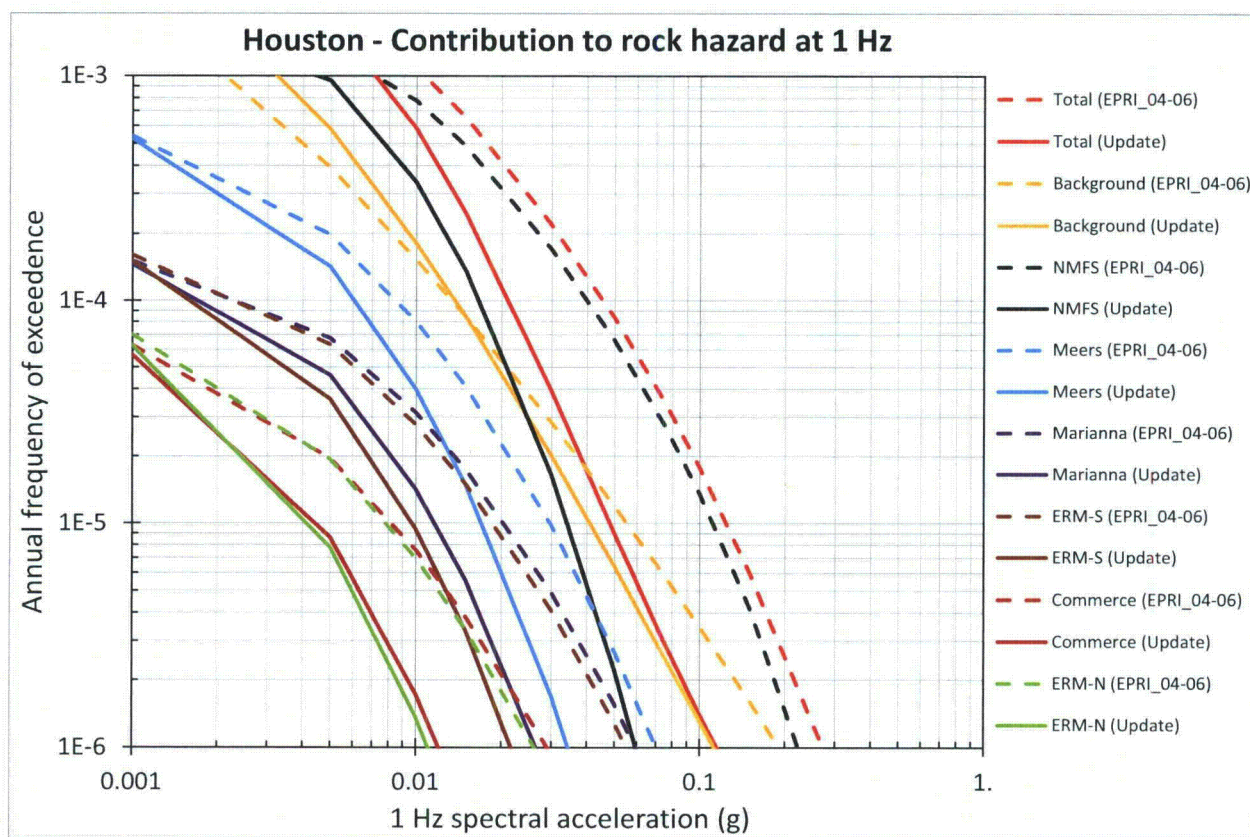


Figure 8.2-3f
Houston site, contribution to rock 1 Hz hazard by seismic source

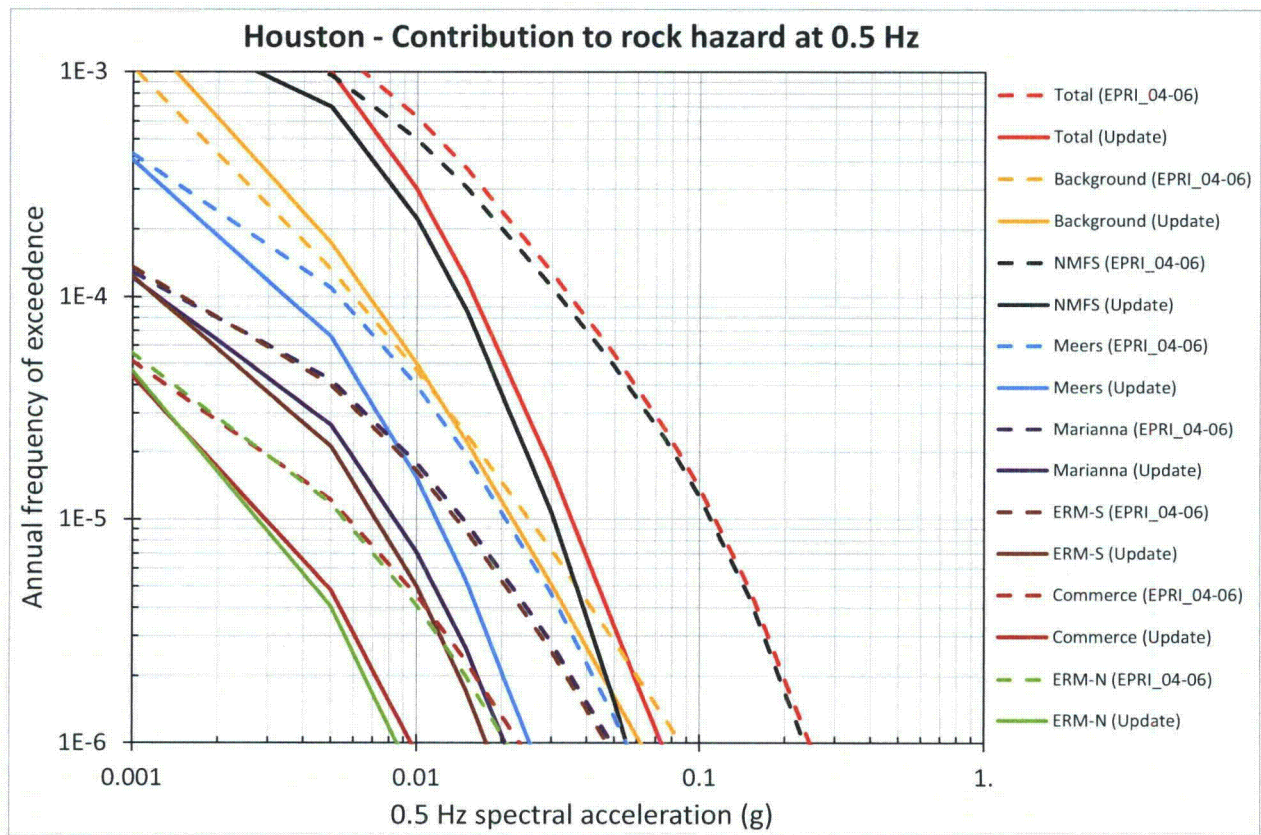


Figure 8.2-3g
Houston site, contribution to rock 0.5 Hz hazard by seismic source

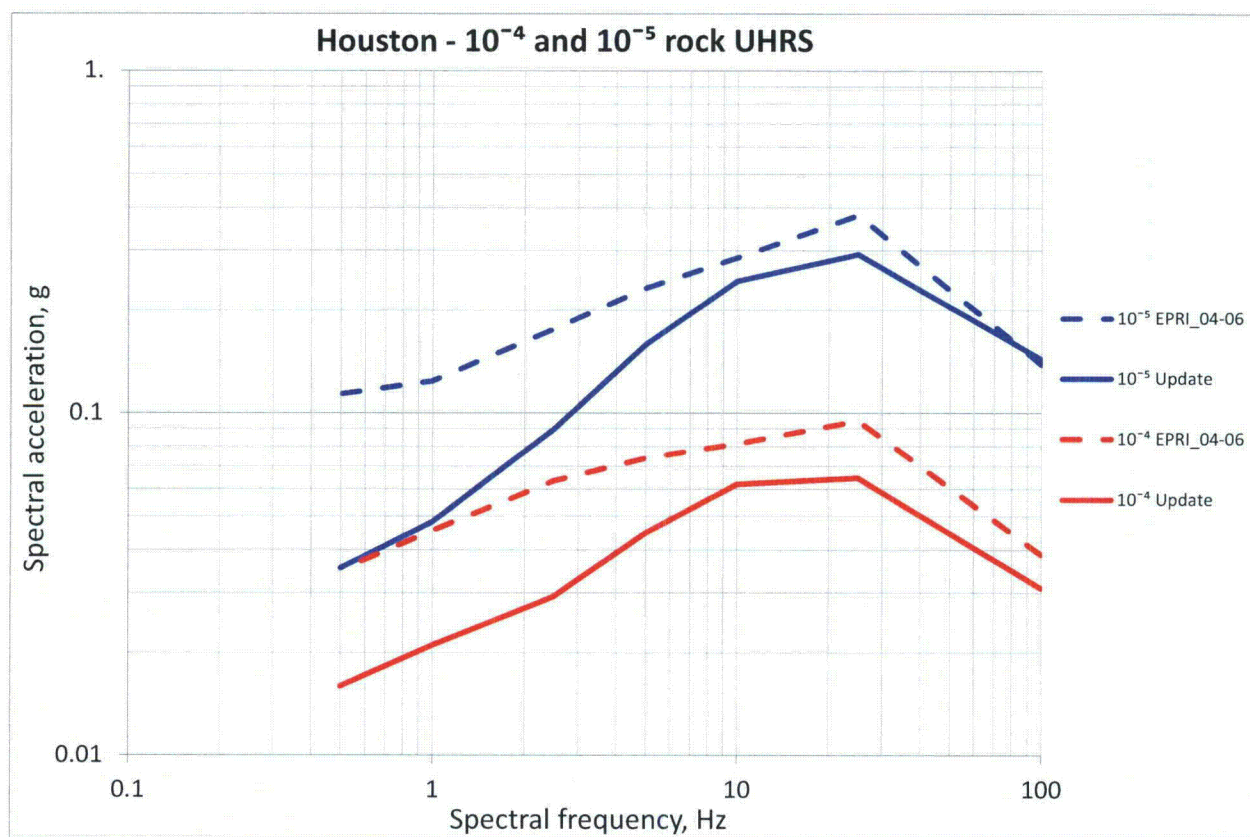


Figure 8.2-3h
Houston site, 10^{-4} and 10^{-5} rock UHRS

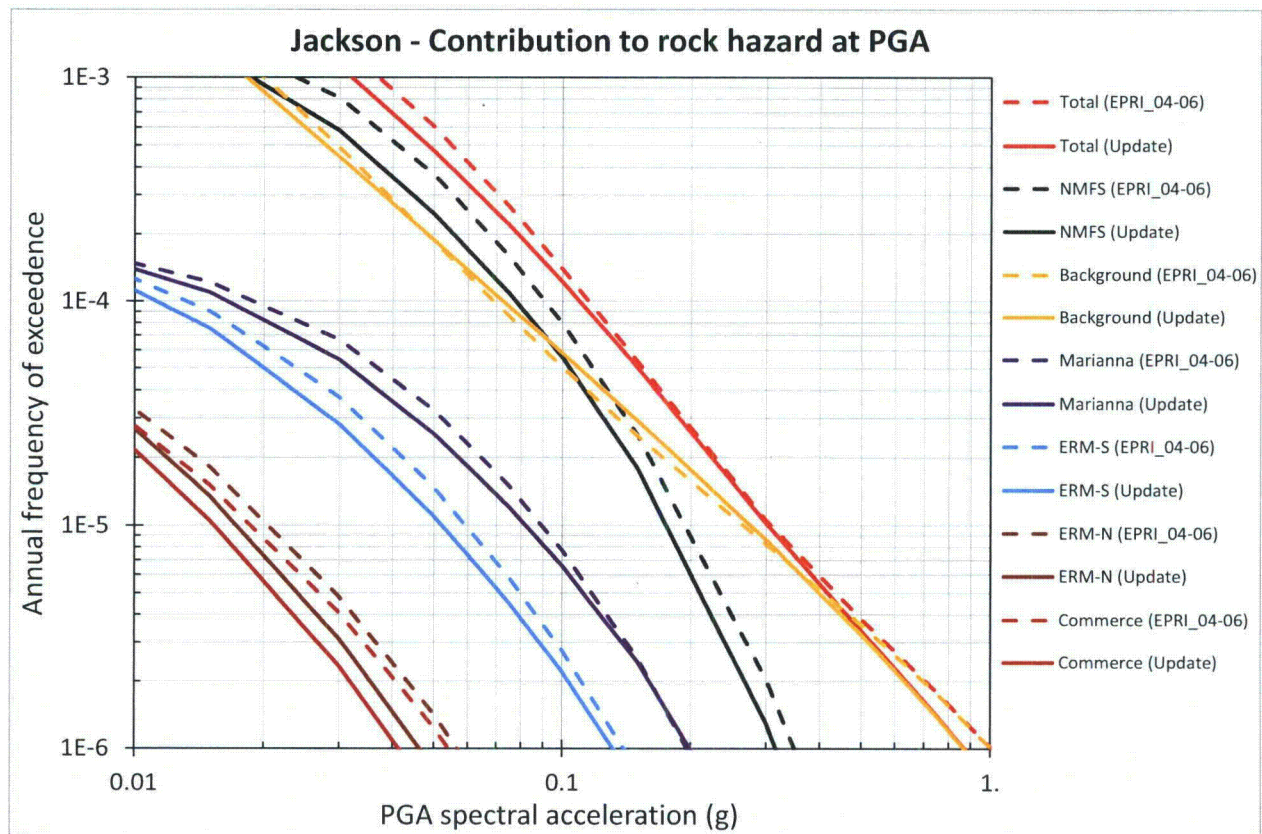


Figure 8.2-4a
Jackson site, contribution to rock PGA hazard by seismic source

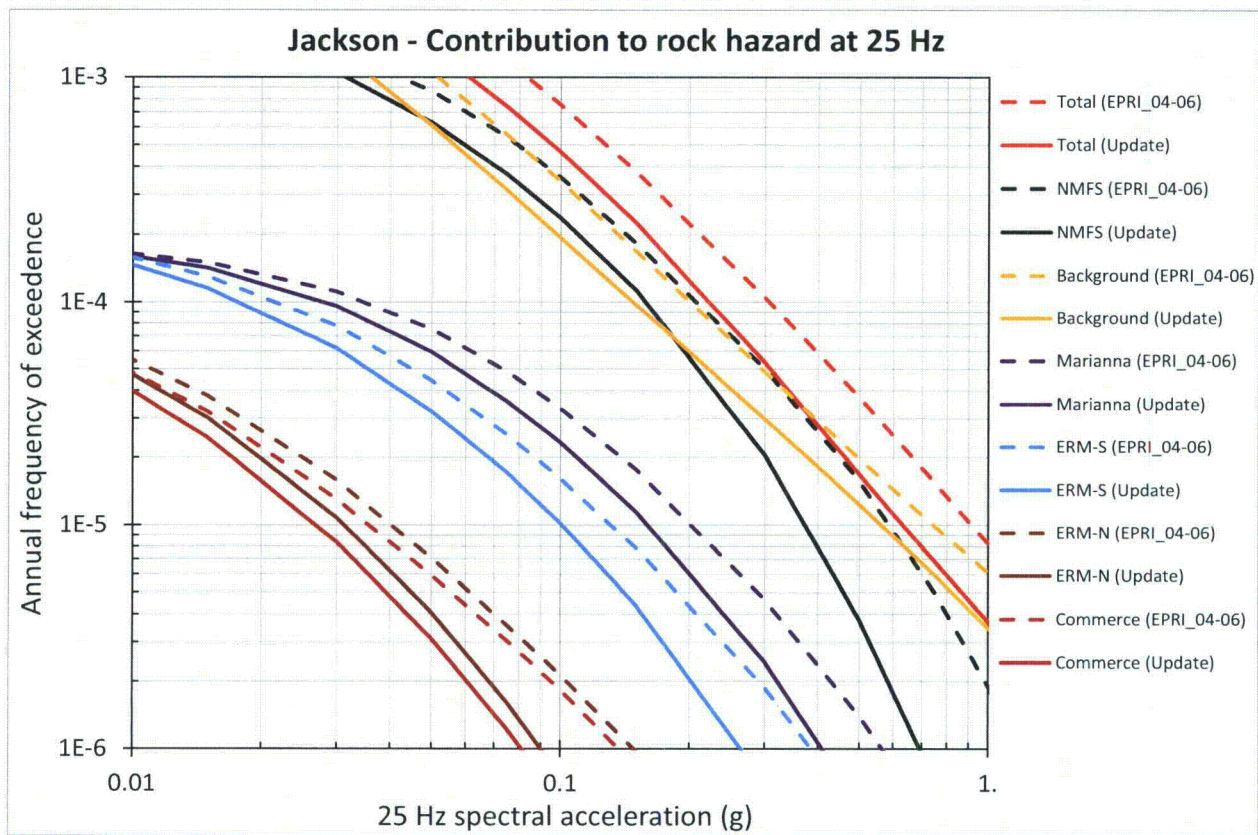


Figure 8.2-4b
Jackson site, contribution to rock 25 Hz hazard by seismic source

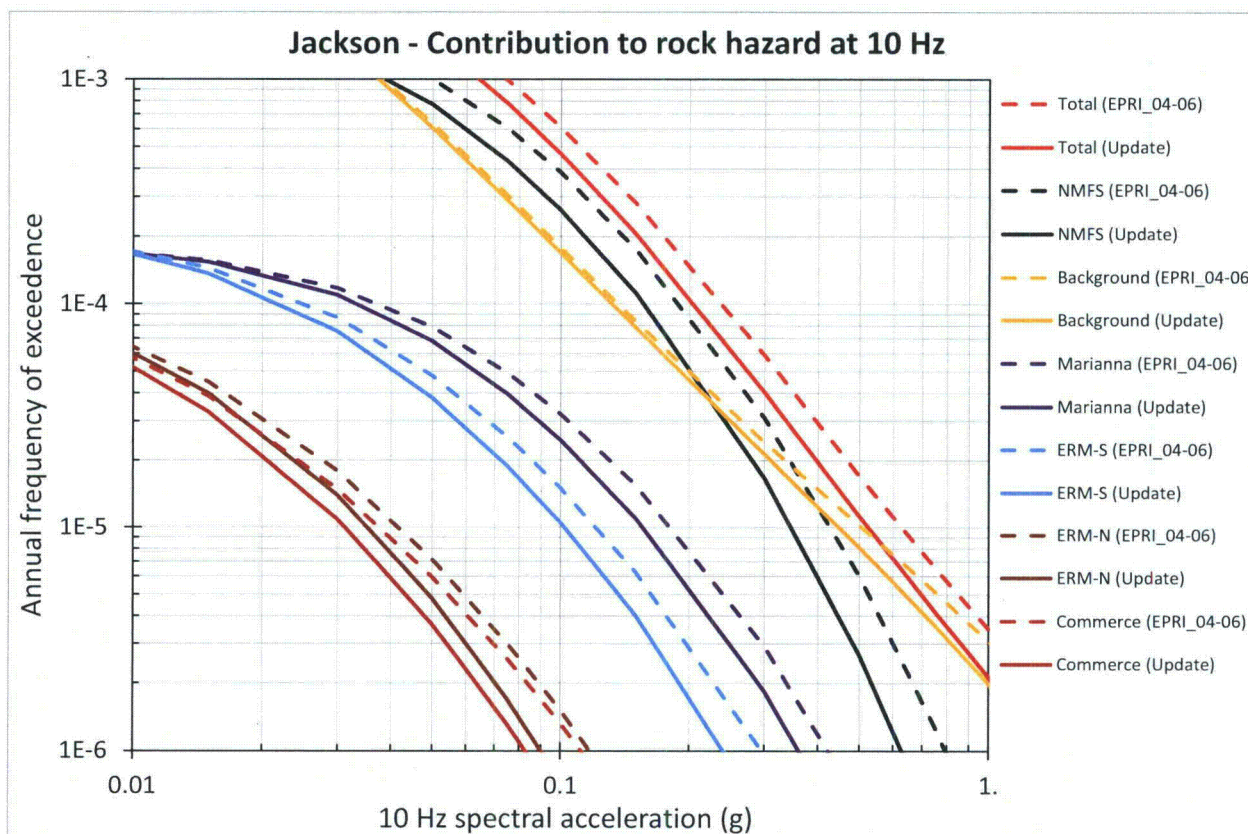


Figure 8.2-4c
Jackson site, contribution to rock 10 Hz hazard by seismic source

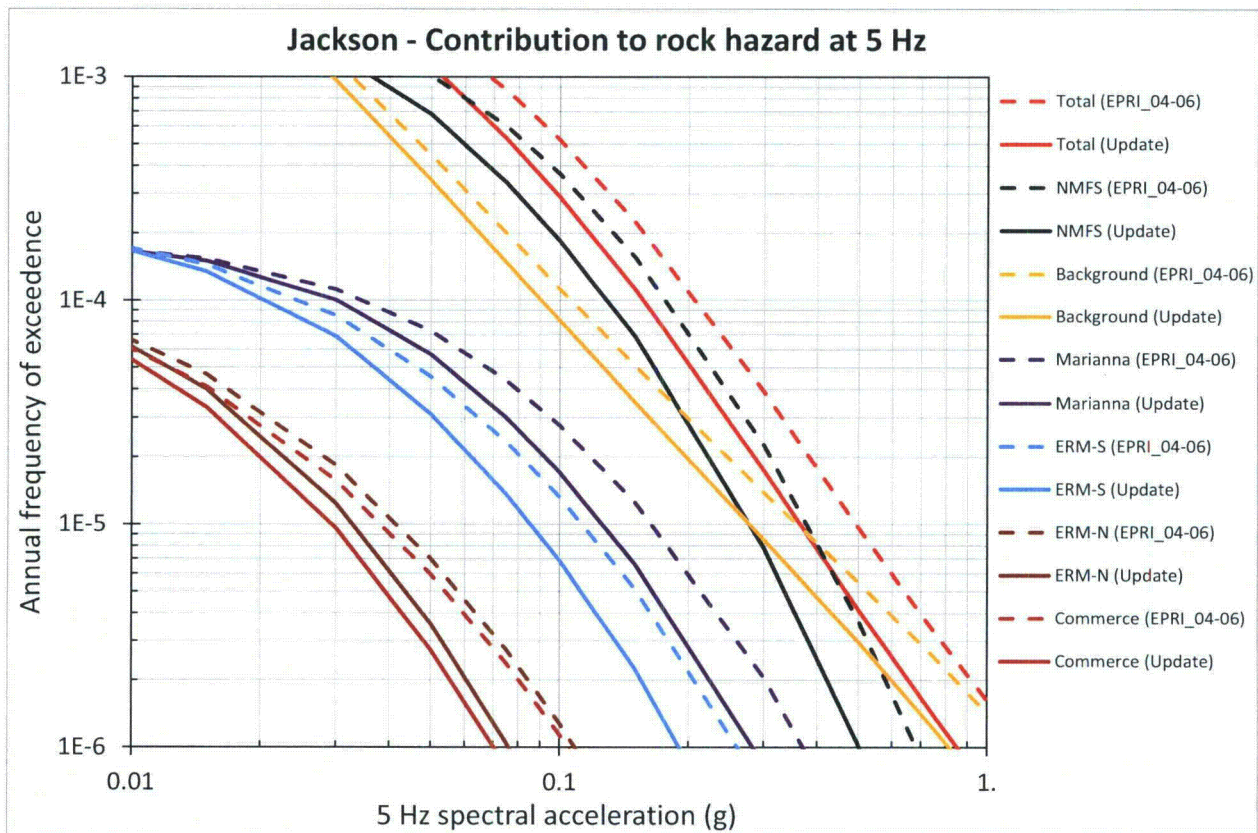


Figure 8.2-4d
Jackson site, contribution to rock 5 Hz hazard by seismic source

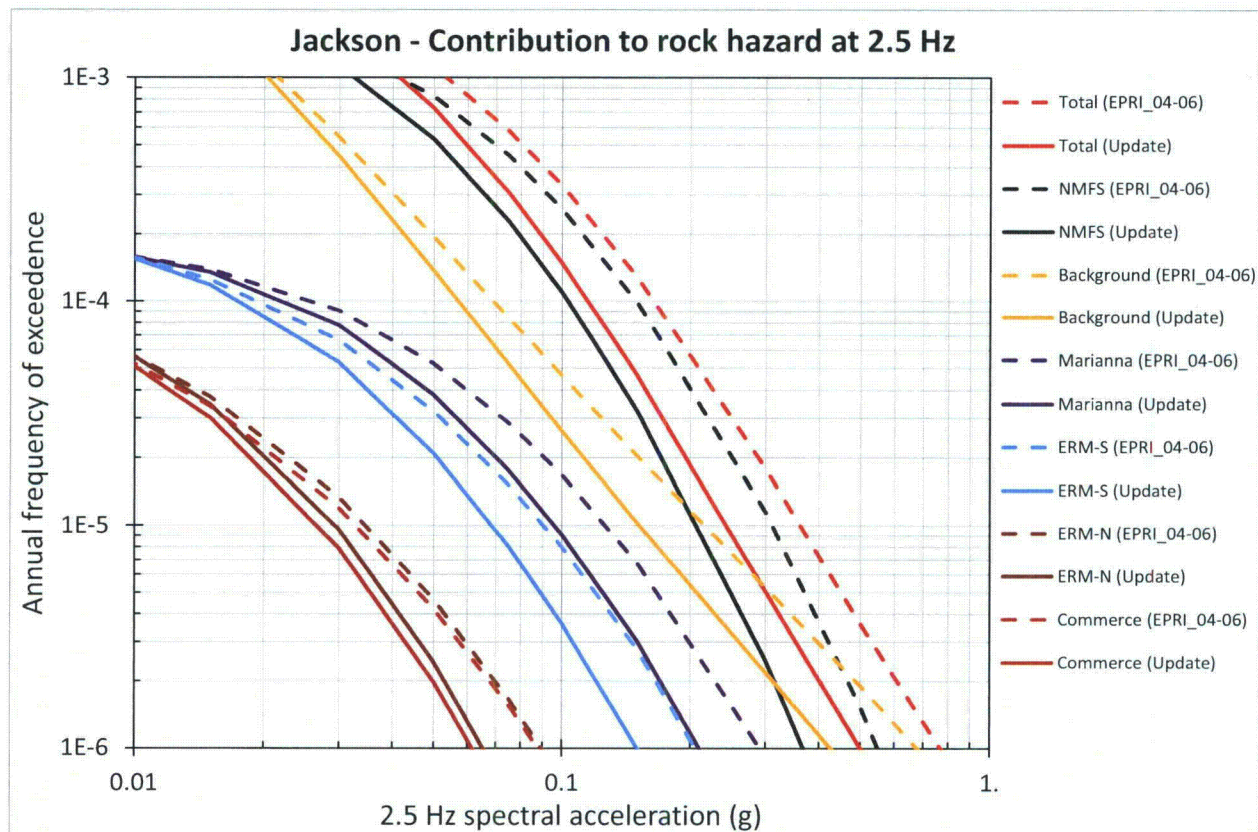


Figure 8.2-4e
Jackson site, contribution to rock 2.5 Hz hazard by seismic source

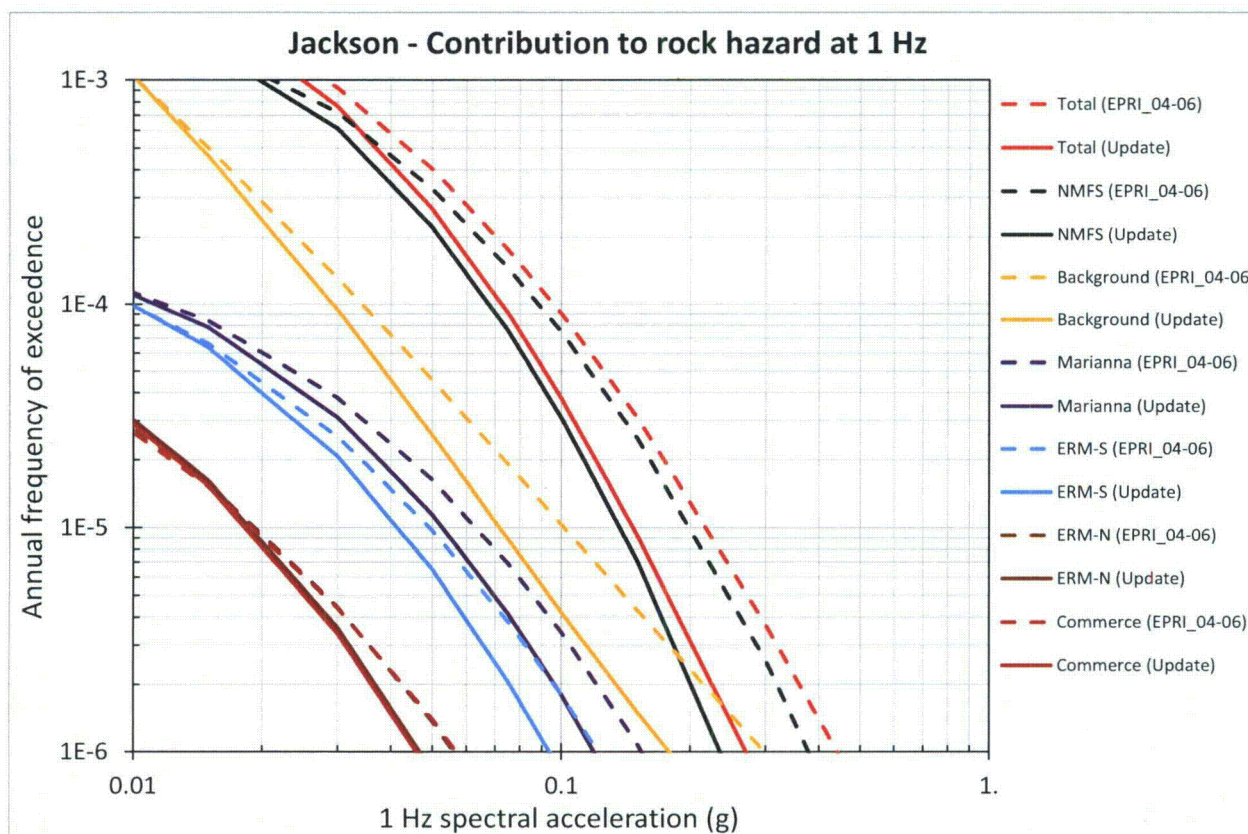


Figure 8.2-4f
Jackson site, contribution to rock 1 Hz hazard by seismic source

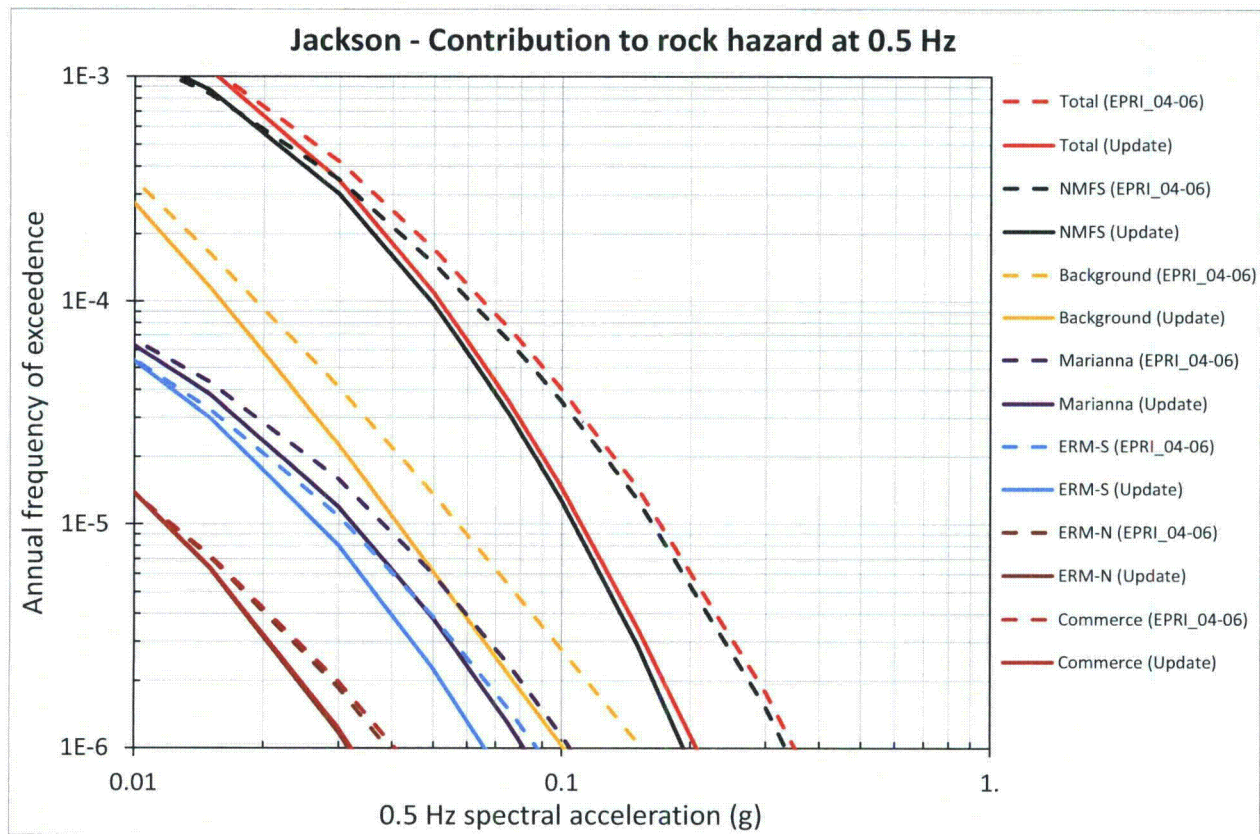


Figure 8.2-4g
Jackson site, contribution to rock 0.5 Hz hazard by seismic source

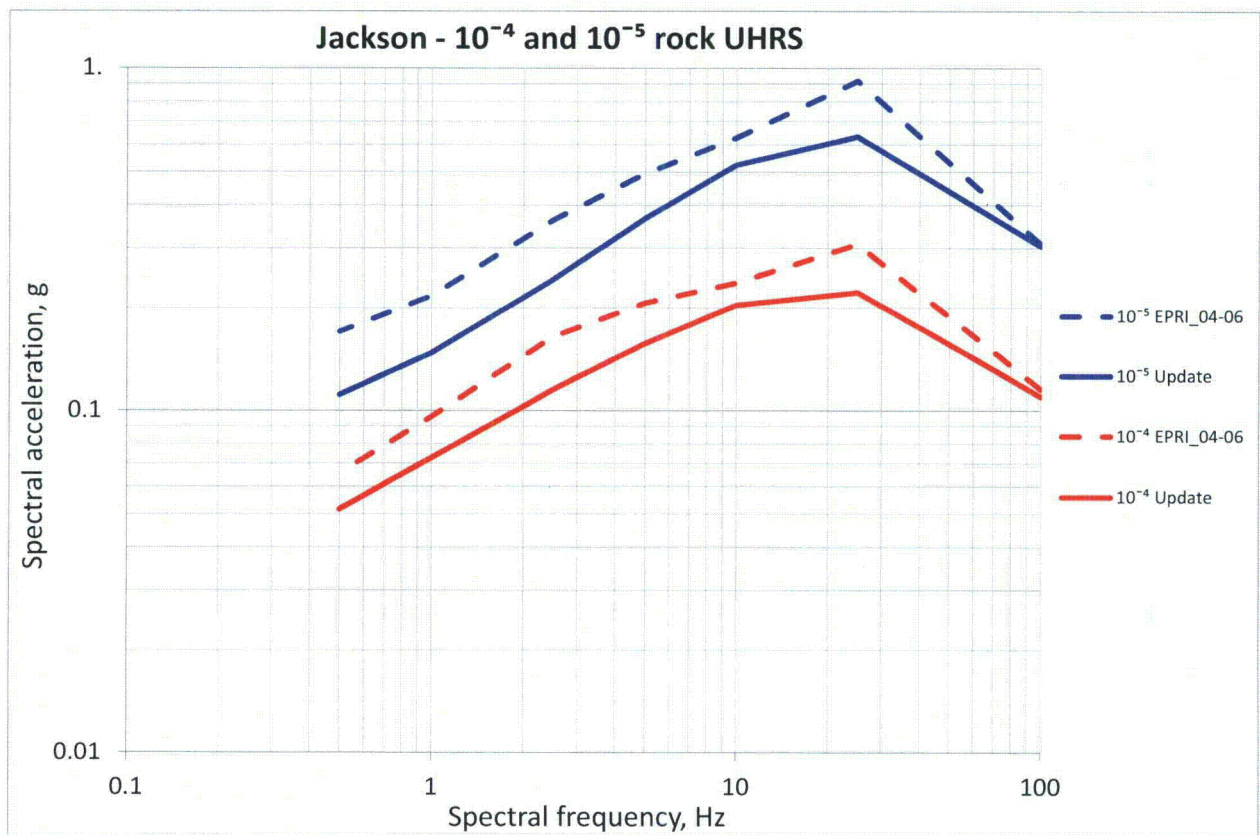


Figure 8.2-4h
Jackson site, 10^{-4} and 10^{-5} rock UHRS

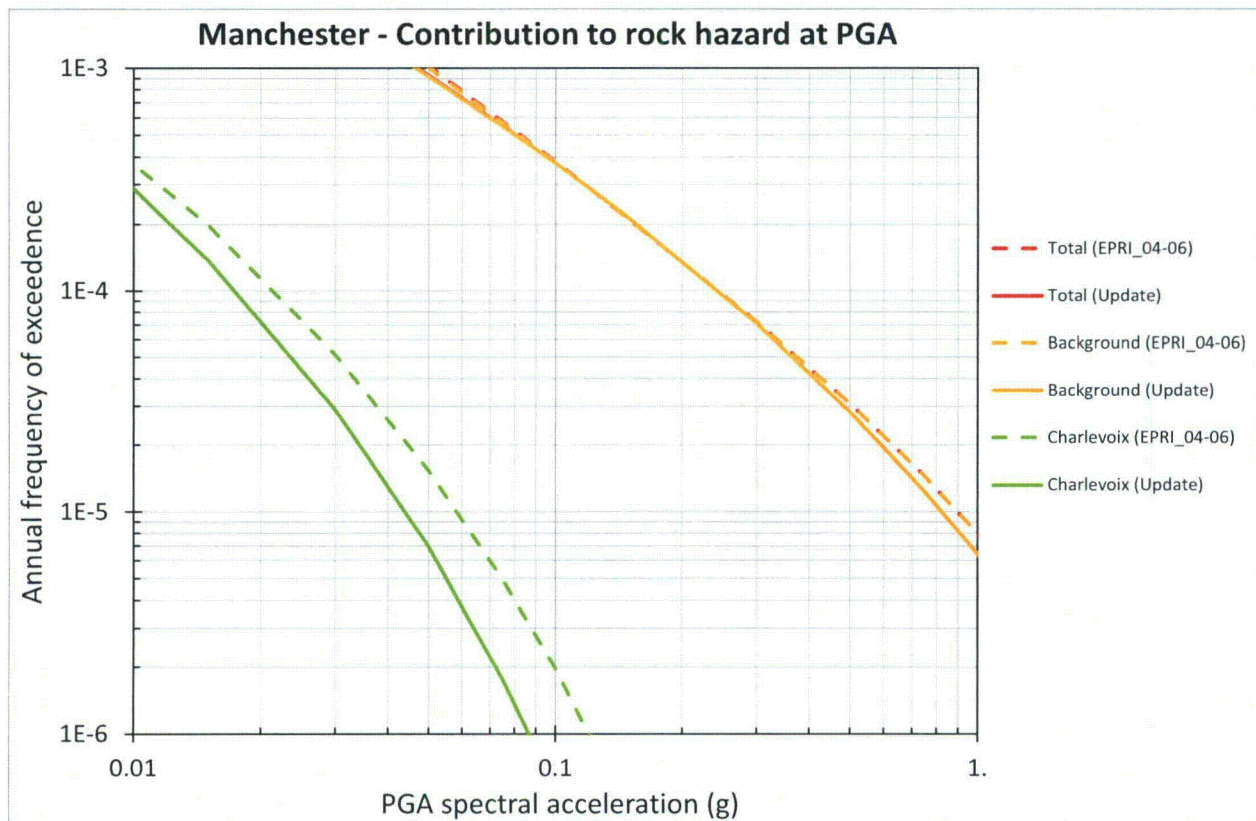


Figure 8.2-5a
Manchester site, contribution to rock PGA hazard by seismic source

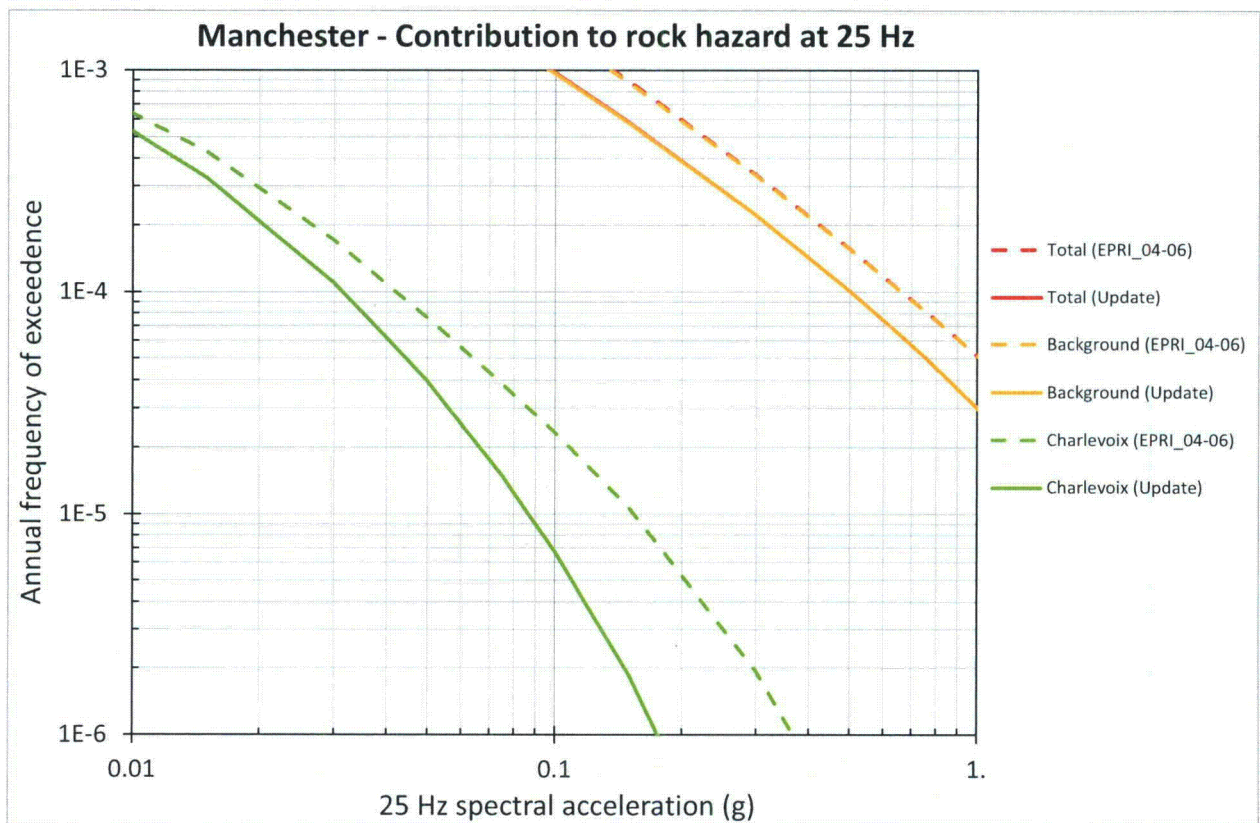


Figure 8.2-5b
Manchester site, contribution to rock 25 Hz hazard by seismic source

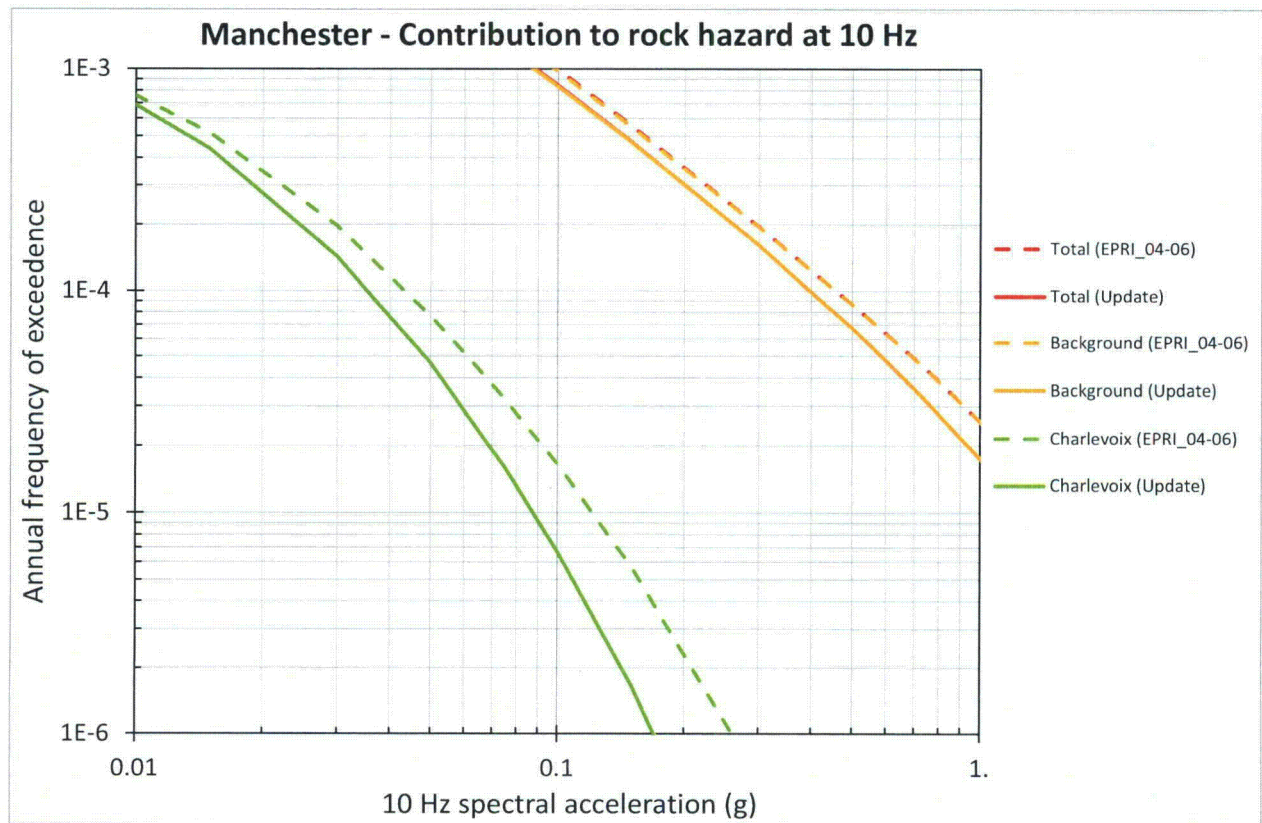


Figure 8.2-5c
Manchester site, contribution to rock 10 Hz hazard by seismic source

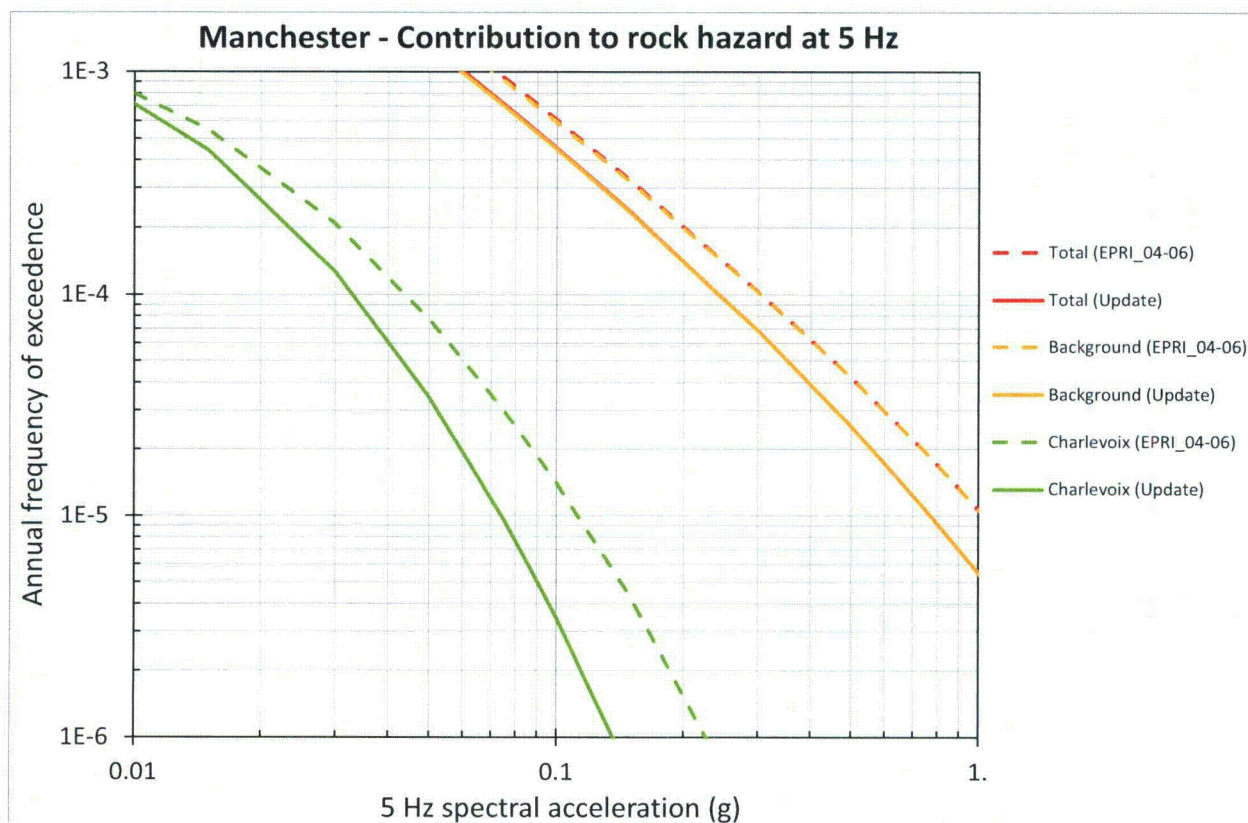


Figure 8.2-5d
Manchester site, contribution to rock 5 Hz hazard by seismic source

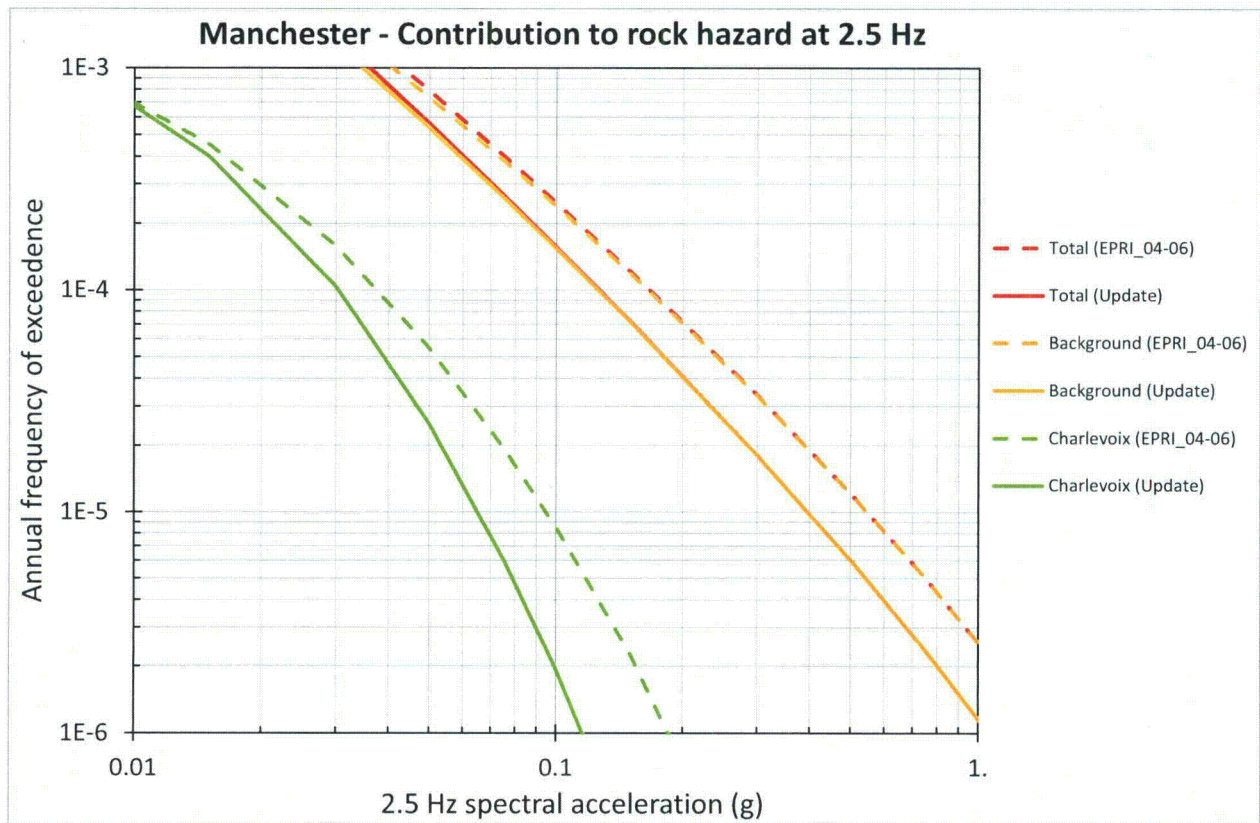


Figure 8.2-5e
Manchester site, contribution to rock 2.5 Hz hazard by seismic source

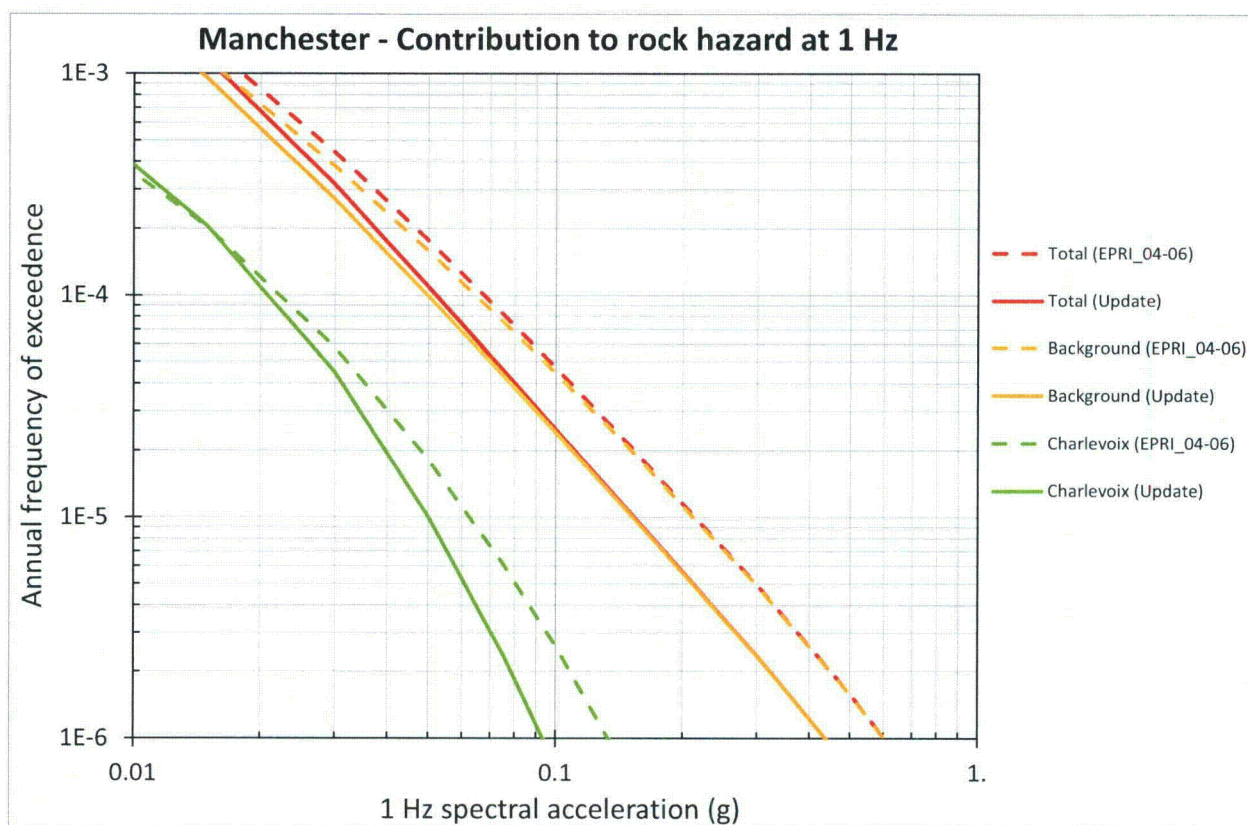


Figure 8.2-5f
Manchester site, contribution to rock 1 Hz hazard by seismic source

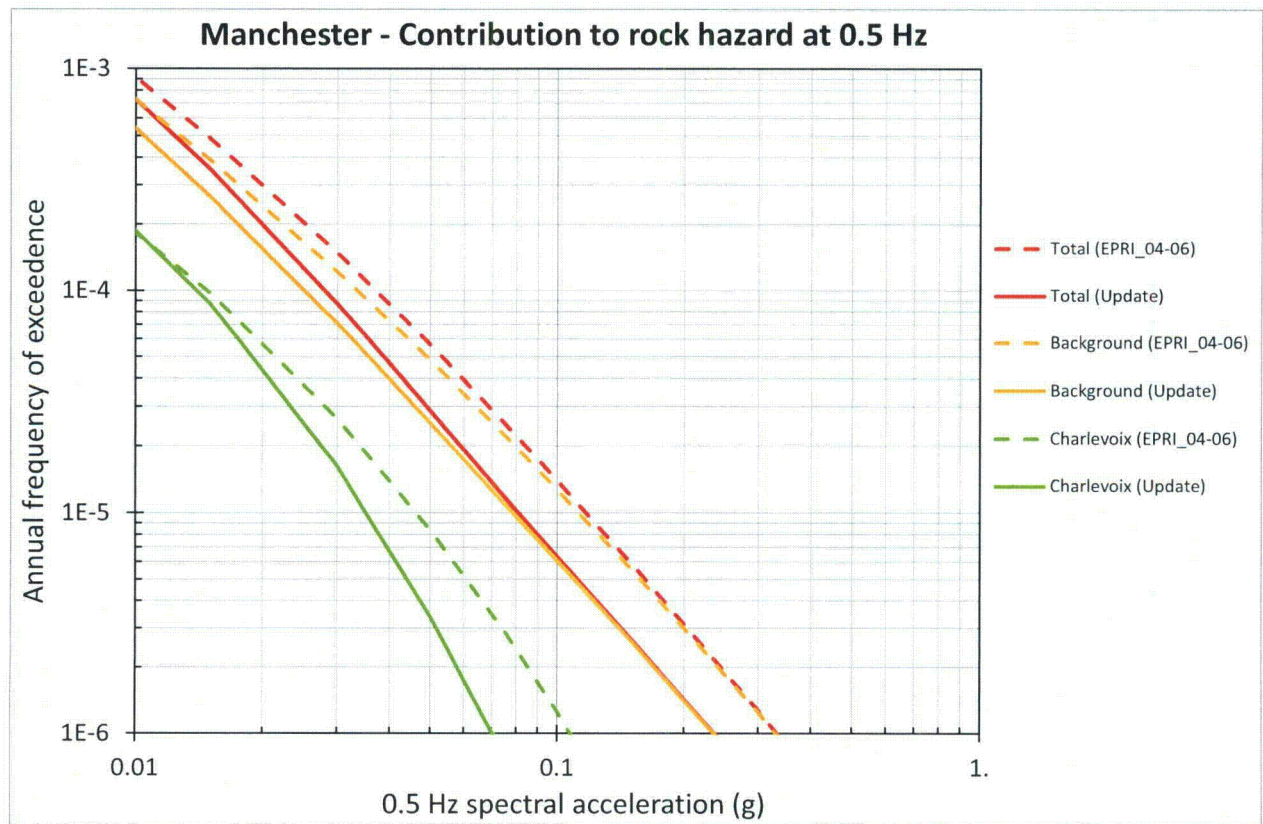


Figure 8.2-5g
Manchester site, contribution to rock 0.5 Hz hazard by seismic source

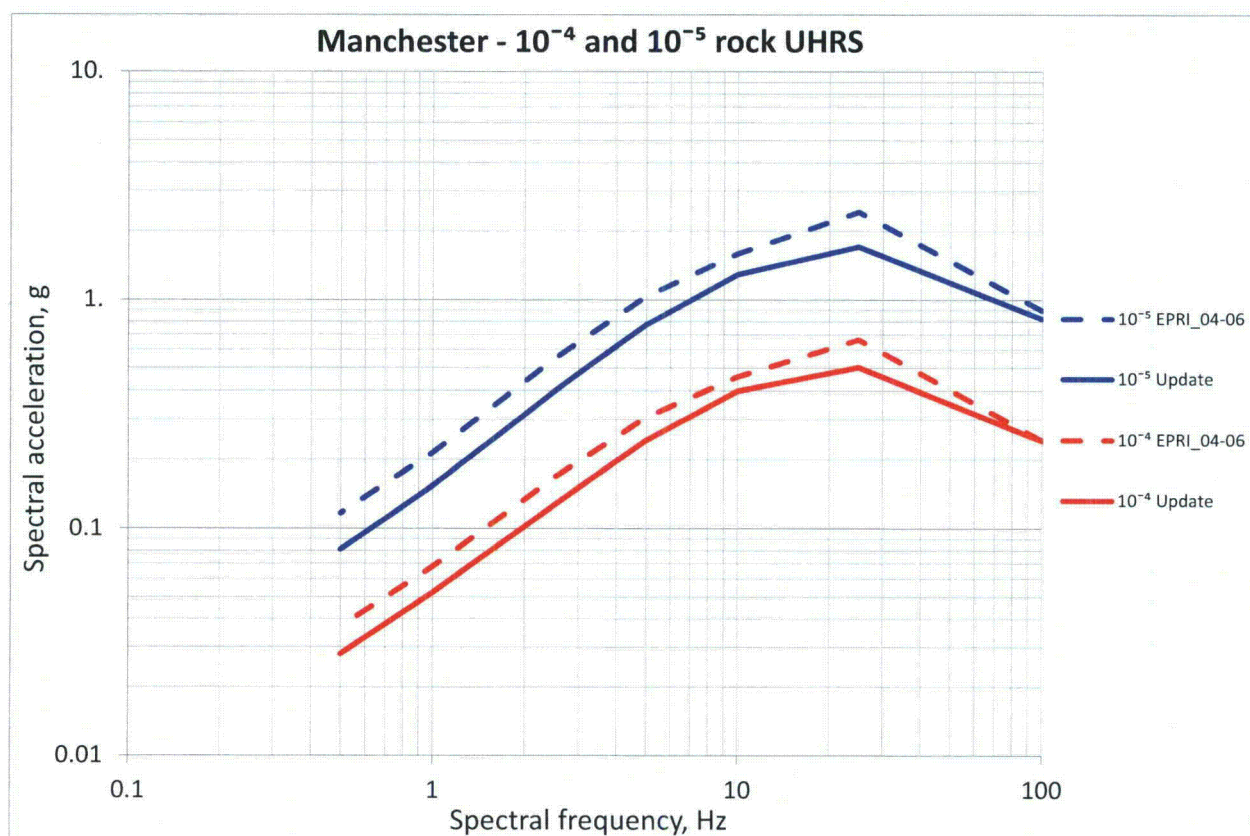


Figure 8.2-5h
Manchester site, 10^{-4} and 10^{-5} rock UHRS

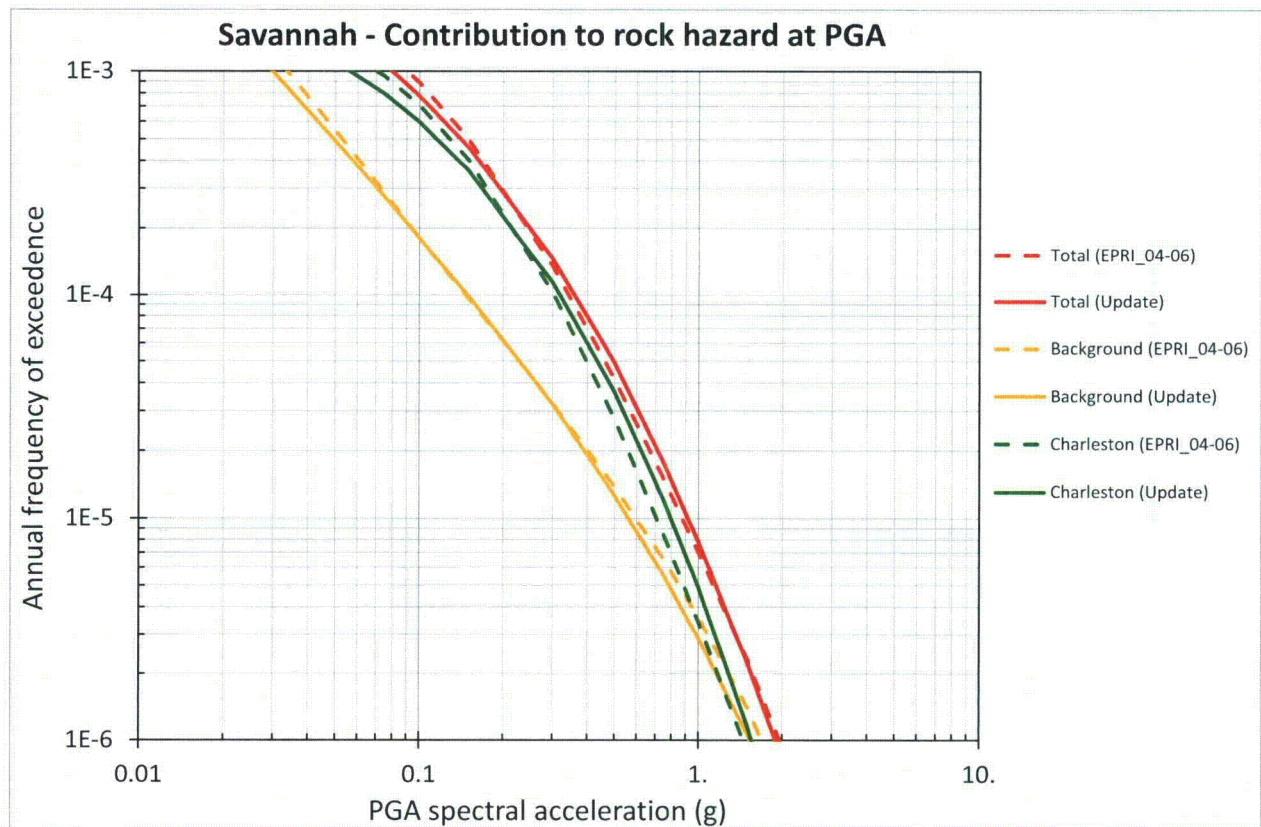


Figure 8.2-6a
Savannah site, contribution to rock PGA hazard by seismic source

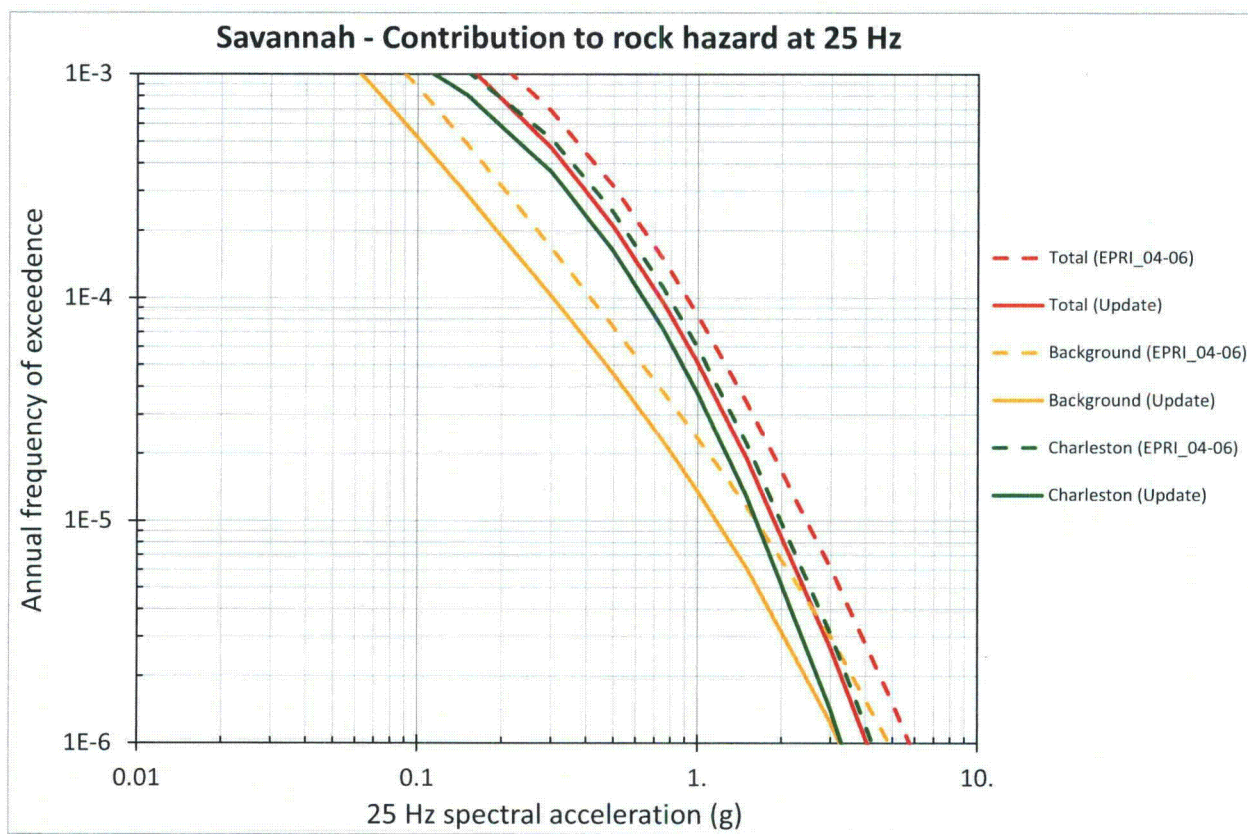


Figure 8.2-6b
Savannah site, contribution to rock 25 Hz hazard by seismic source

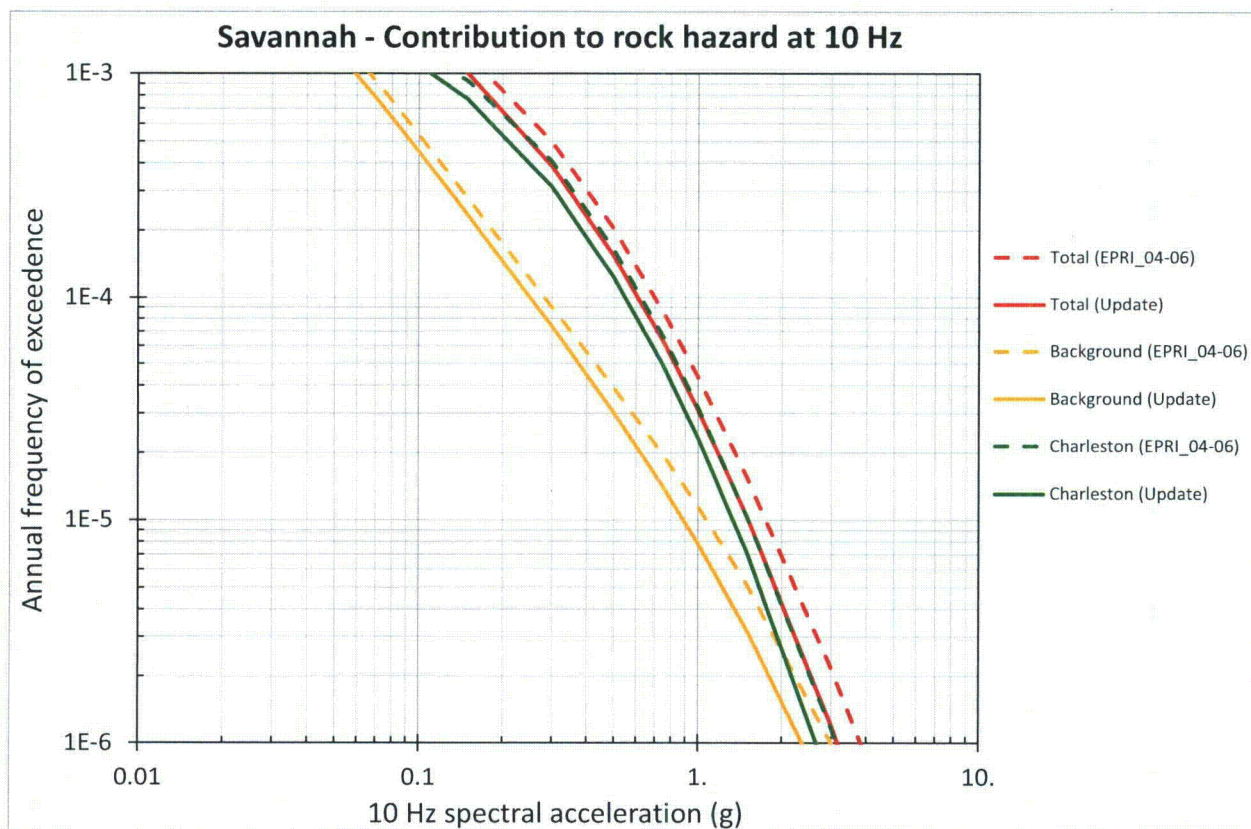


Figure 8.2-6c
Savannah site, contribution to rock 10 Hz hazard by seismic source

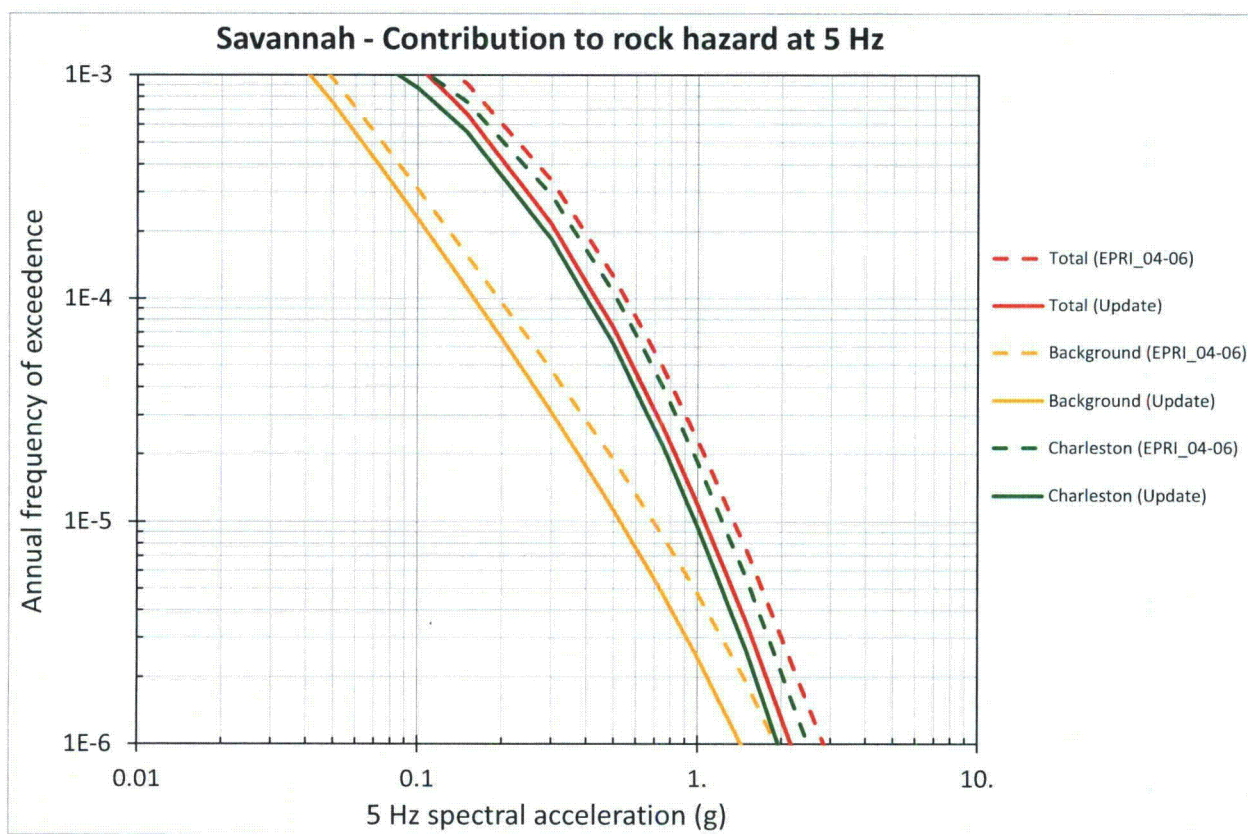


Figure 8.2-6d
Savannah site, contribution to rock 5 Hz hazard by seismic source

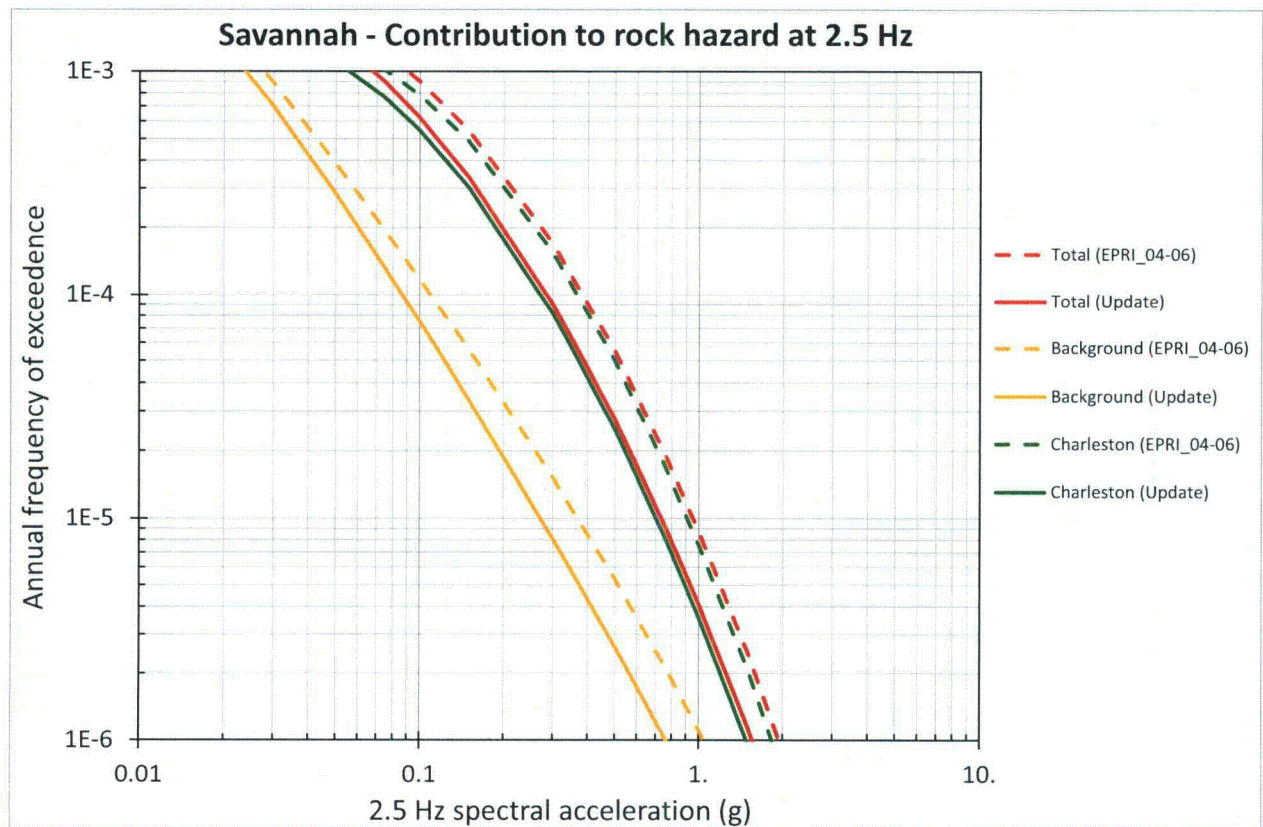


Figure 8.2-6e
Savannah site, contribution to rock 2.5 Hz hazard by seismic source

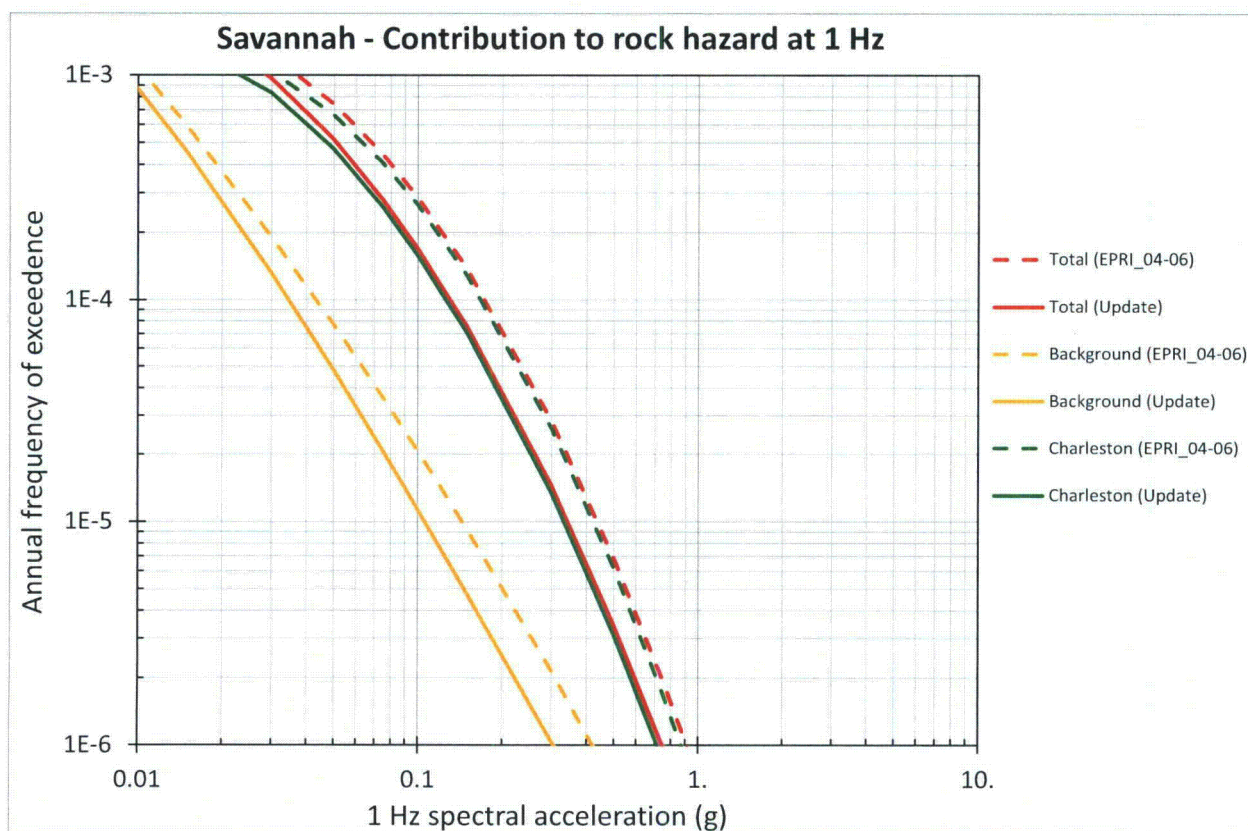


Figure 8.2-6f
Savannah site, contribution to rock 1 Hz hazard by seismic source

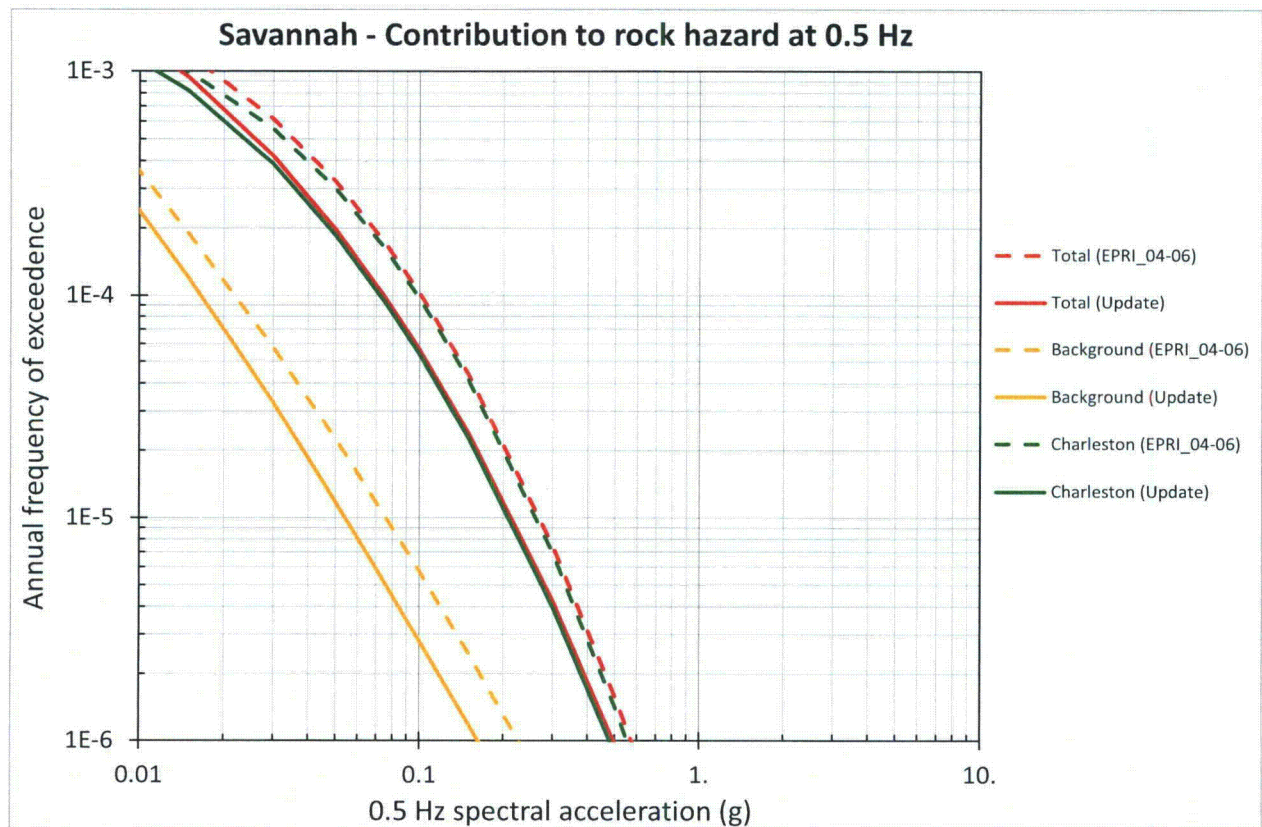


Figure 8.2-6g
Savannah site, contribution to rock 0.5 Hz hazard by seismic source

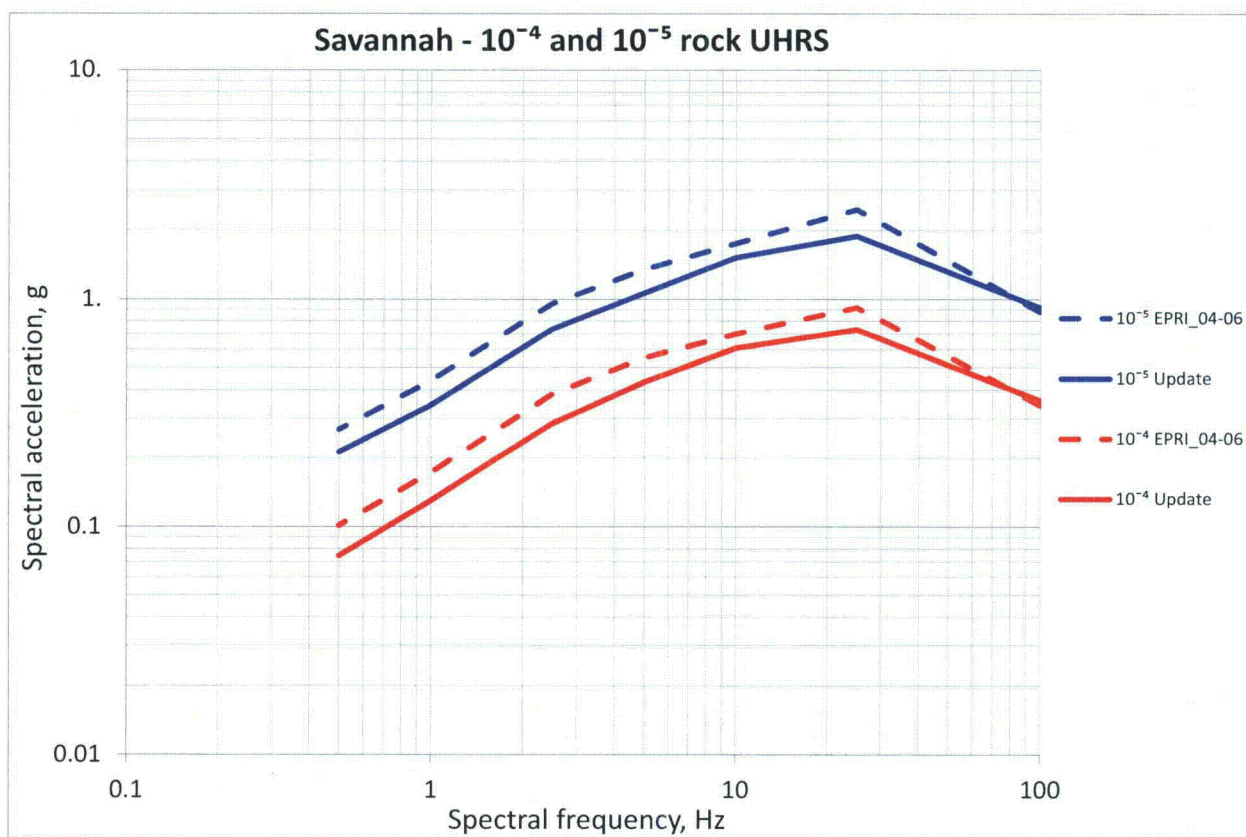


Figure 8.2-6h
Savannah site, 10^{-4} and 10^{-5} rock UHRS

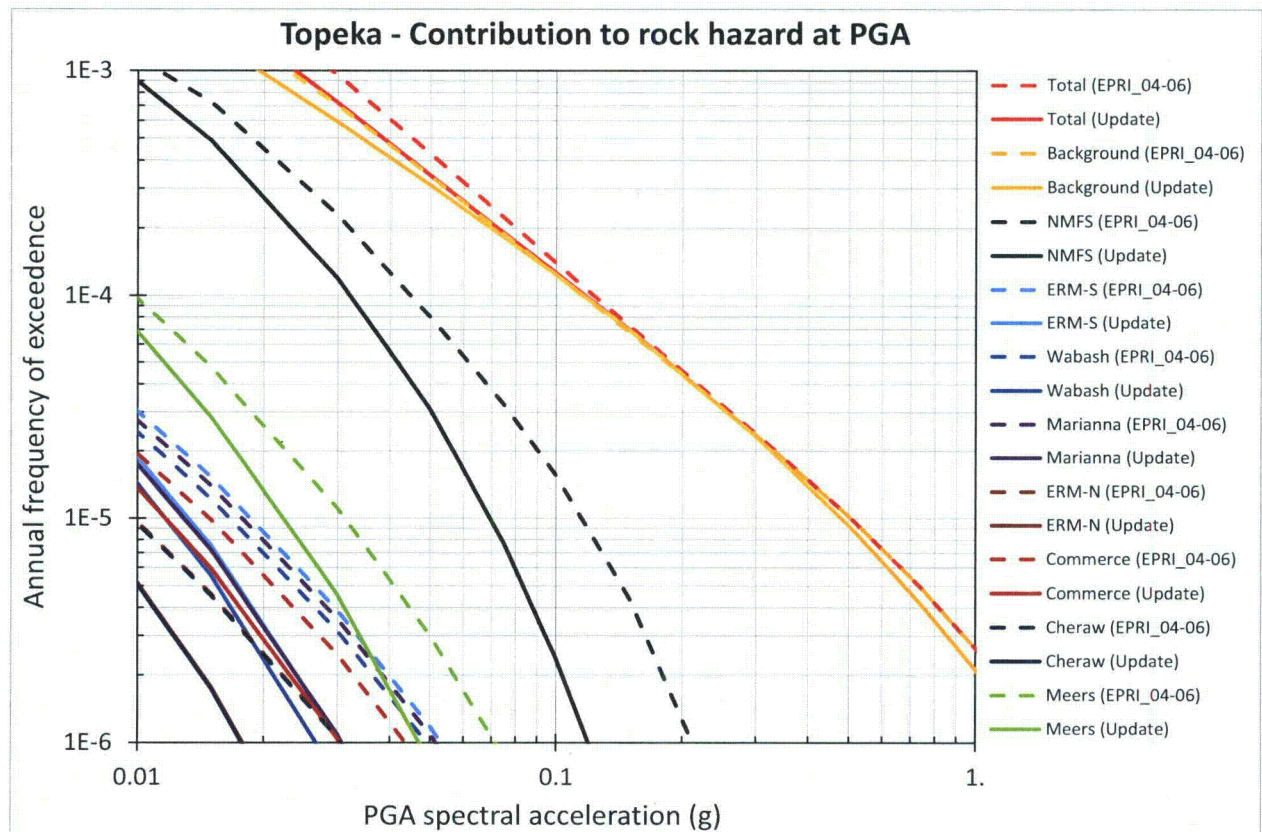


Figure 8.2-7a
Topeka site, contribution to rock PGA hazard by seismic source

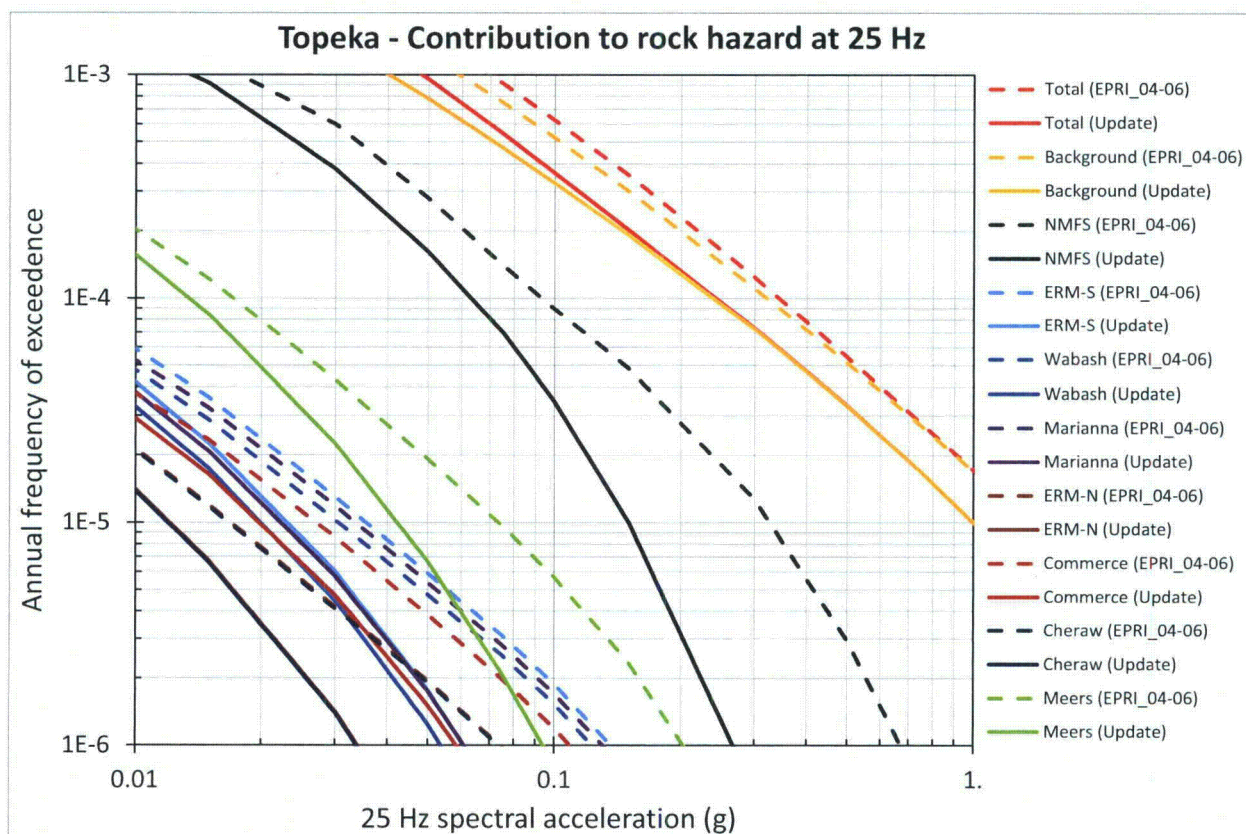


Figure 8.2-7b
Topeka site, contribution to rock 25 Hz hazard by seismic source

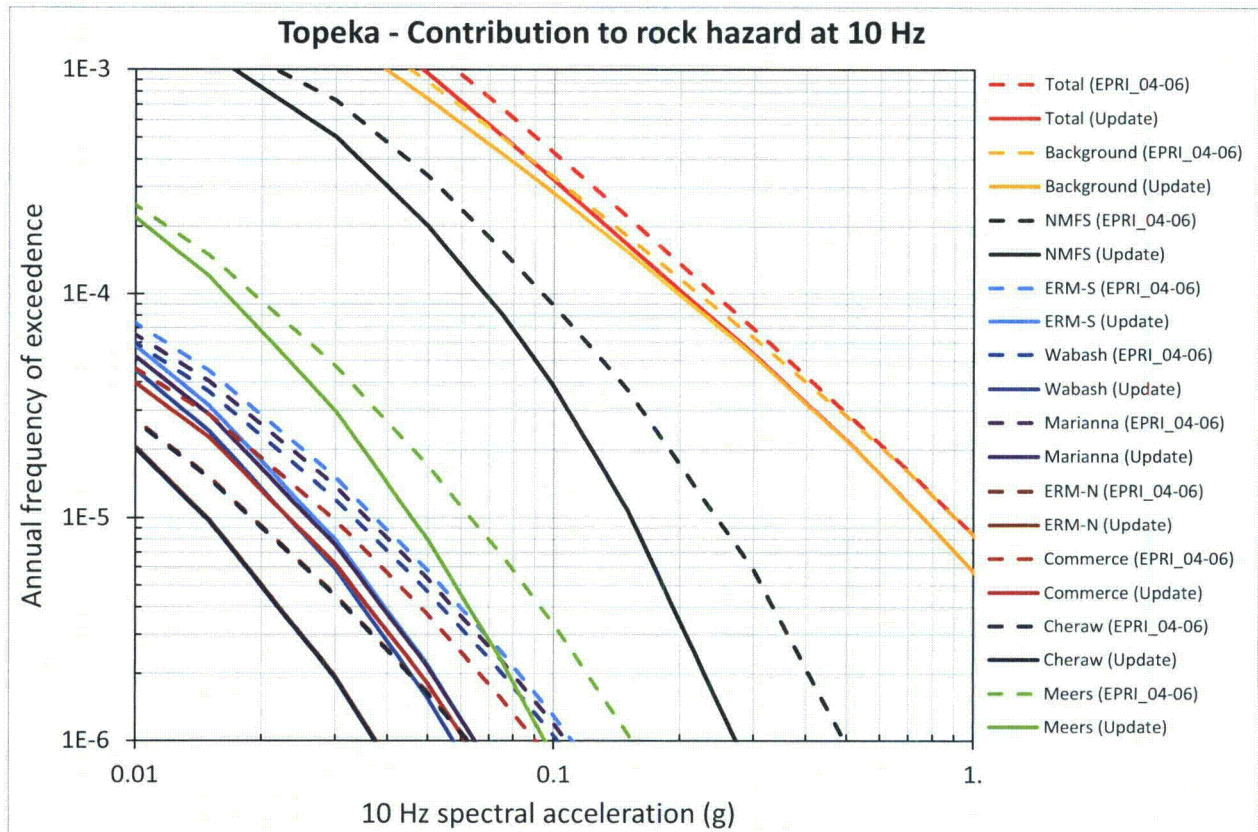


Figure 8.2-7c
Topeka site, contribution to rock 10 Hz hazard by seismic source

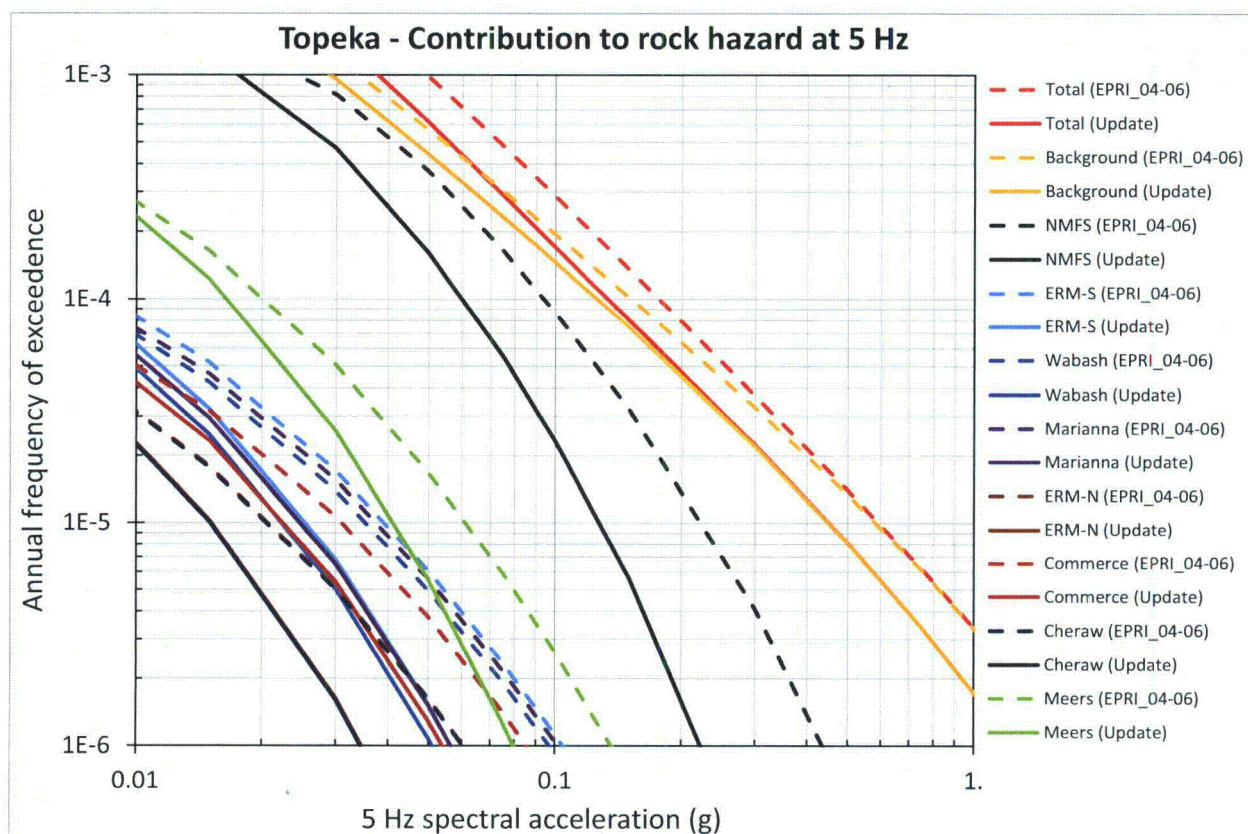


Figure 8.2-7d
Topeka site, contribution to rock 5 Hz hazard by seismic source

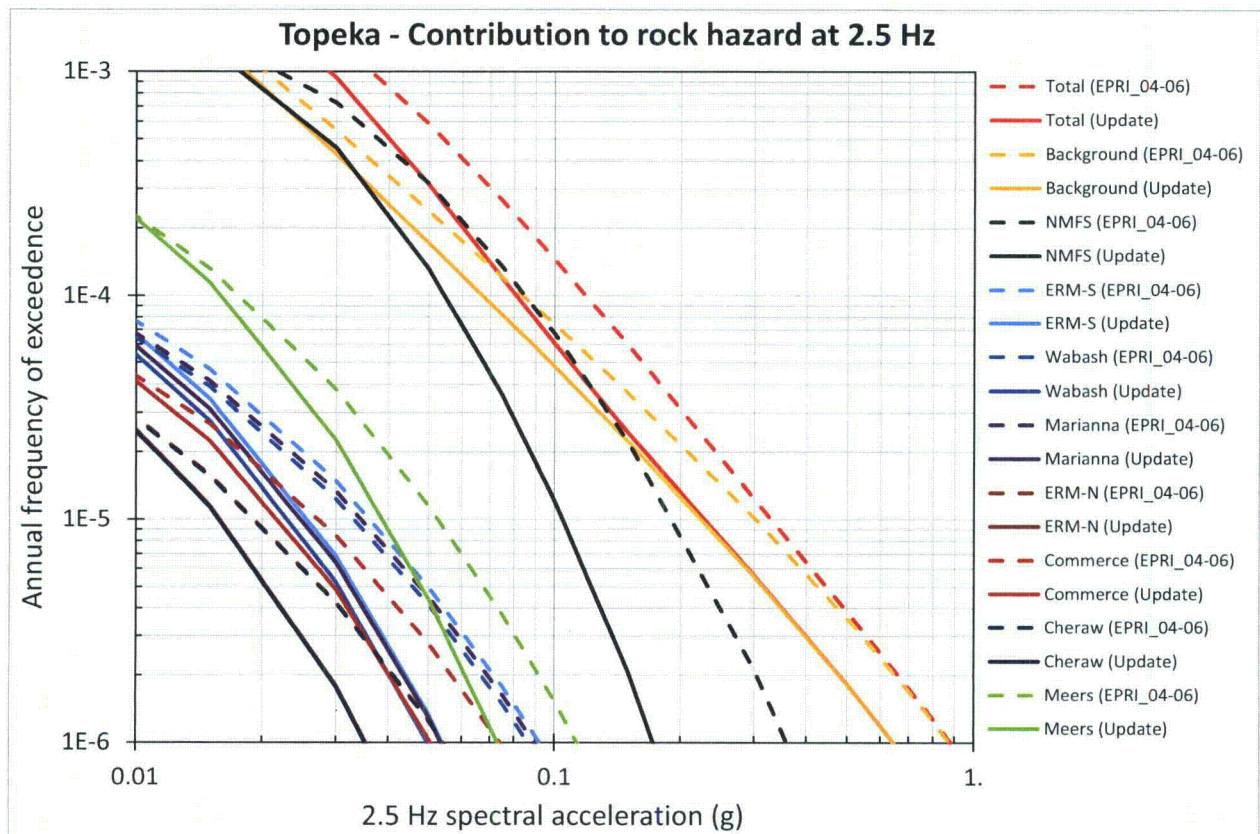


Figure 8.2-7e
Topeka site, contribution to rock 2.5 Hz hazard by seismic source

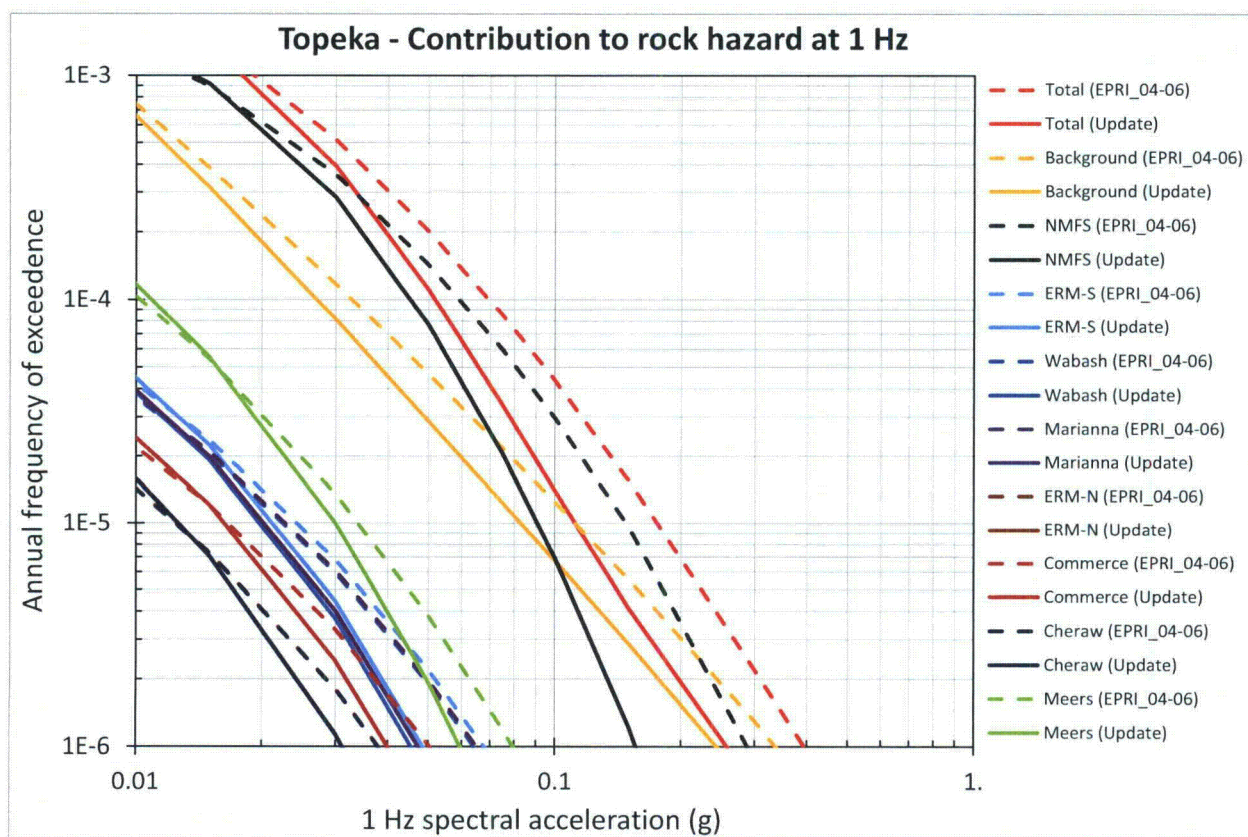


Figure 8.2-7f
Topeka site, contribution to rock 1 Hz hazard by seismic source

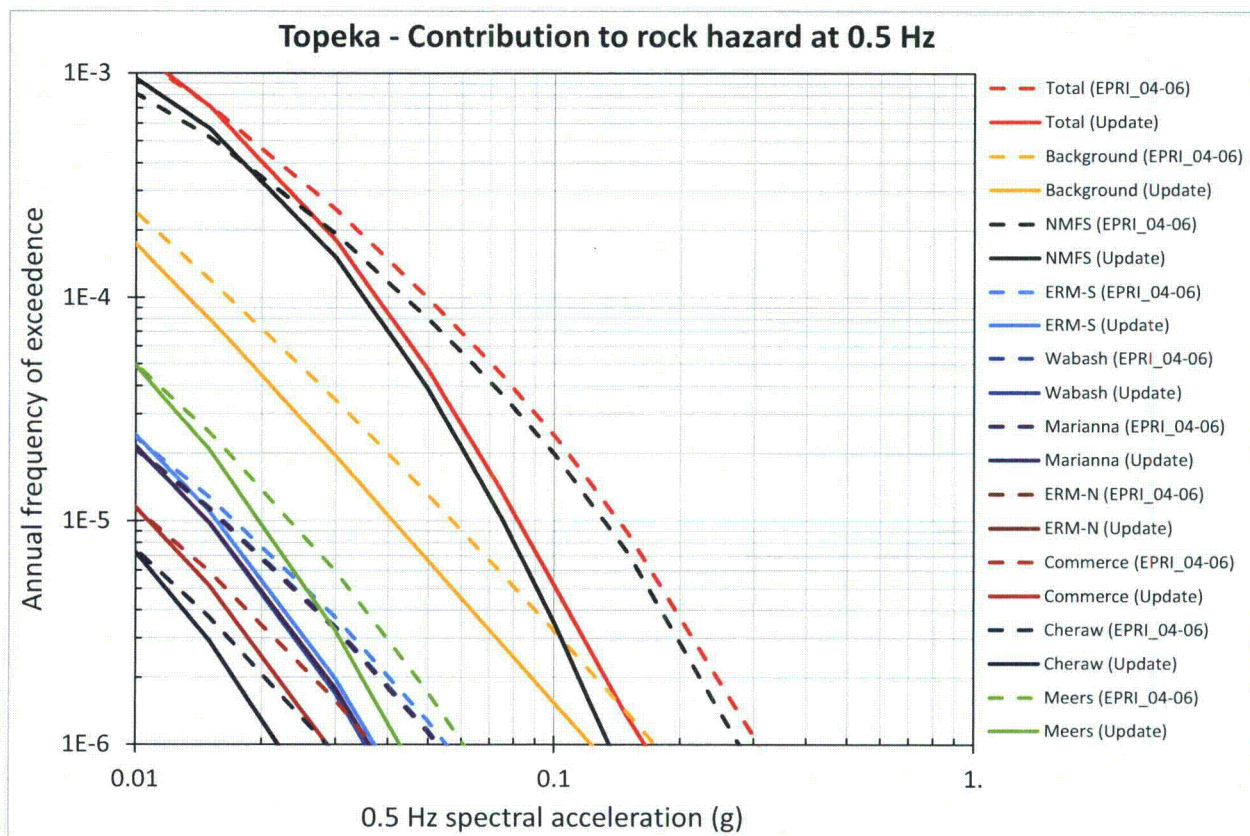


Figure 8.2-7g
Topeka site, contribution to rock 0.5 Hz hazard by seismic source

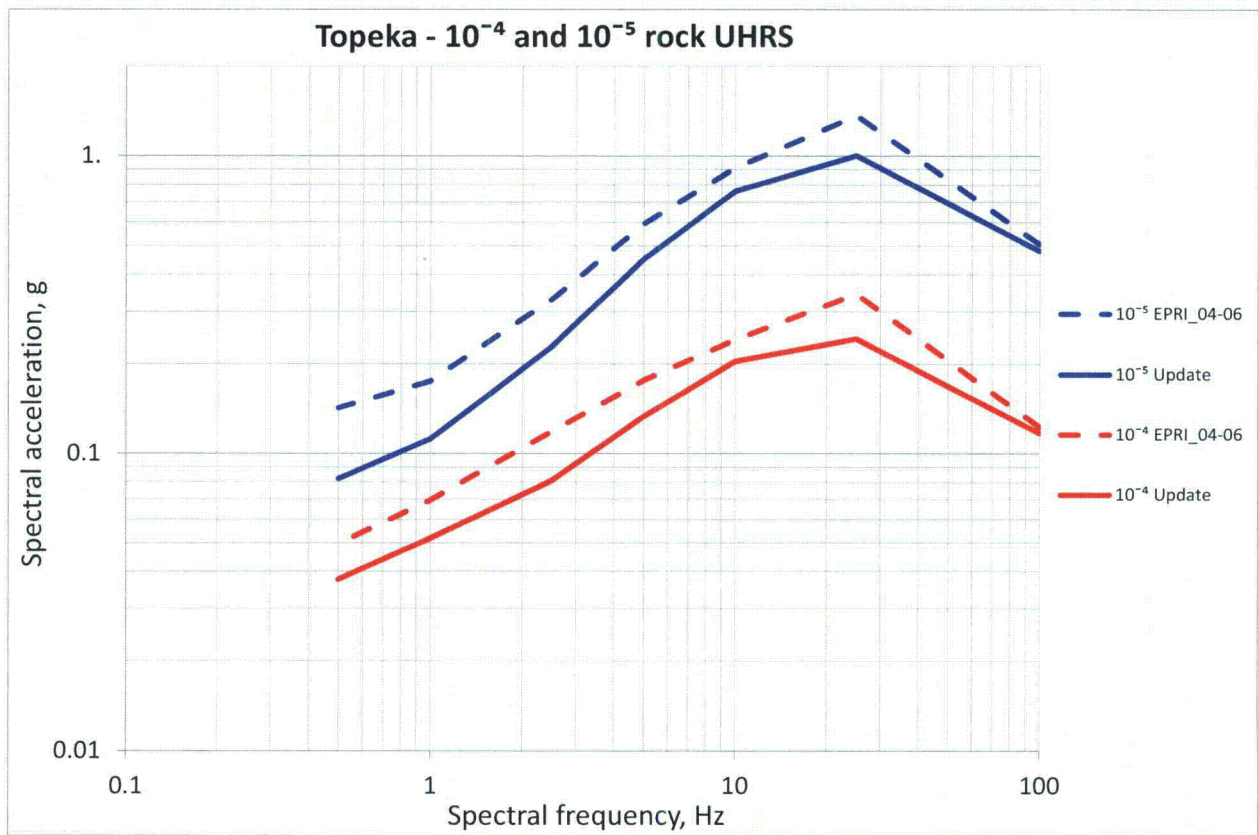


Figure 8.2-7h
Topeka site, 10^{-4} and 10^{-5} rock UHRS

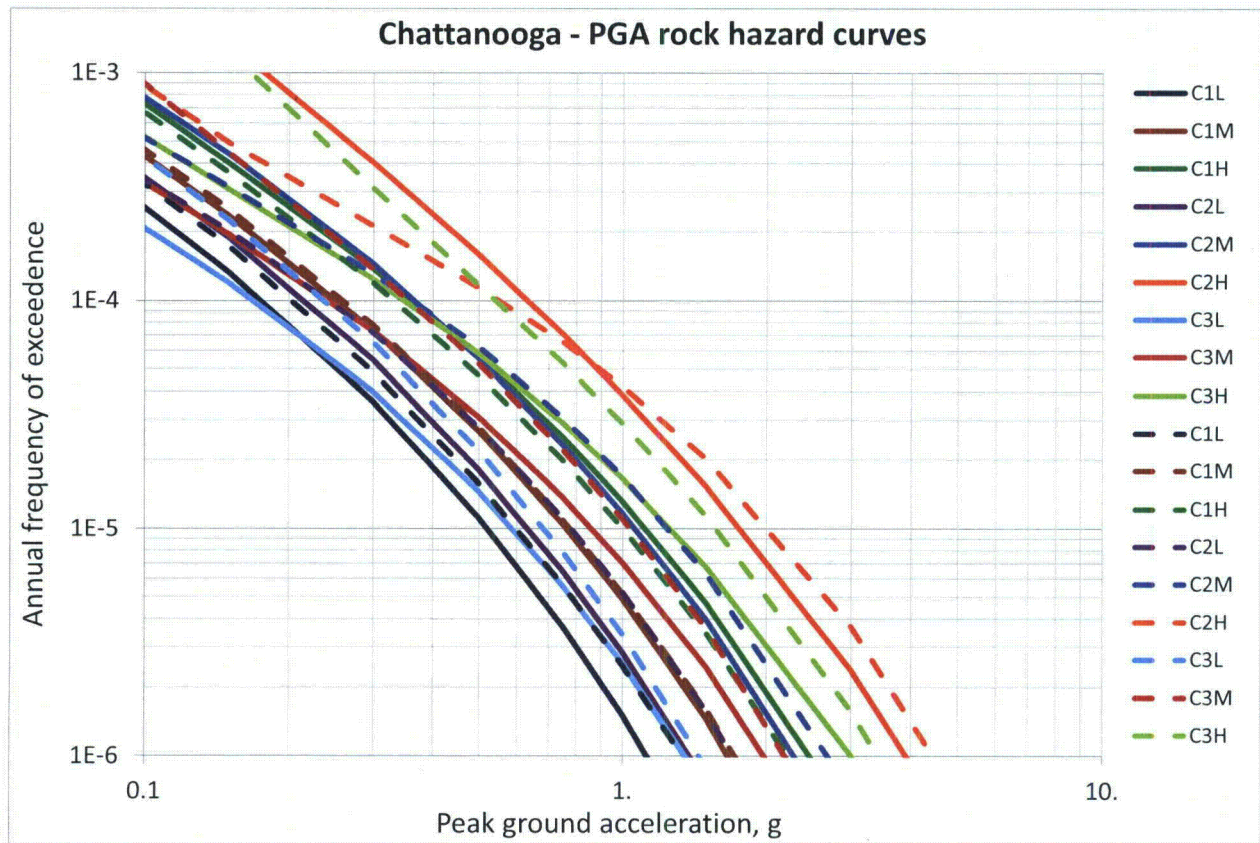


Figure 8.2-8
Chattanooga site, sensitivity of PGA rock hazard to 9 ground-motion equations. Solid curves show hazard for the Updated GMM; dashed curves show hazard for the EPRI (2004, 2006) GMM

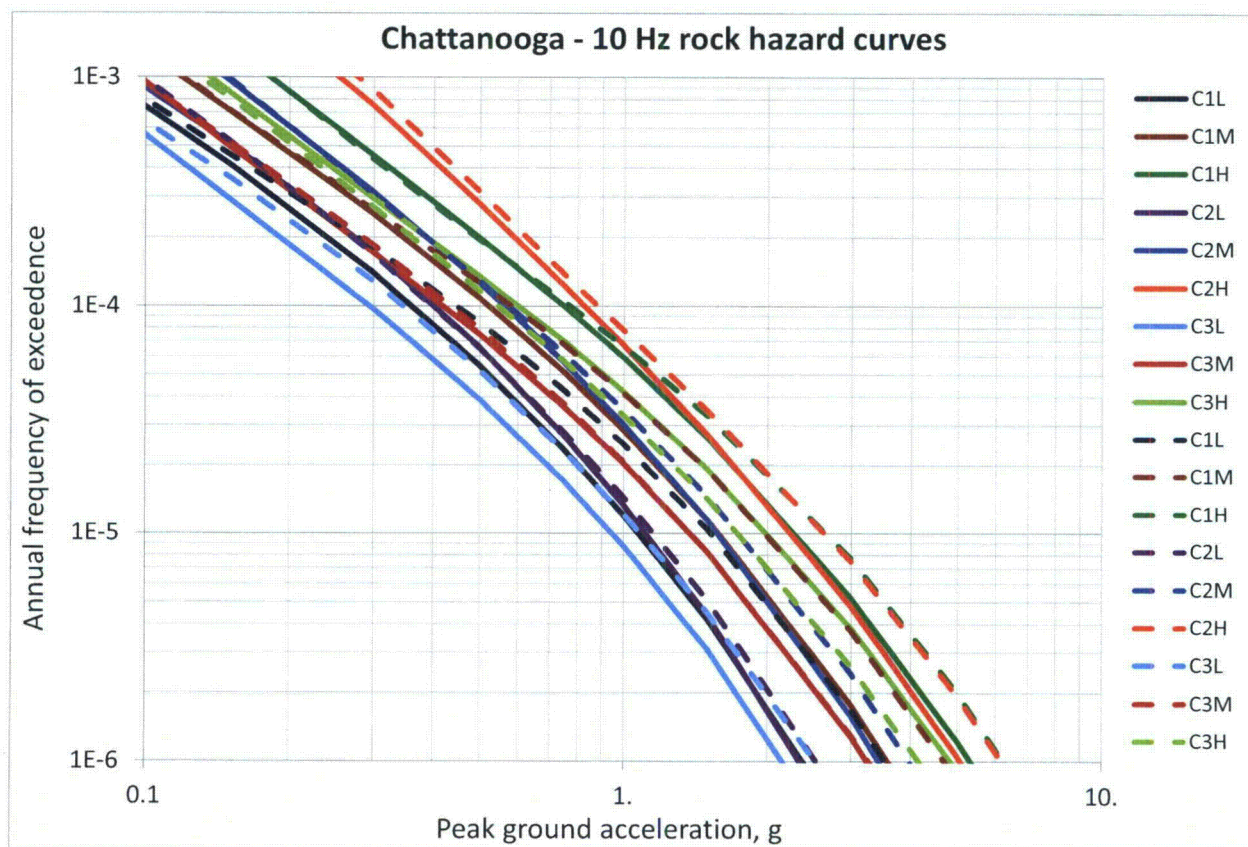


Figure 8.2-9
 Chattanooga site, sensitivity of 10 Hz rock hazard to 9 ground-motion equations. Solid curves show hazard for the Updated GMM; dashed curves show hazard for the EPRI (2004, 2006) GMM

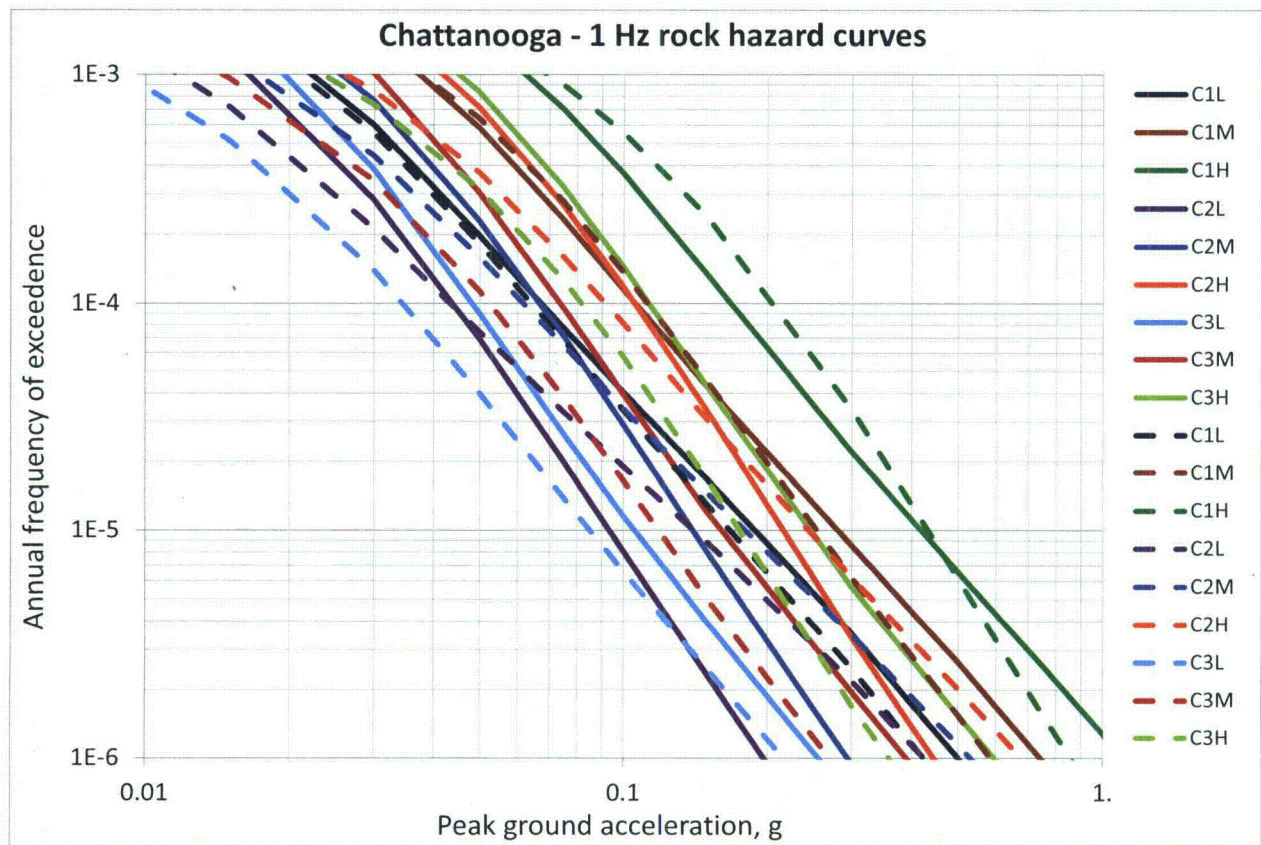


Figure 8.2-10
Chattanooga site, sensitivity of 1 Hz rock hazard to 9 ground-motion equations. Solid curves show hazard for the Updated GMM; dashed curves show hazard for the EPRI (2004, 2006) GMM

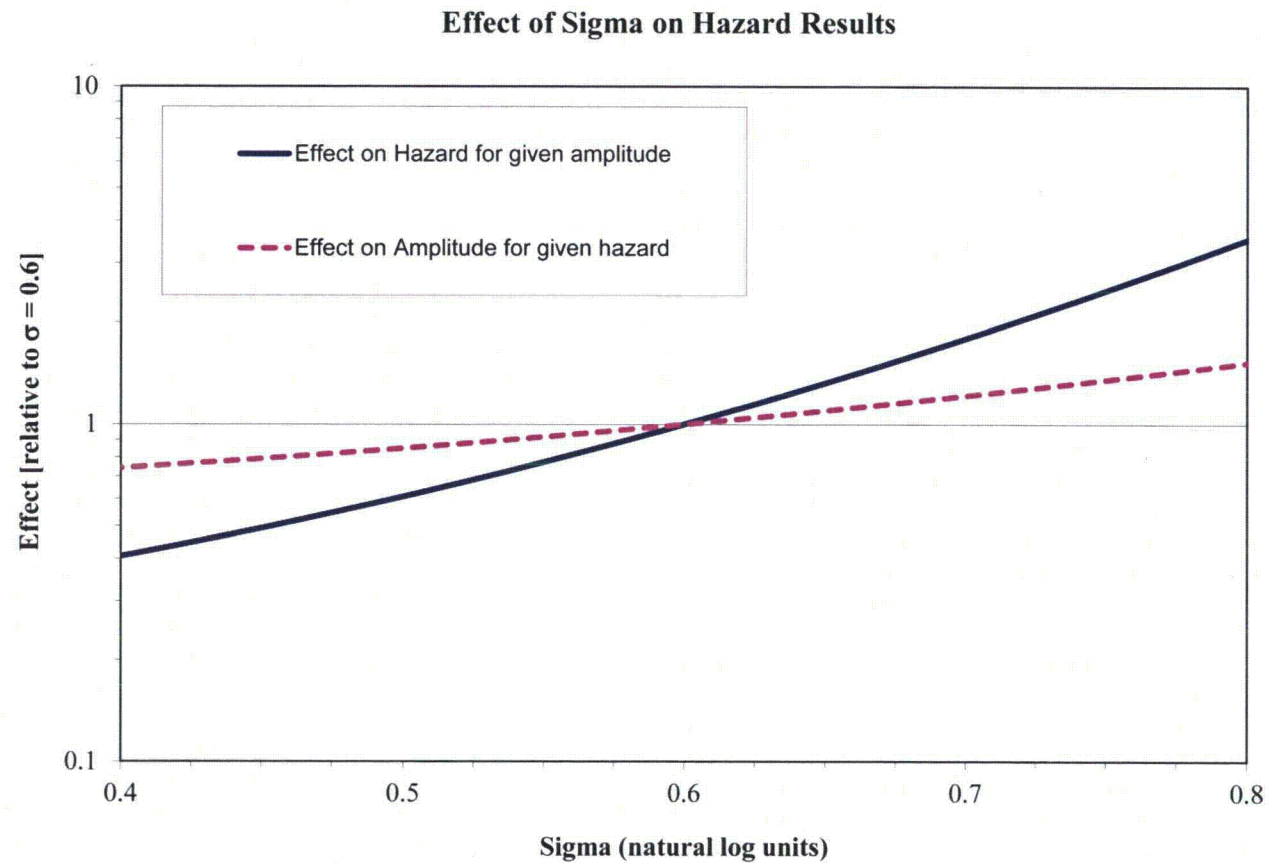


Figure 8.2-11
Sensitivity of hazard to aleatory uncertainty (logarithmic standard deviation, or sigma). Note: This result was obtained using the approach in Appendix I of EPRI (2004), assuming a logarithmic slope of 3 for the hazard curve