The staff confirmatory analysis shows that the APR1400 synthetic acceleration time histories envelop the CSDRS for all specified damping values based on the SRP 3.7.1, Rev. 4, Option 1, Approach 1 criteria. The staff confirmatory analysis also shows that the power spectral density (PSD) functions of these time histories are higher in the frequency range of interest than 70% of the target PSDs developed by the staff, using strong motion durations defined as the duration of near maximum and nearly stationary power of an acceleration time history record. The target PSDs were developed following the SRP 3.7.1 Rev. 4, Appendix B procedure.

However, the Fourier spectra of the time histories show evidence of low pass filtering with corner frequencies lower than 50 Hz, as shown in the figures below. The issue is more evident in the NS direction, with a corner frequency around 48 Hz. The gaps between the corner frequencies and 50 Hz are small so the effect of filtering out the input motion components between the corner frequency and 50 Hz may not be great. However, an evaluation of this effect can lead to higher confidence in the validity of these time histories. Therefore, the staff requests the applicant to explain why filtering was needed in the development of the synthetic acceleration time histories and develop some justification so that this issue can be discussed during the audit.

As a comparison, the time histories compatible with the HRHF RS do not show this behavior in their Fourier spectra.

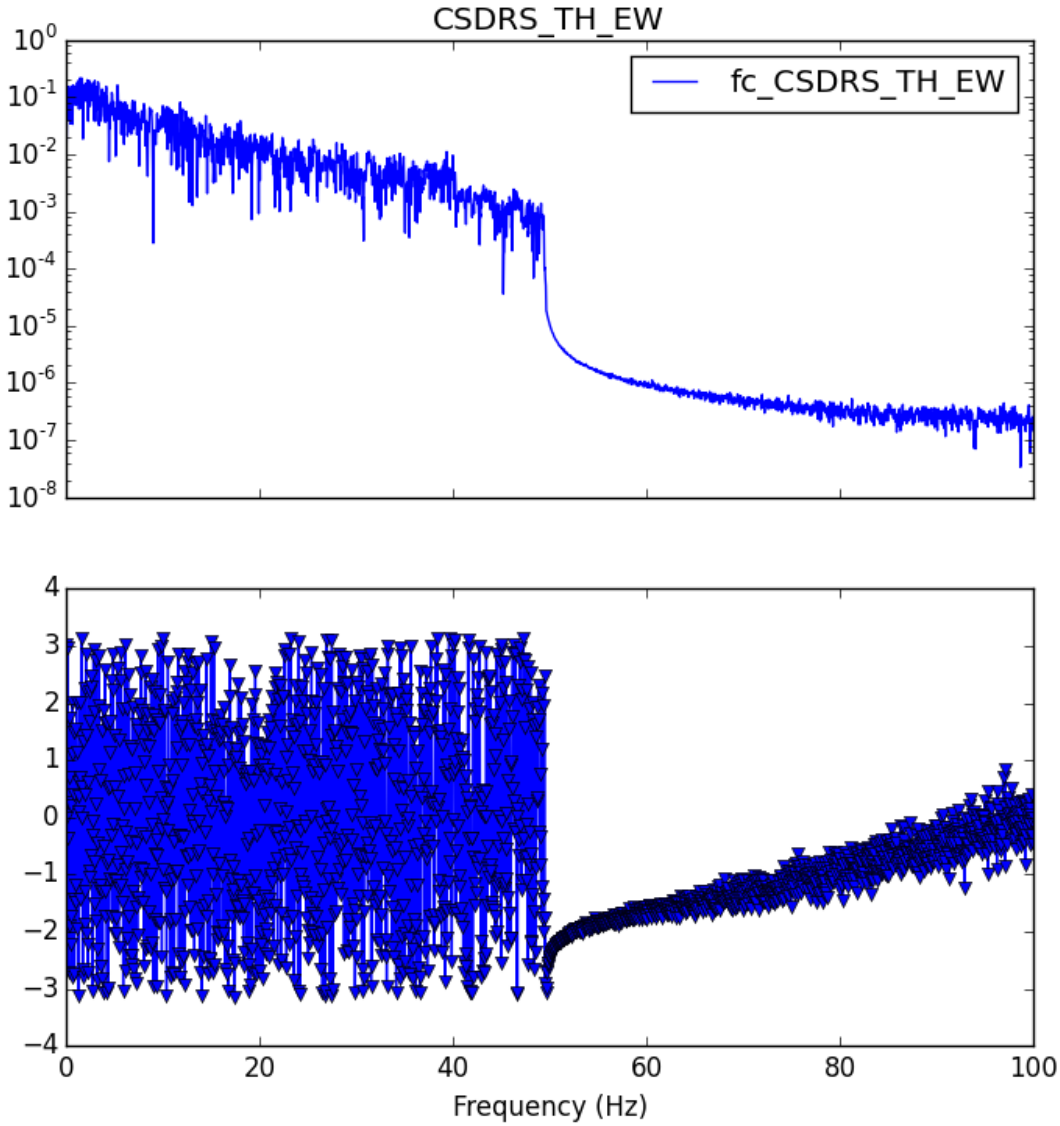

Figure 1 Fourier Spectra for TH in the EW Direction

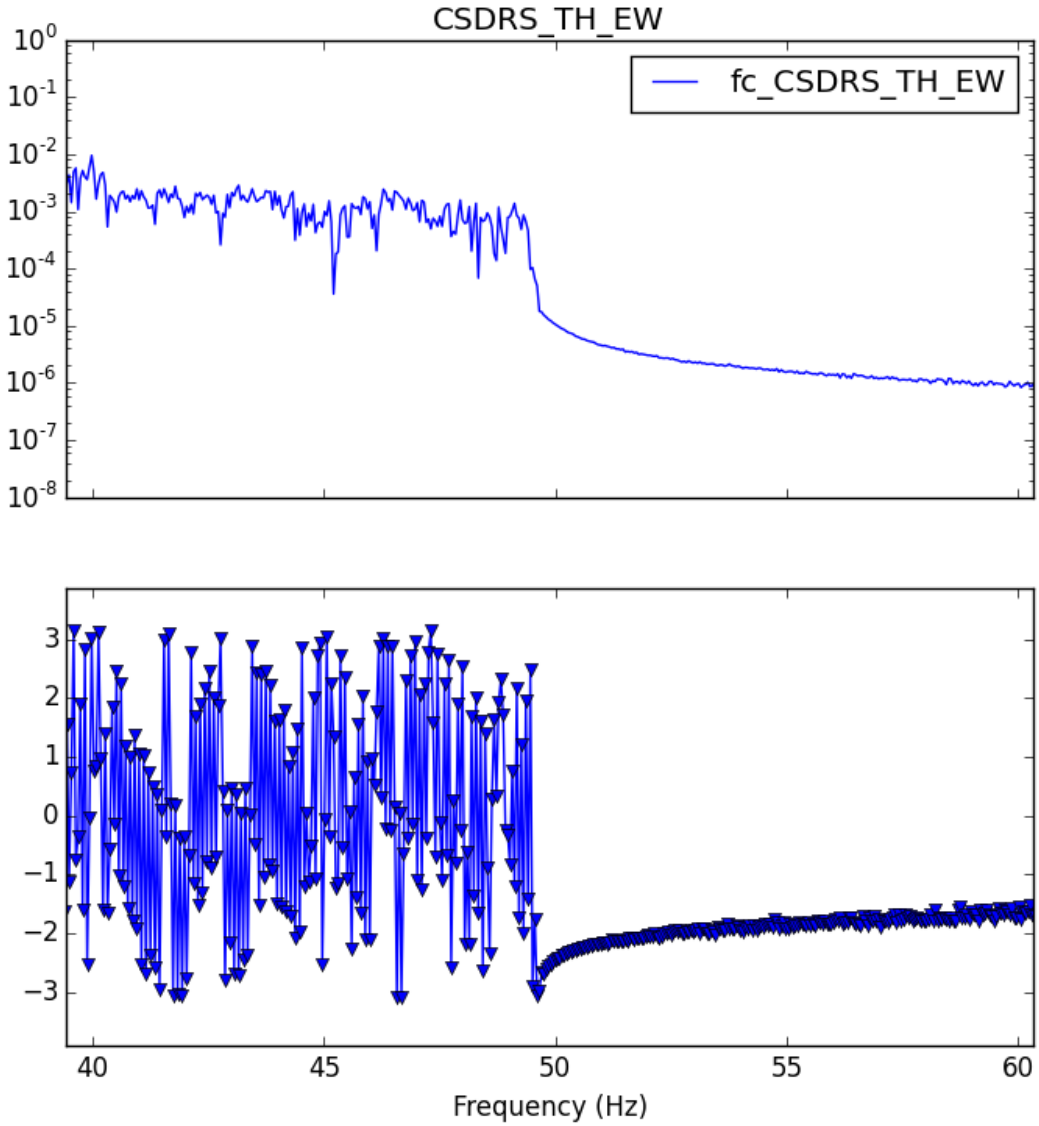

Figure 2 Fourier Spectra for TH in the EW Direction (Zoomed in around 50 Hz)

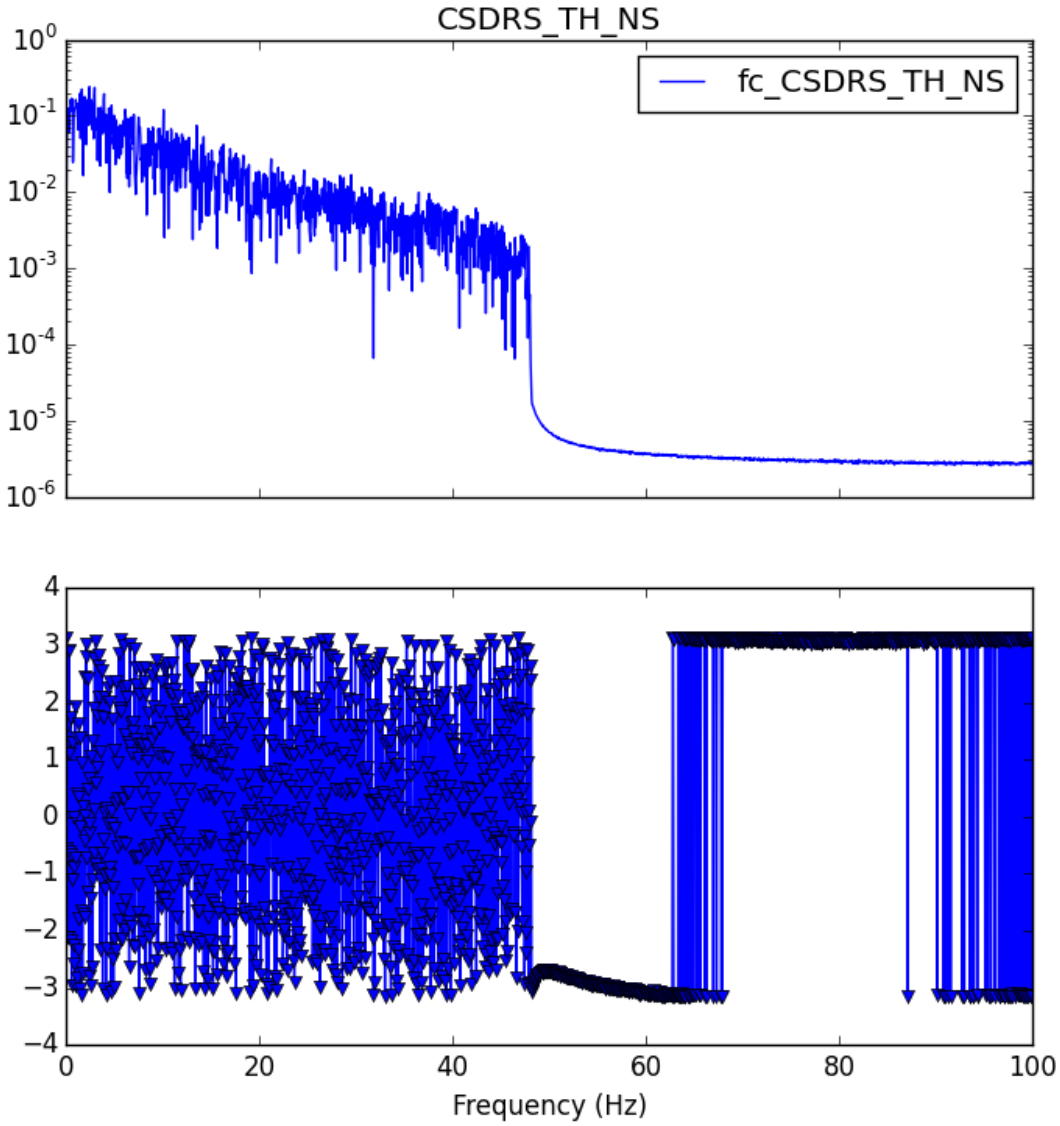

Figure 3 Fourier Spectra for TH in the NS Direction

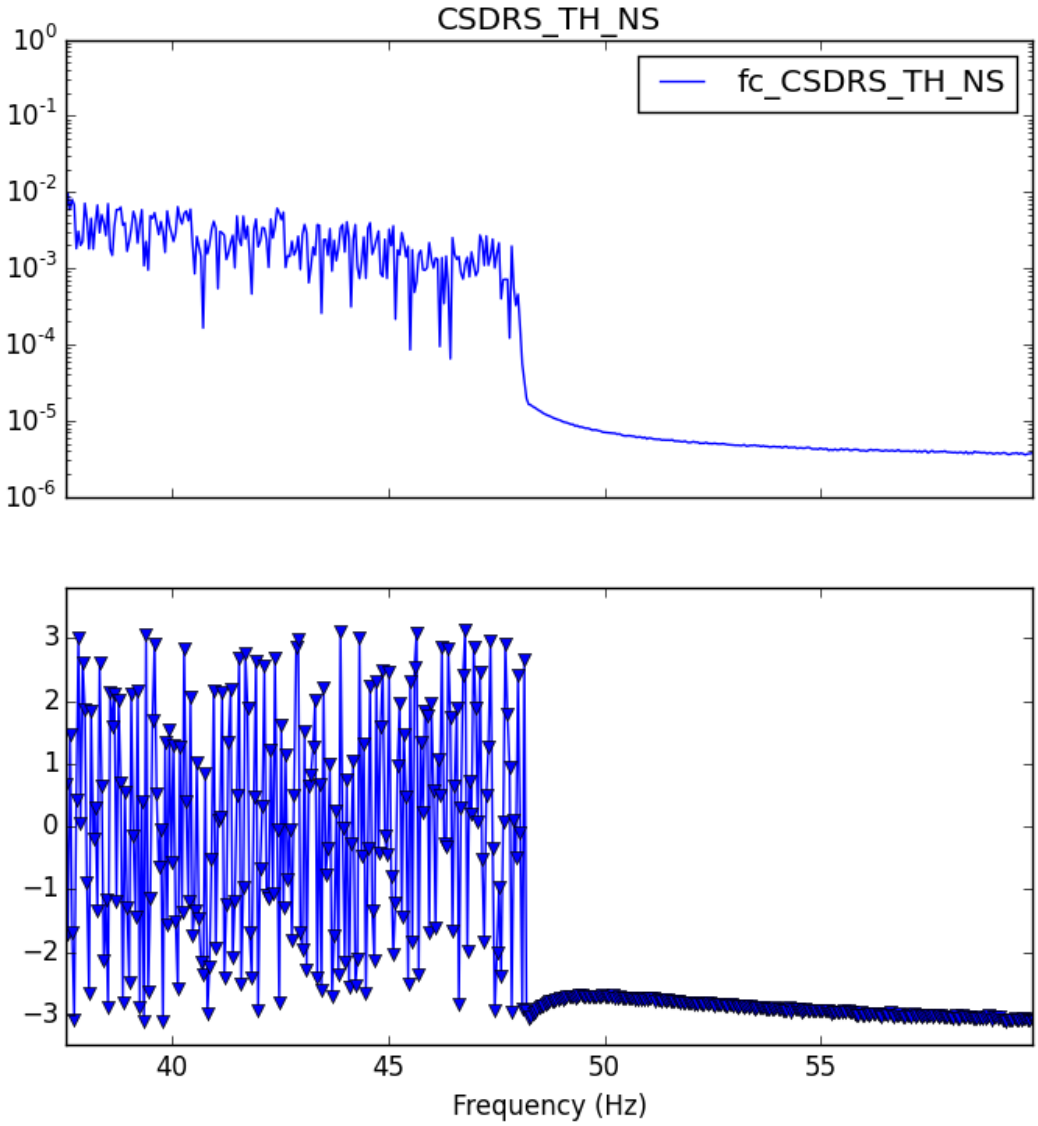

Figure 4 Fourier Spectra for TH in the NS Direction (Zoomed in around 50 Hz)

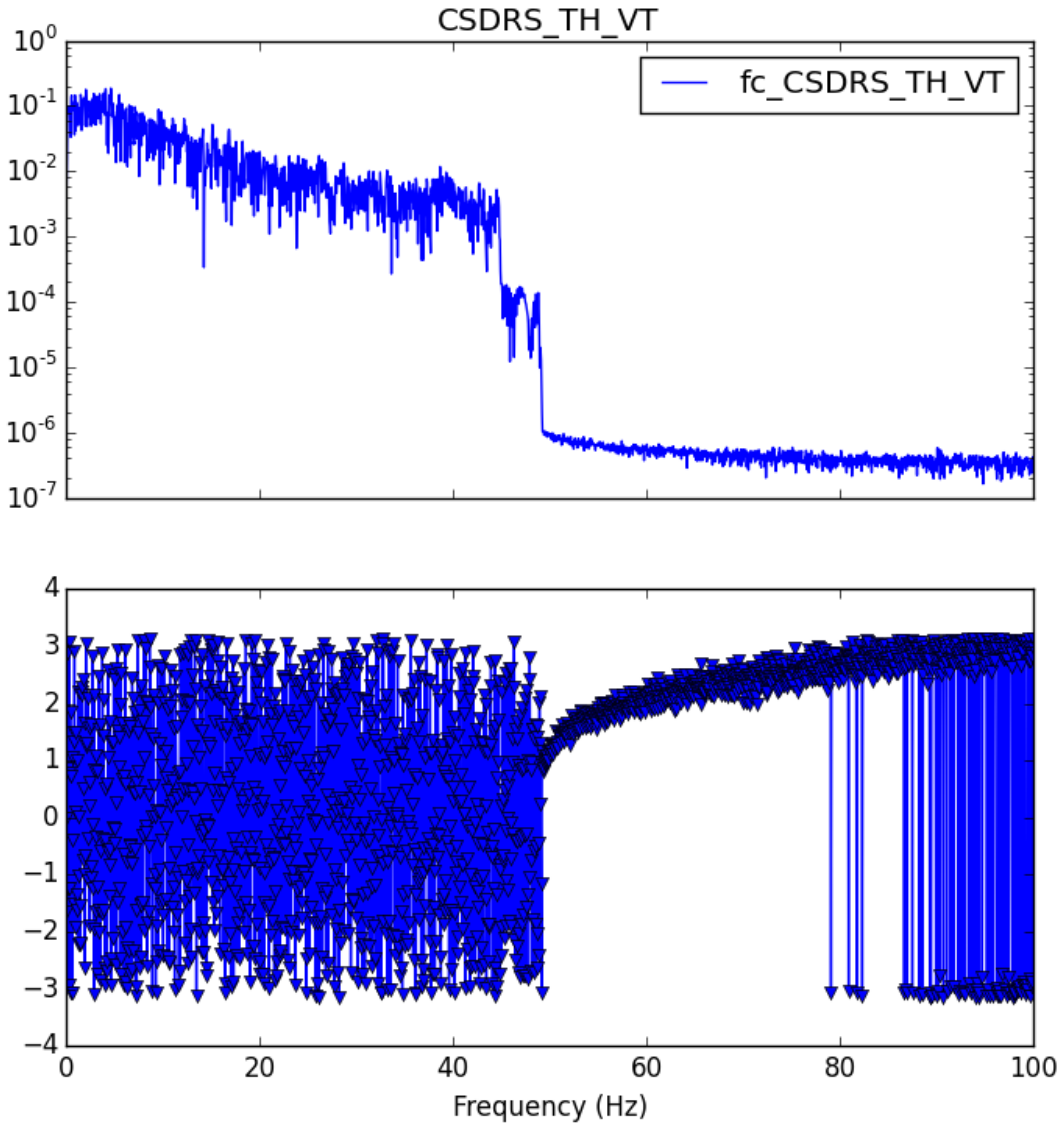

Figure 5 Fourier Spectra for TH in the VT Direction

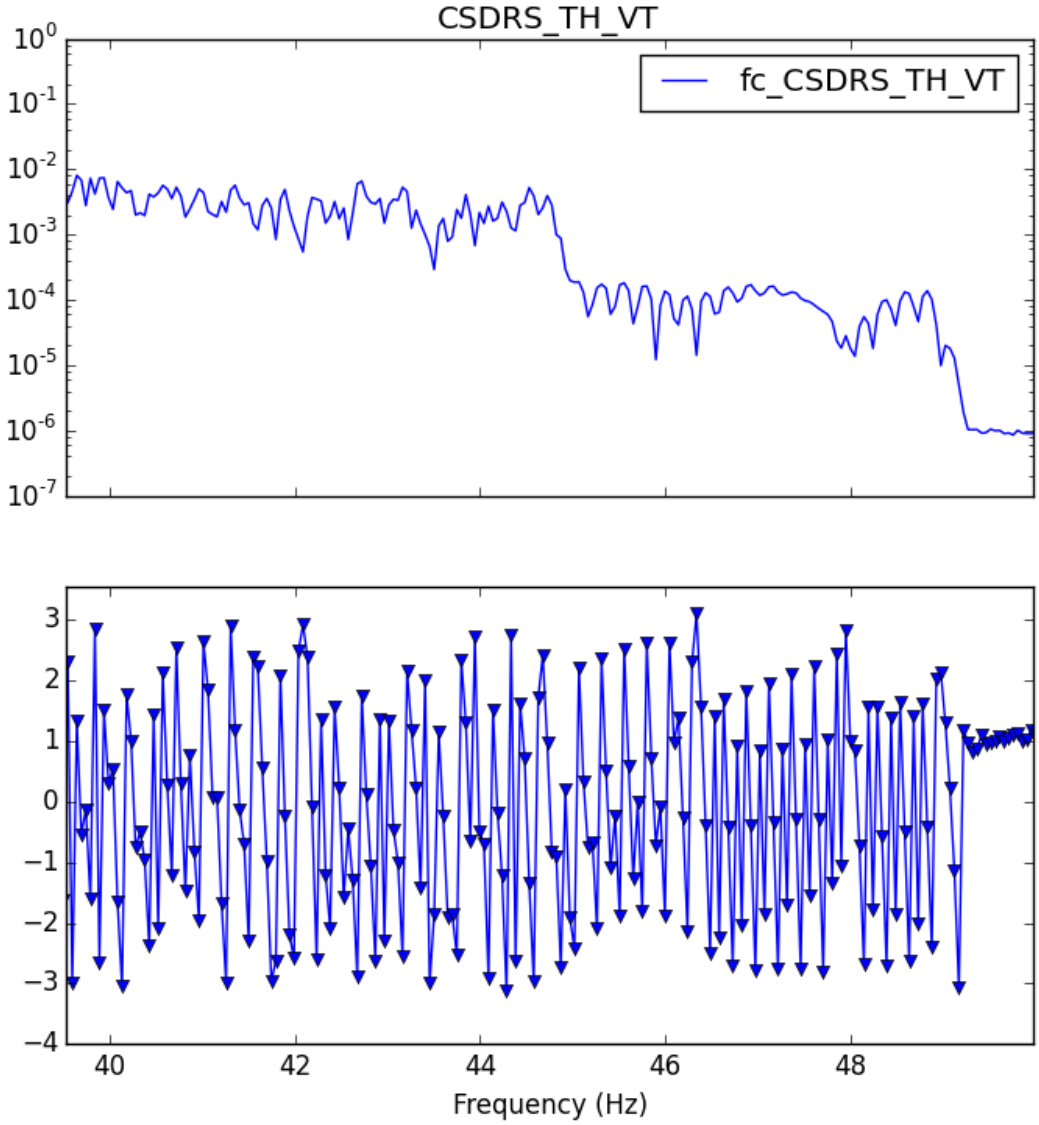

Figure 6 Fourier Spectra for TH in the VT Direction (Zoomed in around 50 Hz)

KHNP INPUT

In the development of synthetic acceleration time histories to match the APR1400 CSDRS of multiple damping values, a low-pass filter was applied to the time histories because the base-line correction and/or clipping of time history that were performed during the spectrum-matching process introduces artificial high-frequency motion contents in the modified time histories. The upper-frequency value of the low-pass filter near 50 Hz was chosen because 50 Hz was the cut-off frequency of the APR1400 CSDRS. The actual upper-frequency value chosen for the low-pass filter was 48 Hz for the NS component, 49.5 Hz for the EW component, and 48.5 Hz for the vertical component of the synthetic acceleration time history. There was no particular reason for selecting the specific upper-frequency values of the low-pass filter as indicated above. The values chosen produced good results in the response-spectrum matching in the high frequency range near and above 50 Hz. If the above-mentioned low-pass filter was not used, the modified time history generated would have time-history response spectrum values that would not match and converge to the PGA value in the frequency range equal to and higher than 50 Hz.

The response-spectrum-compatible synthetic acceleration time histories generated satisfy the SRP 3.7.1, Rev. 4, Option 1, Approach 1 response-spectrum enveloping criteria for the frequency range from 0.2 to 50 Hz. The power spectral density functions (PSDs) computed from the generated synthetic acceleration time histories envelop, over the frequency range from 0.3 to 50 Hz, the minimum-required (80%) target PSDs compatible with the CSDRS developed following the guidelines and procedures provided in the SRP 3.7.1, Rev. 4, Appendix A, for the low frequency range from 0.3 to 9 Hz and following the time-history simulation method described in NUREG/CR-5347 for the high frequency range from 9 to 50 Hz.

The average PSD which is smoothed over a frequency band width of ±20 percent, centered on the frequency, will help to smooth out any PSD gap between 48 Hz to 50Hz. In addition, due to the band width of the response transfer function of the SDOF system at and near 50 Hz, the spectral response between 48 Hz to 50 Hz shows adequate spectral response amplitude in this frequency range as indicated by the time history response spectra matching the target response spectral values.