REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**182-8160**
SRP Section:	**03.07.01 – Seismic Design Parameters**
Application Section:	**3.7.1**
Date of RAI Issue:	**08/31/2015**

Question No. 03.07.01-3

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the safe shutdown earthquake (SSE) ground motion through design, testing, or qualification methods. In accordance with 10 CFR 50 Appendix S, the staff reviewed the adequacy of the method to estimate the power spectral density (PSD) functions for the acceleration time histories for the certified seismic design response spectra (CSDRS) and the hard rock high frequency (HRHF) response spectra (RS). In order for the staff to understand whether the PSD functions were estimated using a method consistent with the guidance of SRP Appendices A and B, the applicant is requested to provide the following additional information.

a) Explain the method used to estimate PSD for the CSDRS time histories

In DCD Section 3.7.1.1.2, the PSDs of the design acceleration time histories are compared to the corresponding target PSD. However, the method to estimate the PSD from an acceleration time history is not provided. Therefore, the applicant is requested to provide a description of the method for the PSD estimation and justify any difference of the method as compared to the guidance provided in SRP 3.7.1. The provided information should include the definition of the strong motion duration, portion of the time history used to compute the Fourier spectra, PSD smoothing, and any normalization parameters used in Fourier transform and PSD calculation.

b) Justification of the method used to estimate PSD for the HRHF time histories

Section 3.5.3 of APR1400-E-S-NR-14004-P, Rev. 1, “Evaluation of Effects of HRHF Response Spectra on SSCs,” describes the method used to calculate the PSD function from an acceleration time history. It utilizes an “equivalent stationary strong-motion duration” as the strong motion duration. The equivalent stationary strong motion is defined as the time for a P1-to-P2 rise of the cumulative Arias intensity, divided by (P2-P1). The applicant stated, “the equivalent stationary duration Tis for the entire time histories as determined from Eq. (3-3) is the duration over which the total energy of the time history is built up from 0 to 100 percent with the constant slope S." In this statement, the parameters P1, P2, and S are not defined. As such, the applicant is requested to provide these three parameters for the three HRHF acceleration time histories. In addition, it appears that the PSD estimate is very sensitive to the choice of P1 and P2; for example a P1=0 and P2=100% will lead to an equivalent stationary strong-motion duration Ts equal to the total duration of the time history. As such, the applicant is also requested to provide a justification for the values of P1 and P2.

Eq. (3-4) is described in Section 3.5.3 as the one-sided PSD, but it appears to be the two-sided PSD formula. Please confirm the validity of Eq. (3-4) and explain how this equation is implemented in the development of target PSDs and in estimating the PSD function for each time history (i.e., one-sided vs two-sided).

Eq. (3-5), the amplitude of the Fourier spectrum, is provided in terms of continuous time *t* and the integration is performed over the entire time history. Please provide the corresponding equation for the discrete Fourier transform implemented for the APR1400.

Appendices A and B of SRP 3.7.1 indicate that PSD should be estimated based on the strong motion duration. Therefore, the staff requests that the applicant provide a justification for the use of equivalent stationary strong-motion duration. Similarly, the applicant is requested to explain why the entire time histories were used in the Fourier transform. The use of the equivalent stationary strong-motion duration, which is shorter than the entire duration as shown in Figure 3-27 of APR1400-E-S-NR-14004-P, Rev. 1, together with the entire time history used in the Fourier transform, may overestimate the PSD for those frequencies that have very low magnitude but span the entire time history

Response – (Rev. 1)

(a) The method for computing the PSD of an acceleration time history is in accordance with the guidance in SRP 3.7.1, Revision 4, supplemented with the additional guidance provided in NUREG/CR-5347, Appendix A (January 1989), Page A-5. The summary for computing the PSD of an acceleration time history is described below.

The one-sided PSD, $s_i(f)$ of time history $a_i(f)$ using following equation.

$$S_i\,(f) = \frac{2|A_i\,(f)|^2}{T_S^i} \tag{1}$$

where $|A_i\,(f)|$ is the amplitude of the Fourier spectrum obtained from the following equation:

$$A_i\,(f) = \int_0^{T_i} a_i\;(t)e^{-i2\pi f t}\,dt \tag{2}$$

where T_i is the total duration of the time history $a_i(t)$.

Equation (2) is a symbolic mathematical equation. In actual numerical calculation, the discrete Fourier spectrum is computed using the Fast Fourier Transform algorithm.

The one-sided PSD $S_i\,(f)$ as given by Equation (1) is in the PSD unit of (in^2/sec^4/Hz) and the frequency unit of f associated with Equation (1) is cycle/second (Hz).

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If, in Equation (1), the PSD $S_i\,(f)$ is to be computed in the PSD unit of (in^2/sec^4/rps), where the frequency unit is in radian/second (rps), then Equation (1) should be replaced by the following equation:

$$S_i\,(f) = \frac{2|A_i\,(f)|^2}{2\pi\, T_S^i} \tag{1a}$$

When PSD is computed using Equation (1a), the frequency unit must be in rps (radian/sec), which is commonly expressed using the frequency symbol ω. Using the symbol ω with the frequency unit of rps, Equation (1a) would be more appropriately expressed as follows:

$$S_i\,(\omega) = \frac{2|A_i\,(\omega)|^2}{2\pi\, T_S^i} \tag{1a}$$

and Equation (2) would be more appropriately expressed as:

$$A_i\,(\omega) = \int_0^{T_i} a_i\,(t) e^{-i\omega t}\, dt \tag{2a}$$

The difference of Equation (1) and Equation (1a) is discussed in NUREG/CR-5347, Appendix A (January 1989), Page A-5.

The discrete form of the mathematical Equation (2a) is computed using the following discrete equation:

$$|A_i(\omega_n)| = \Delta t \left| \sum_{j=0}^{N-1} a_i\,(t_j) e^{-2\pi i (nj/N)} \right| \tag{2b}$$

where $\omega_n = n\Delta\omega = 2\pi n \Delta f = \frac{2\pi n}{(N\Delta t)}; n = 0, 1, \dots, N/2$ and $t_j = j\Delta t, j = 0, 1, \dots, N-1$.

The time history PSD $S_i\,(f)$ computed using Equation (1) or (1a) is smoothed using the moving average technique over a ±20 percent frequency bandwidth centered at the frequency f in accordance with the guidelines in SRP 3.7.1, Revision 4, which refers to NUREG/CR-5347, Appendix B (January 1989).

The definition of strong motion duration is described below.

The full time histories are the time histories of full duration from 0 to 20.48 seconds. The 0% to 100% extended equivalent stationary duration designated as $T_{(100\%\text{-}0\%)}$ is computed as $T_{(100\%\text{-}0\%)} = T_{100\%} - T_{0\%} = (T_{75\%} - T_{5\%})/\ (75\%\text{-}5\%) = T_{(75\%\text{-}5\%)}/0.7$. The time histories, the Fourier amplitudes, PSD and smoothed PSD for time histories of full duration time histories are shown in Figures 1 through 9, respectively.

The PSDs for time histories of truncated duration are computed in accordance with Appendix B of SRP 3.7.1, Rev. 4. The strong motion durations for the CSDRS compatible time histories are defined as shown in Figures 10 through 12. Using the truncated time histories and the corresponding the strong motion duration, the PSDs for the CSDRS compatible time histories are computed as shown in Figures 13 through 21. The PSDs for the CSDRS compatible time histories envelop 70% of target PSD as

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shown in Figures 15, 18, and 21. Thus, the PSDs for the CSDRS compatible time histories satisfy the requirement of Appendix B of SRP 3.7.1, Rev. 4.

As shown in Figure 22 through 24, it can be concluded that the use of full-duration time history and the corresponding 0% to 100% extended equivalent stationary duration T(100%-0%) = T(75%-5%)/0.7 to compute the time-history PSD is a convenient and valid procedure to generate the time-history PSDs.

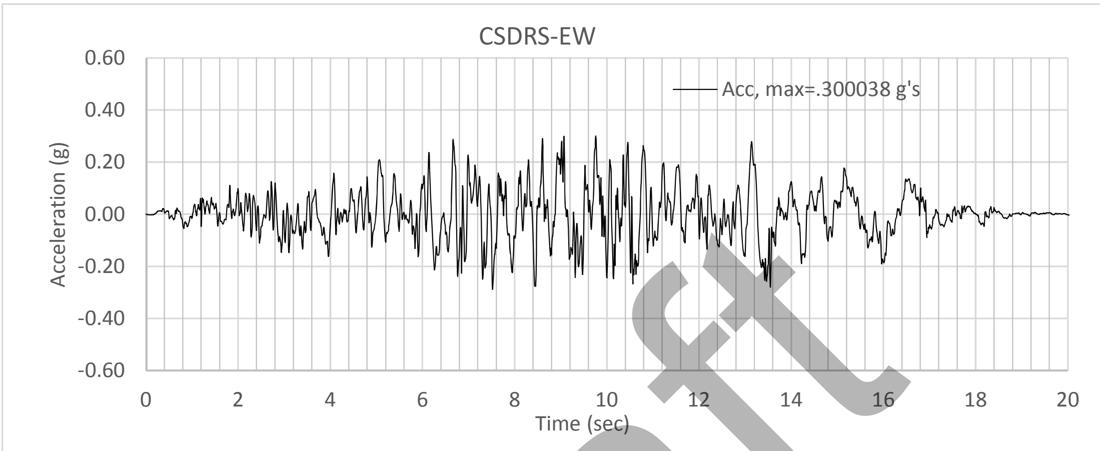

Figure 1 Time History of Full Duration for CSDRS-EW

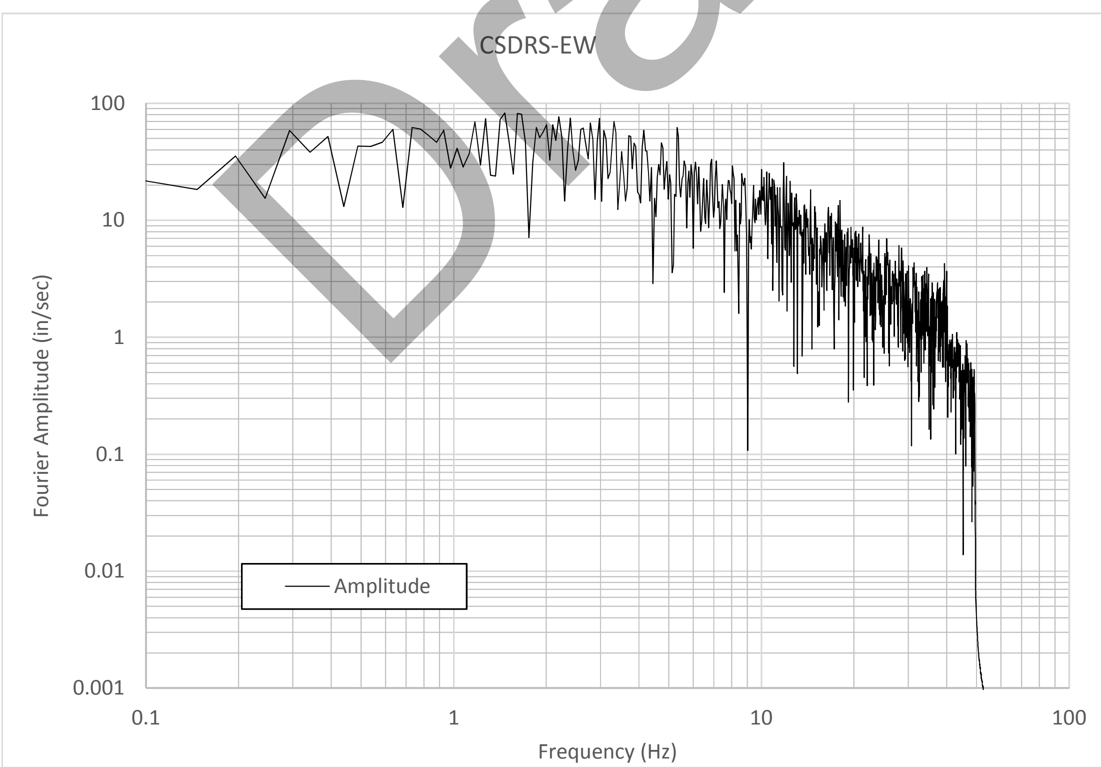

Figure 2 Fourier Amplitudes of Time History of Full Duration for CSDRS-EW

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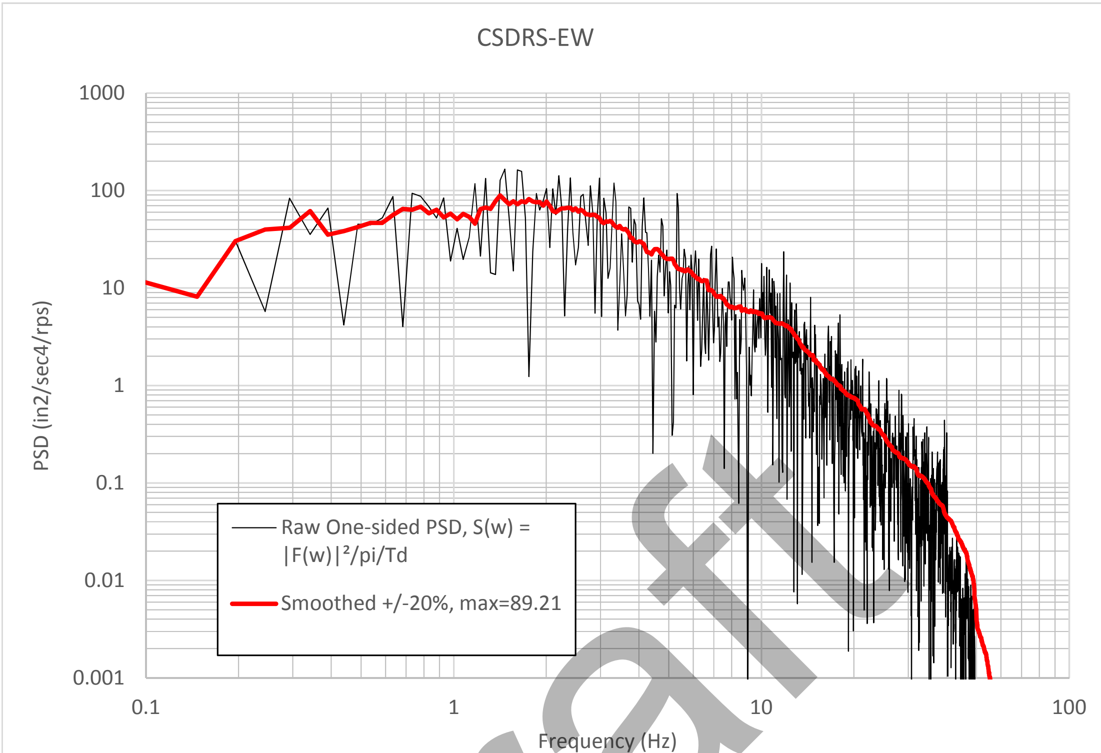

Figure 3 Raw One-sided PSD and Smoothed PSD of Time History of Full Duration for CSDRS-EW

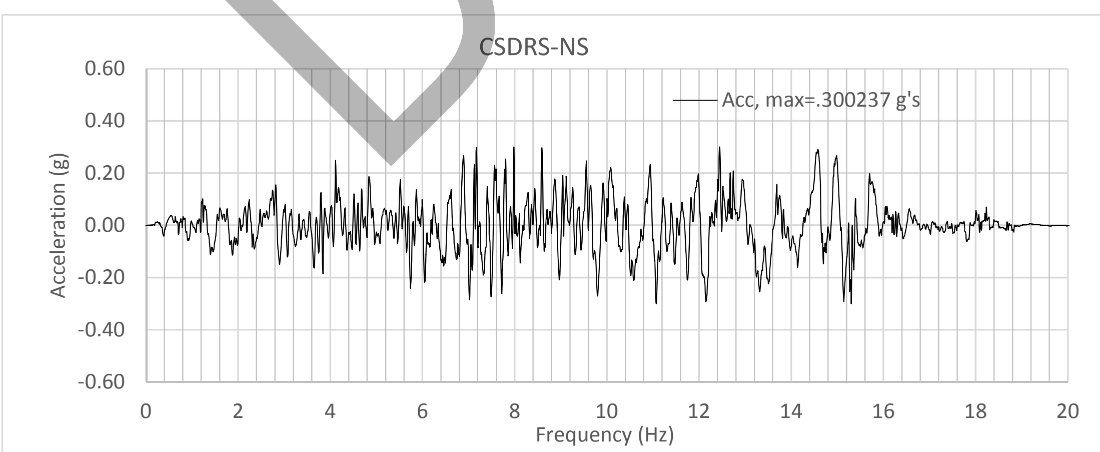

Figure 4 Time History of Full Duration for CSDRS-NS

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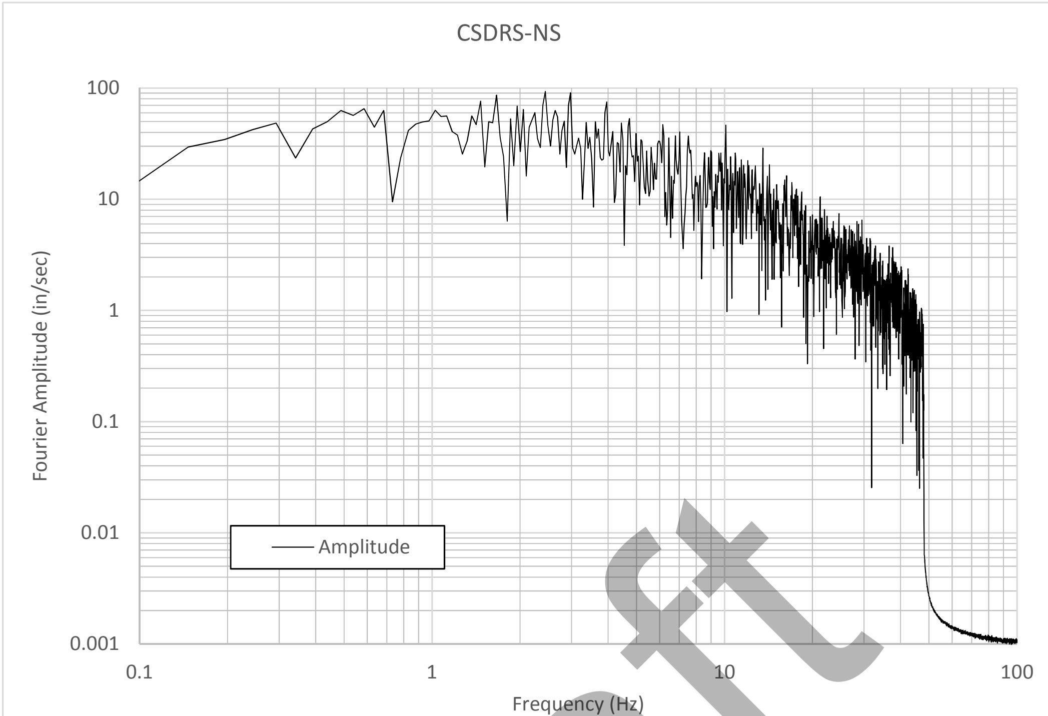

Figure 5 Fourier Amplitudes of Time History of Full Duration for CSDRS-NS

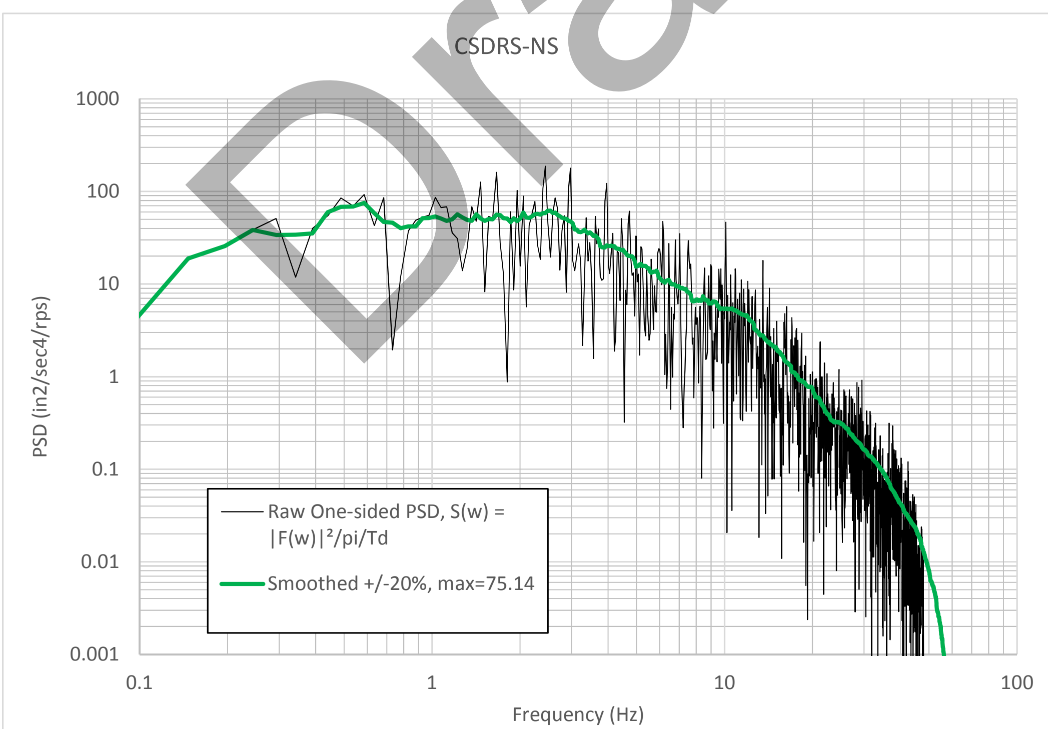

Figure 6 Raw One-sided PSD and Smoothed PSD of Time History of Full Duration for CSDRS-NS

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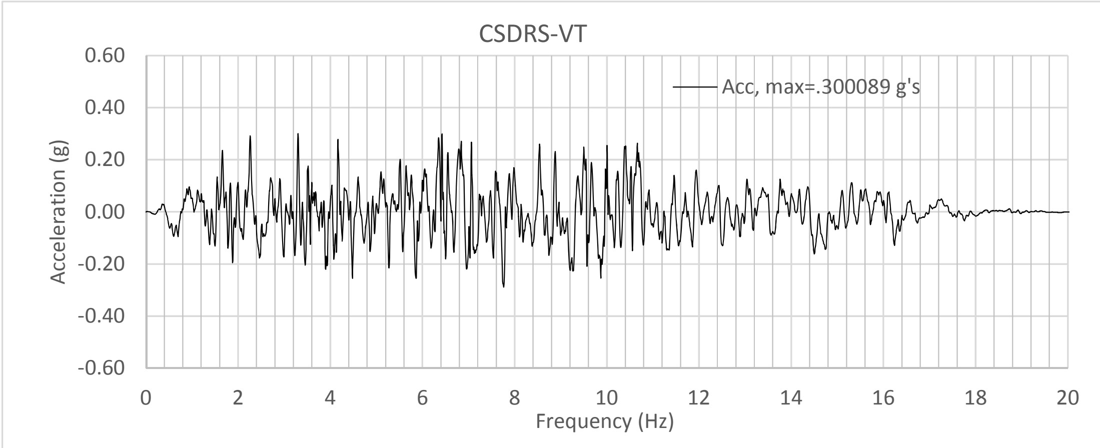

Figure 7 Time History of Full Duration for CSDRS-VT

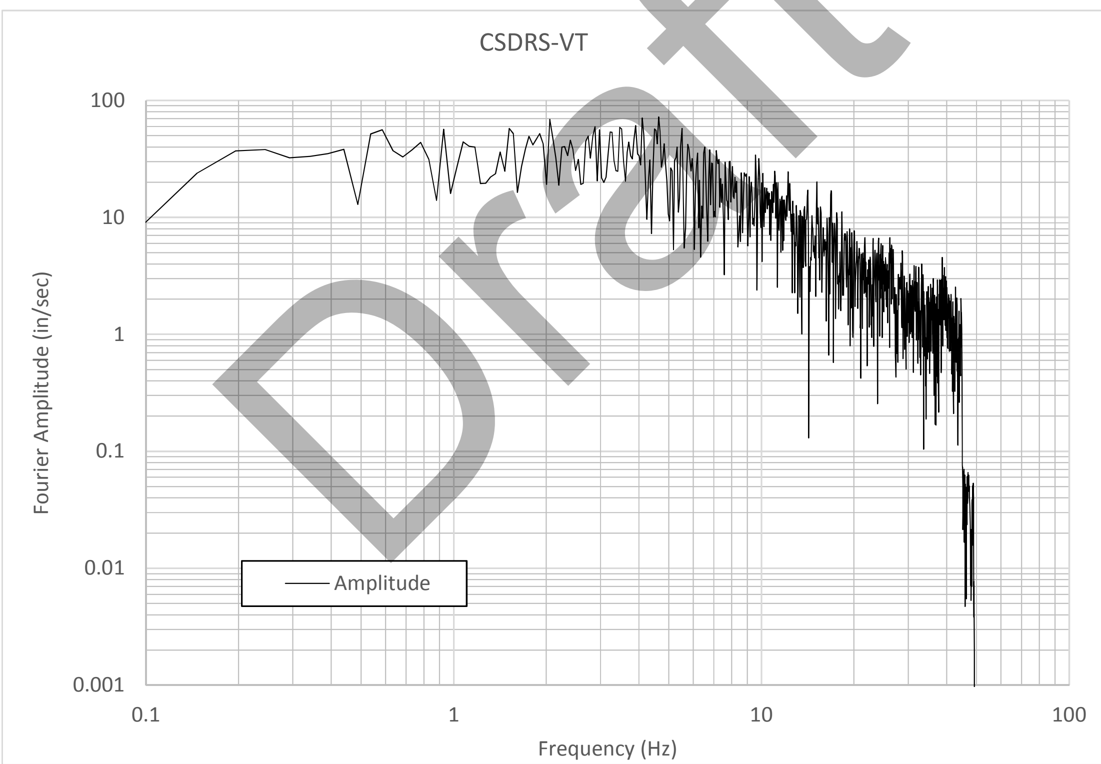

Figure 8 Fourier Amplitudes of Time History of Full Duration for CSDRS-VT

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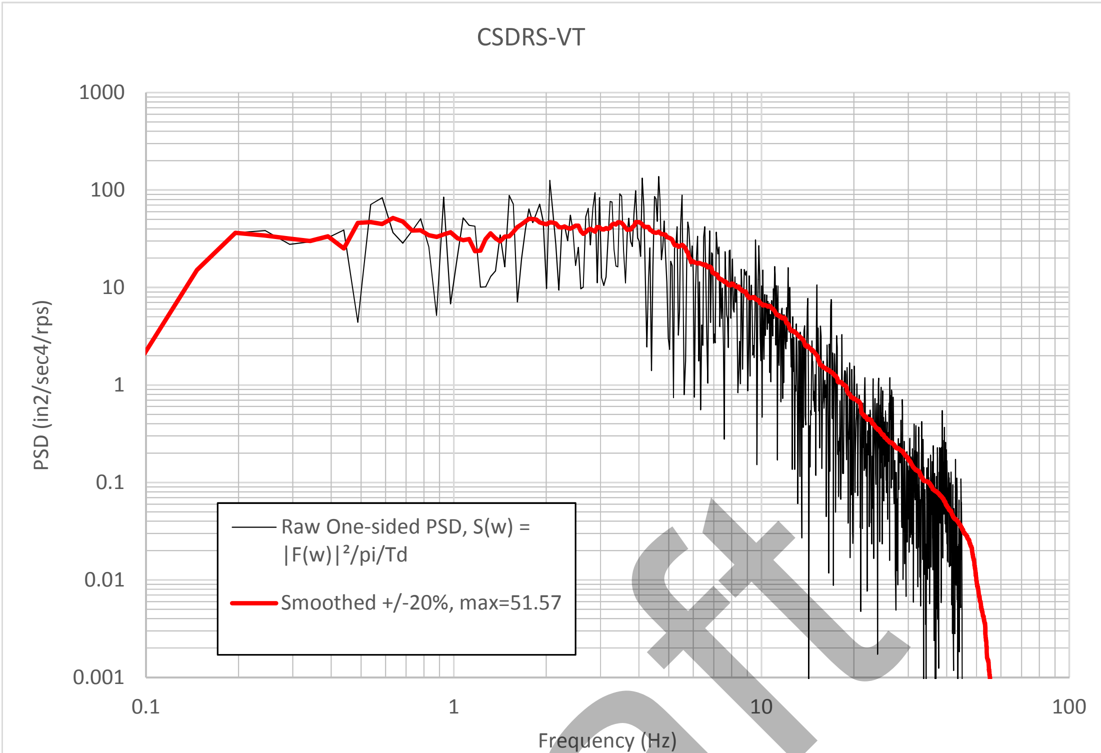

Figure 9 Raw One-sided PSD and Smoothed PSD of Time History of Full Duration for CSDRS-VT

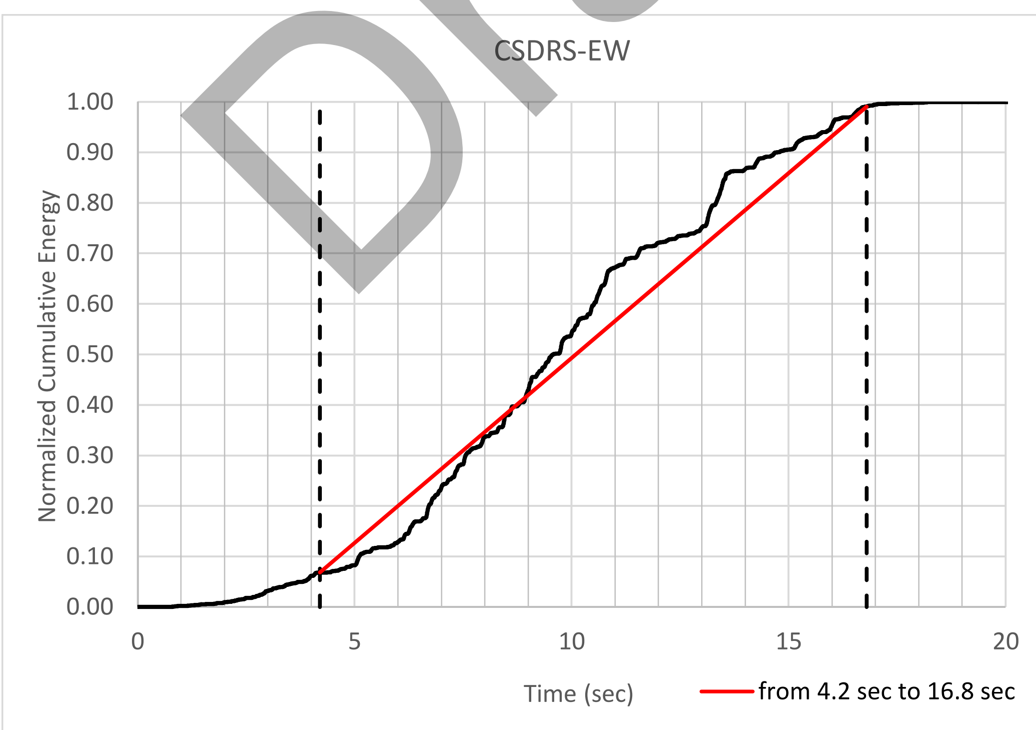

Figure 10 Cumulative Energy (Arias Intensity) Time History for CSDRS-EW

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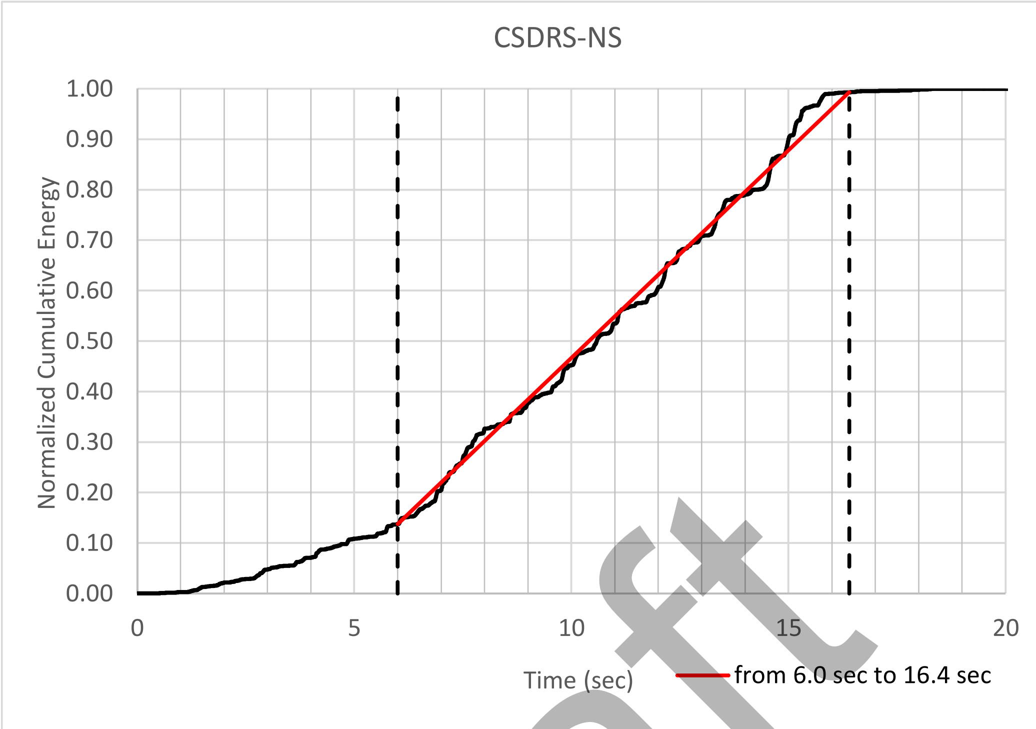

Figure 11 Cumulative Energy (Arias Intensity) Time History for CSDRS-NS

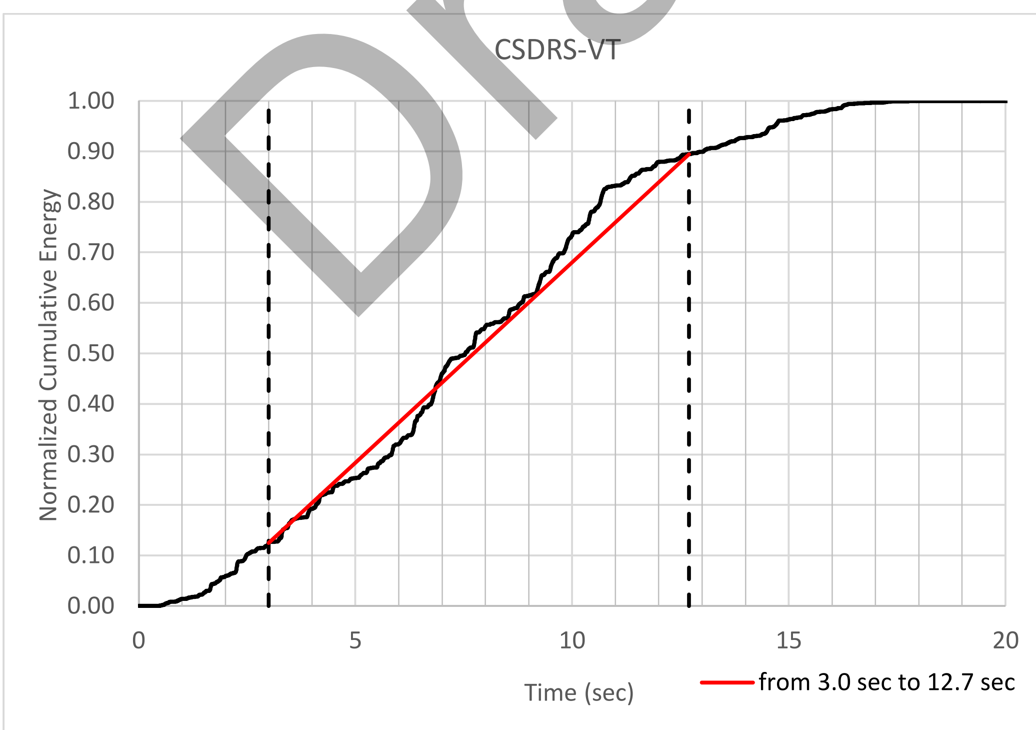

Figure 12 Cumulative Energy (Arias Intensity) Time History for CSDRS-VT

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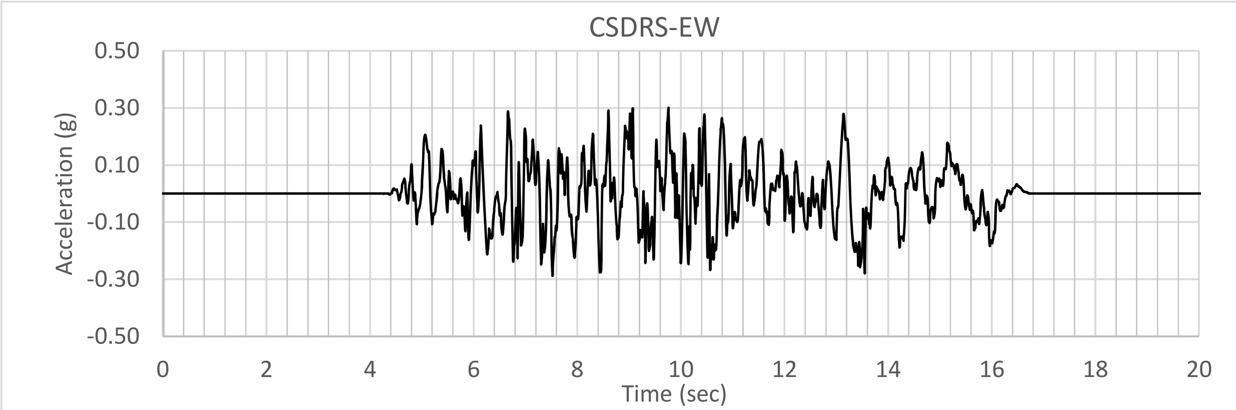

Figure 13 Time History of Truncated Duration from 4.2 sec to 16.8 sec for CSDRS-EW

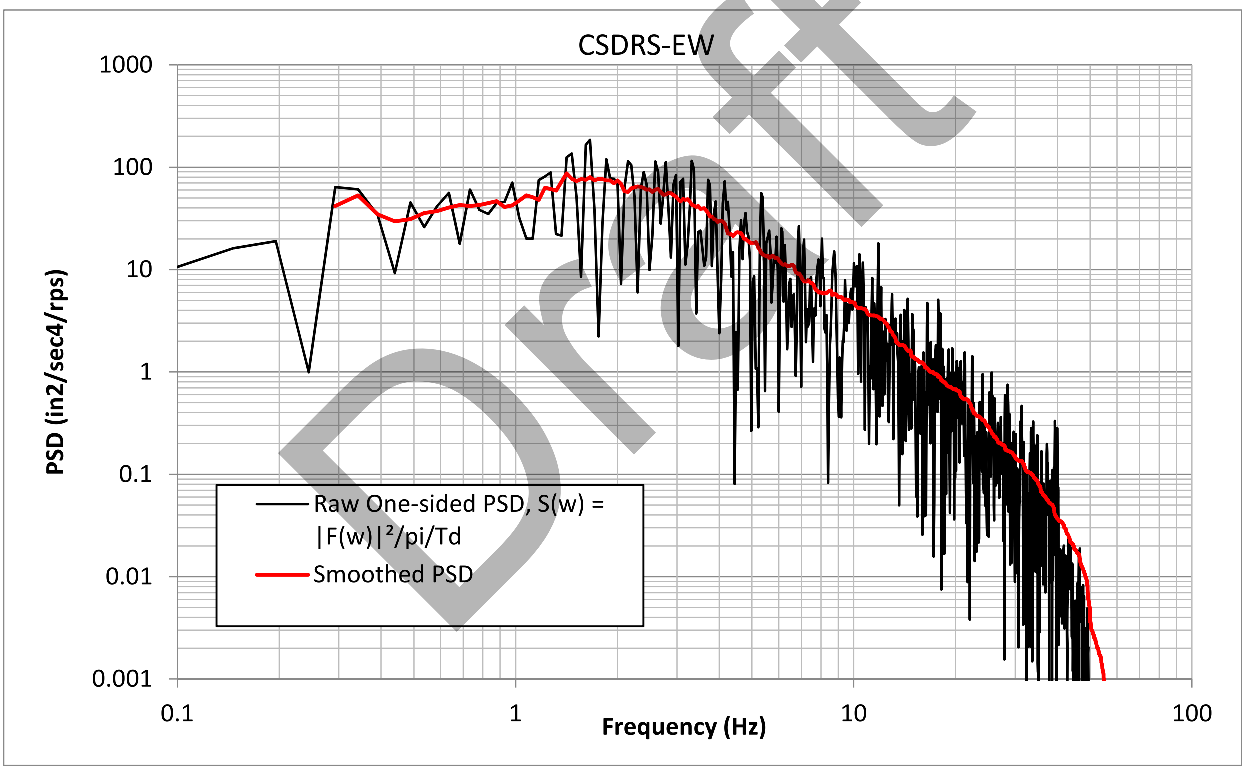

Figure 14 Raw One-sided PSD and Smoothed PSD of Time History of Truncated Duration from 4.2 sec to 16.8 sec for CSDRS-EW

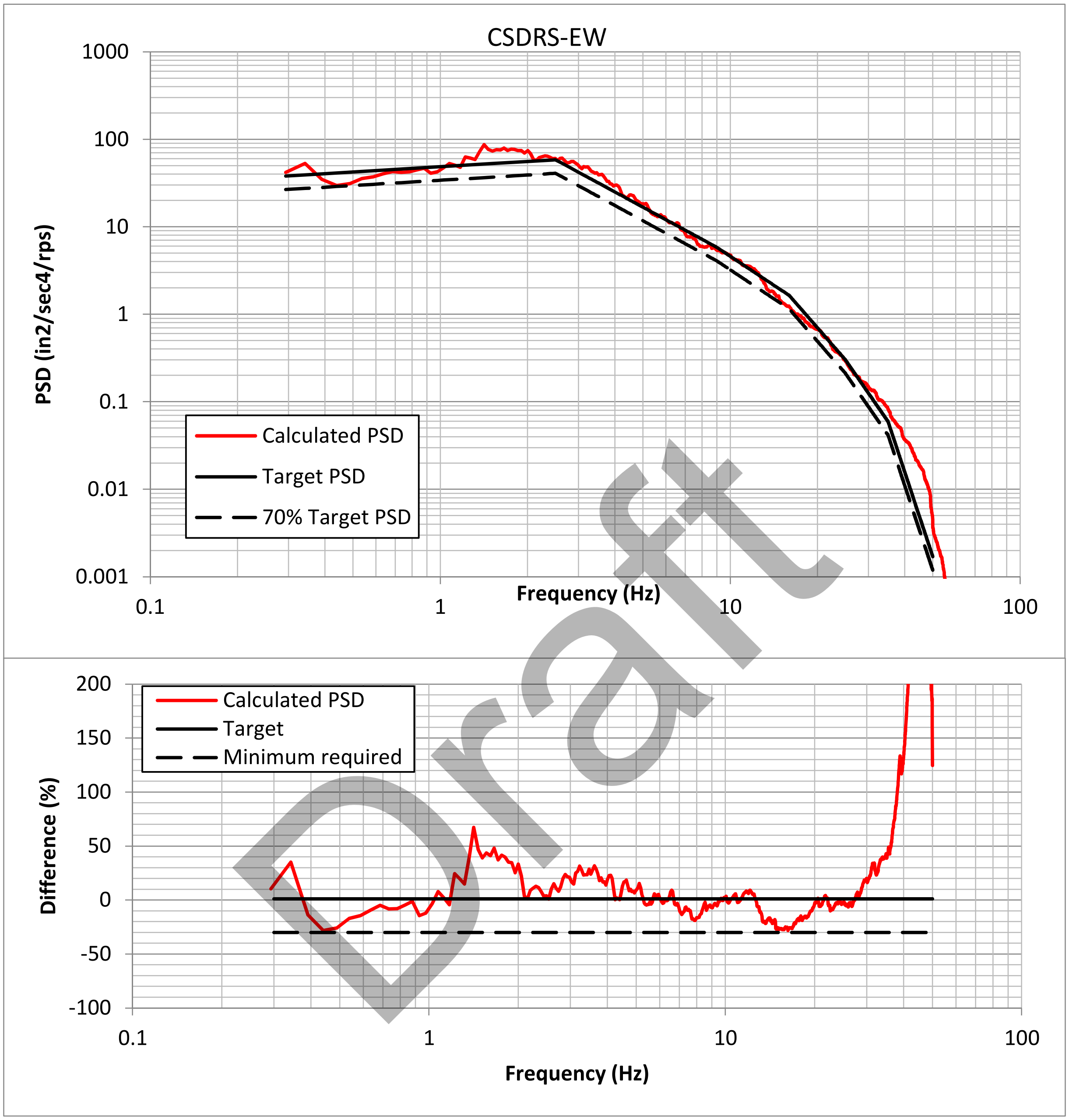

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Figure 15 Comparison of Minimum-Required Target PSD for Horizontal Time History and PSD of Time History of Truncated Duration from 4.2 sec to 16.8 sec for CSDRS-EW

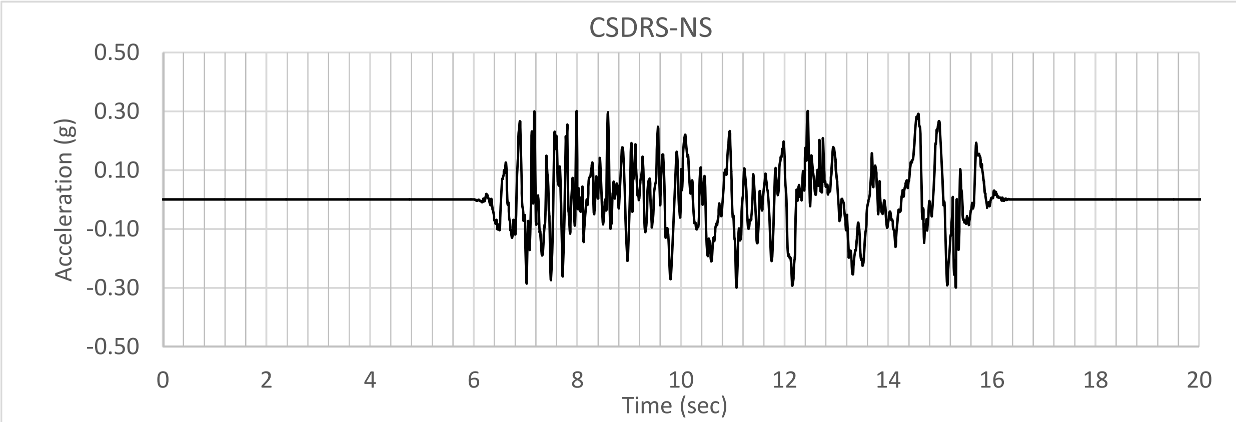

Figure 16 Time History of Truncated Duration from 6.0 sec to 16.4 sec for CSDRS-NS

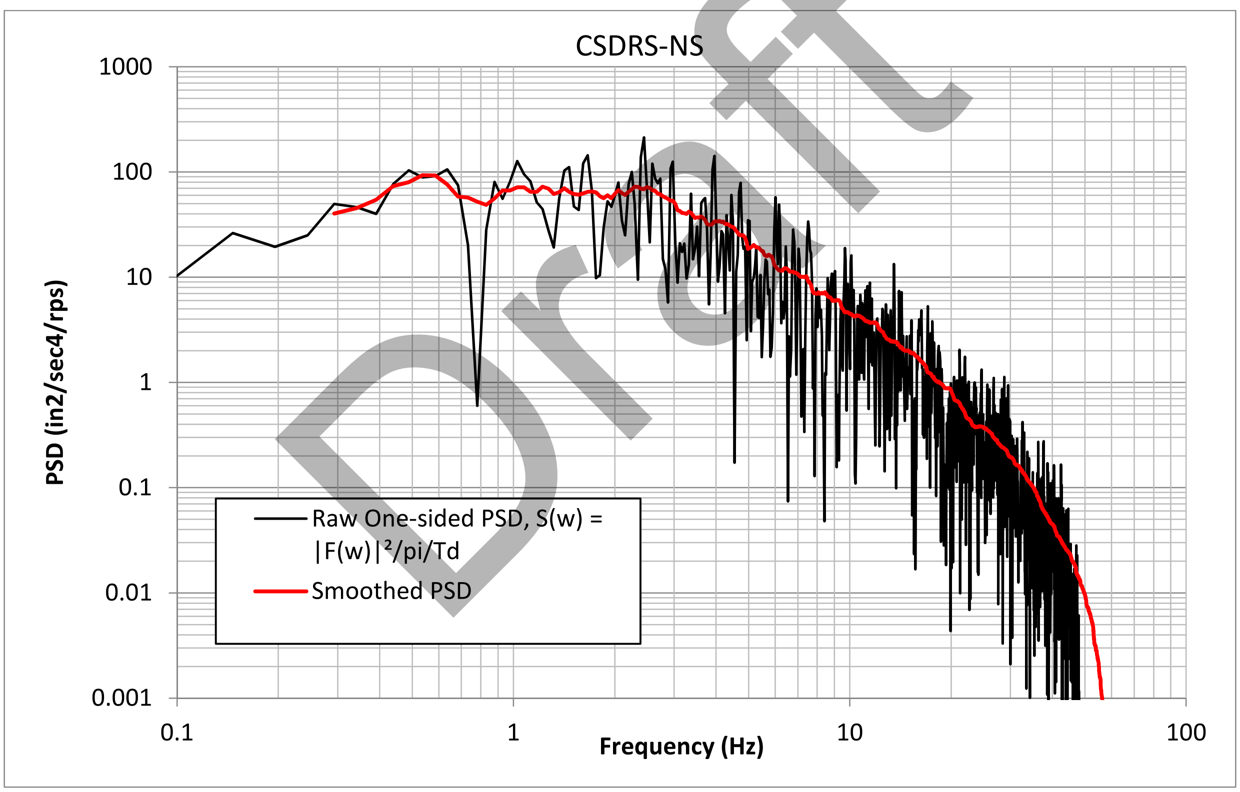

Figure 17 Raw One-sided PSD and Smoothed PSD of Time History of Truncated Duration from 6.0 sec to 16.4 sec for CSDRS-NS

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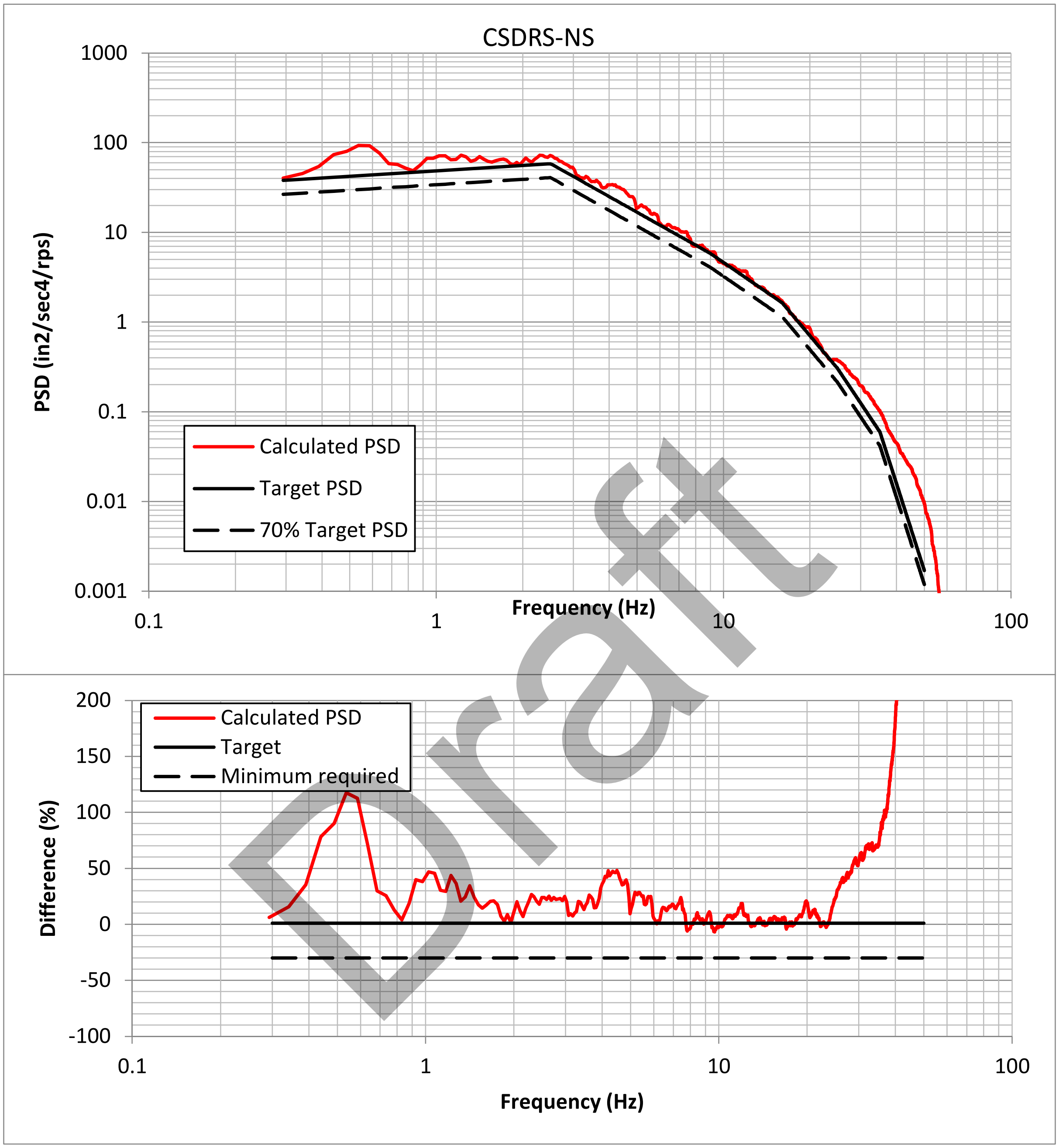

Figure 18 Comparison of Minimum-Required Target PSD for Horizontal Time History and PSD of Time History of Truncated Duration from 6.0 sec to 16.4 sec for CSDRS-NS

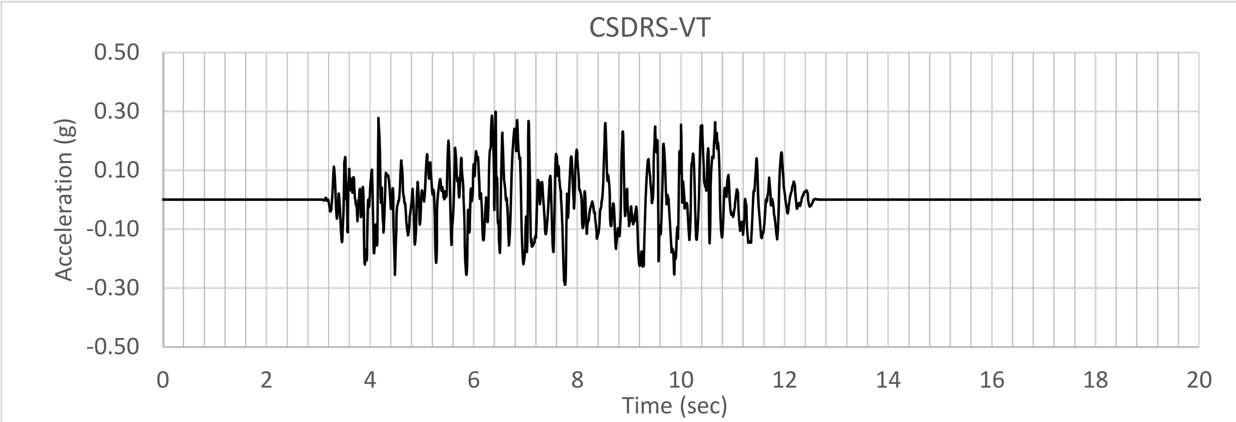

Figure 19 Time History of Truncated Duration from 3.0 sec to 12.7 sec for CSDRS-VT

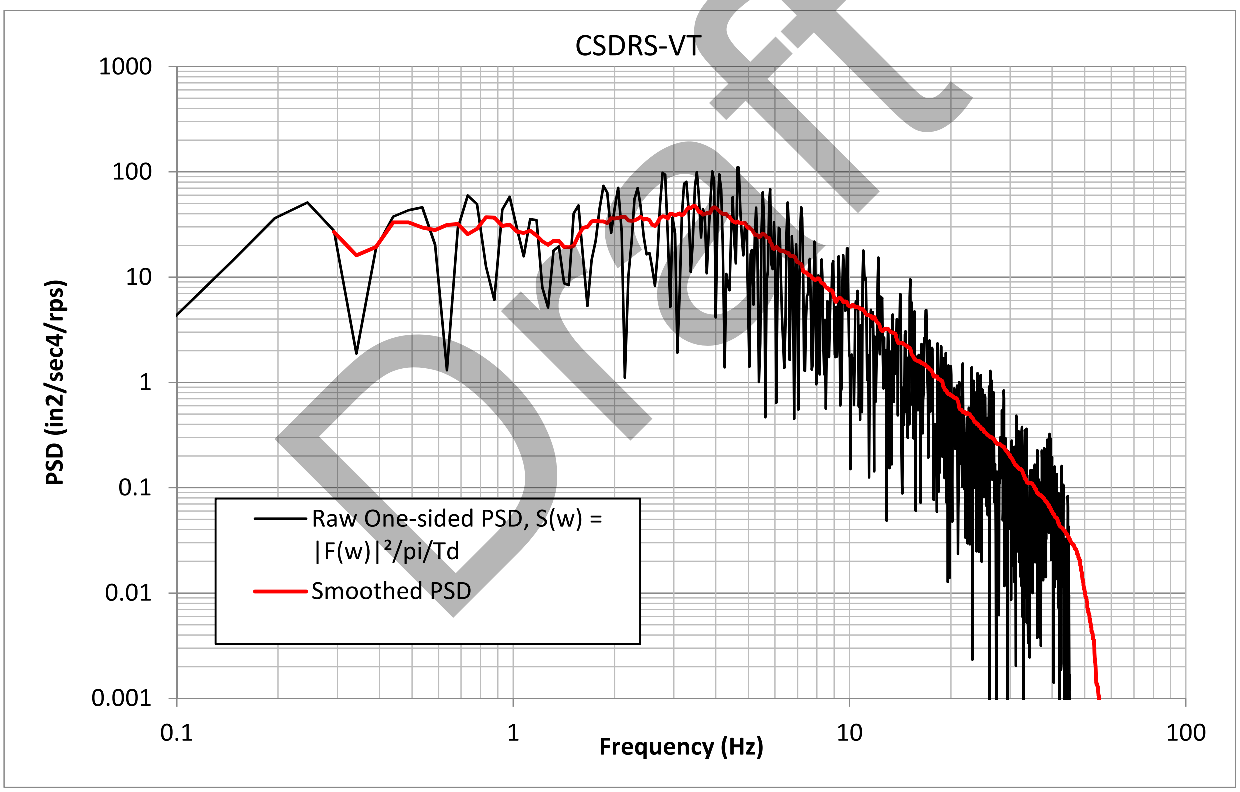

Figure 20 Raw One-sided PSD and Smoothed PSD of Time History of Truncated Duration from 3.0 sec to 12.7 sec for CSDRS-VT

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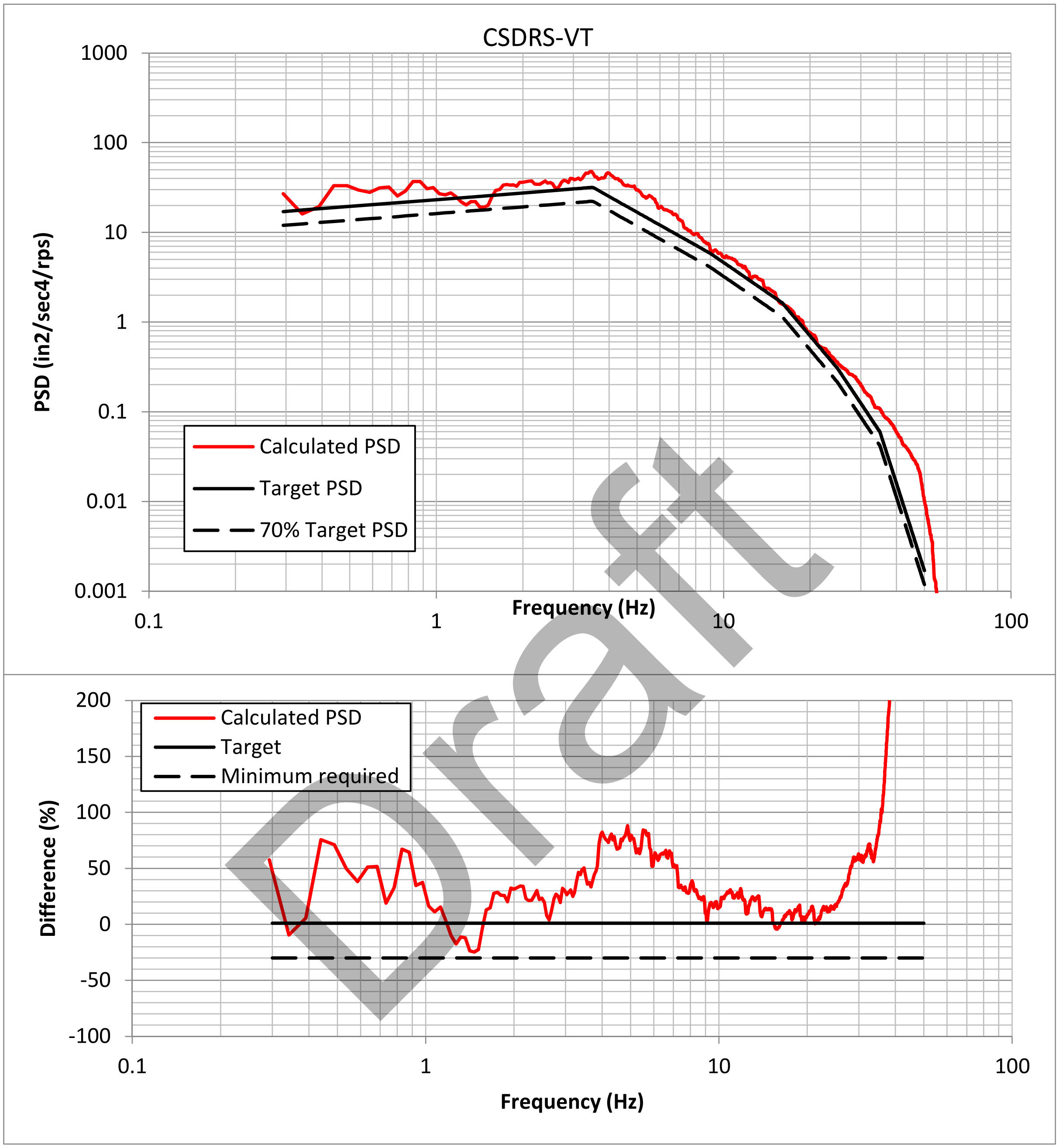

Figure 21 Comparison of Minimum-Required Target PSD for Horizontal Time History and PSD of Time History of Truncated Duration from 3.0 sec to 12.7 sec for CSDRS-VT

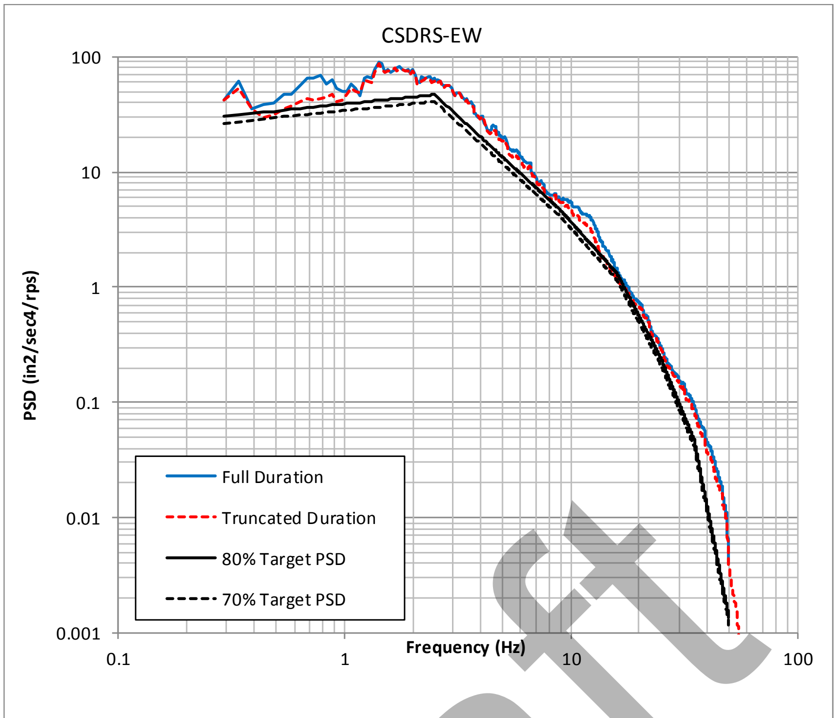

Figure 22 Comparison of PSDs between Time History of Full Duration and Time History of Truncated Duration for CSDRS-EW

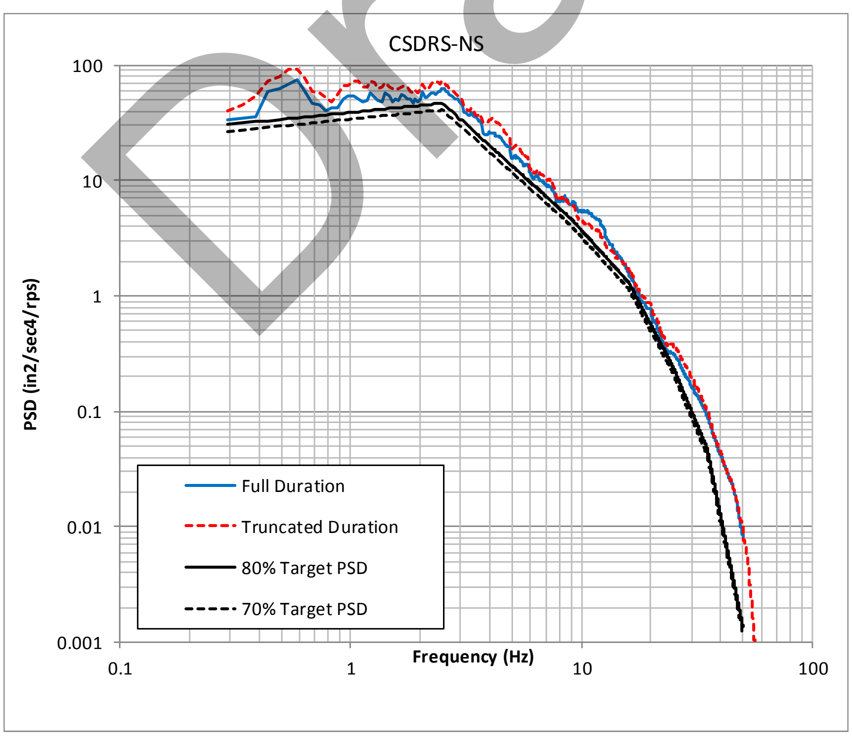

Figure 23 Comparison of PSDs between Time History of Full Duration and Time History of Truncated Duration for CSDRS-NS

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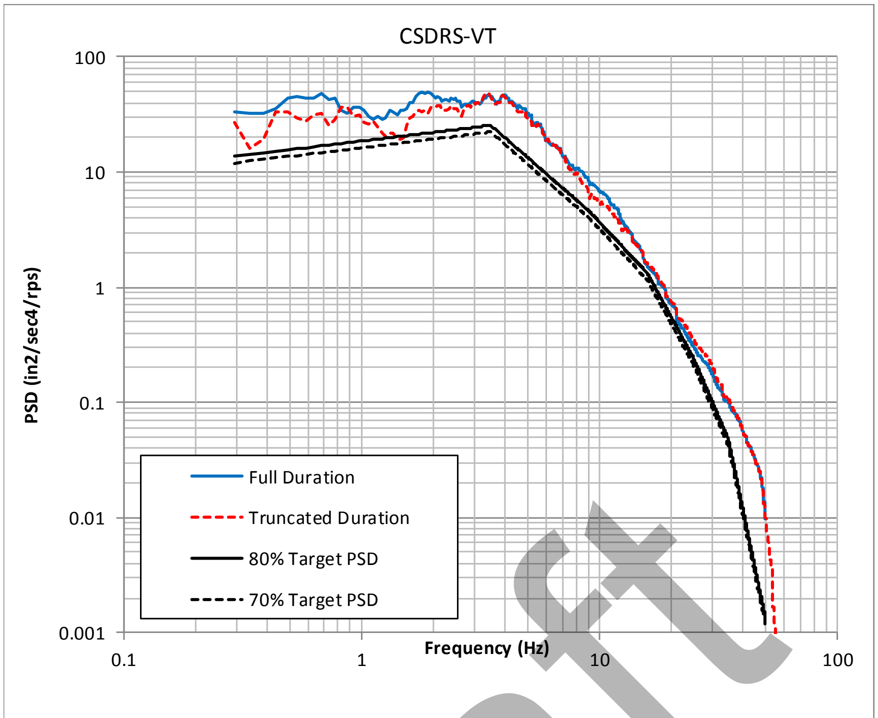

Figure 24 Comparison of PSDs between Time History of Full Duration and Time History of Truncated Duration for CSDRS-VT

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(b) Equation (3-4) in APR1400-E-S-NR-14004-P/NP, Rev. 1, for calculation of the one-sided PSD, S_i (f) of the time history $a_i(t)$, a factor of 2 is missing. For the explanation of Equation (3-4) for the calculation of the one-sided PSD, please refer to the explanations provided previously in response to Question 03.07.01-3 (a).

The discrete form of the mathematical Equation (3-5) in APR1400-E-S-NR-14004-P/NP, Rev. 1 is computed using the following discrete equation:

$$|A_i(\omega_n)| = \Delta t \left|\sum_{j=0}^{N-1} a_i\left(t_j\right) e^{-2\pi i(nj/N)}\right| \qquad (3\text{-}6)$$

where $\omega_n = n\Delta\omega = 2\pi n\Delta f = \frac{2\pi n}{(N\Delta t)}; n = 0, 1, \dots, N/2$ and $t_j = j\Delta t, j = 0, 1, \dots, N-1$.

Referring to the previous explanation in the in response to Question 03.07.01-3 (a), the equivalent strong motion duration is defined by Equation (3-3) as

$$T_S^i = \frac{T_{75\%}^i - T_{5\%}^i}{75\% - 5\%} \qquad (3\text{-}3)$$

Since the slope S of the cumulative energy over the strong motion duration $T_{75\%}^i - T_{5\%}^i$ is constant, Equation (3-3) given above can be recast into the following:

$$T_S^i = \frac{T_{75\%}^i - T_{5\%}^i}{75\% - 5\%} = \frac{T_{100\%}^i - T_{0\%}^i}{100\% - 0\%} = T_{100\%}^i - T_{0\%}^i \qquad (3\text{-}3a)$$

Equation (3-3a) indicates that when the entire time history is used to compute the cumulative energy from 0% to 100%, the equivalent stationary strong-motion duration as defined by Equation (3-3) or (3-3a) should be used. This calculation preserves the slope S of the cumulative energy over the strong motion duration $T_{75\%}^i - T_{5\%}^i$, the procedure does not overestimate the PSD for those frequencies that have very low magnitude but span the entire time history.

The reason to use the equivalent stationary strong-motion duration as defined above and the Fourier transform of the time history over the entire time-history duration is for convenience since the Fourier transform of the input time history is normally computed for the entire time-history duration.

The PSDs for the HRHF RS compatible time histories are computed using the procedure which is described in response to Question 03.07.01-3 (a) as shown in Figure 25 through 36. The PSDs for the HRHF RS compatible time histories satisfy requirement of Appendix B of SRP 3.7.1, Rev. 4 as shown in Figure 30, 33, and 36. The comparison of PSDs between using full duration and truncated durations are shown in Figure 37 through 39.

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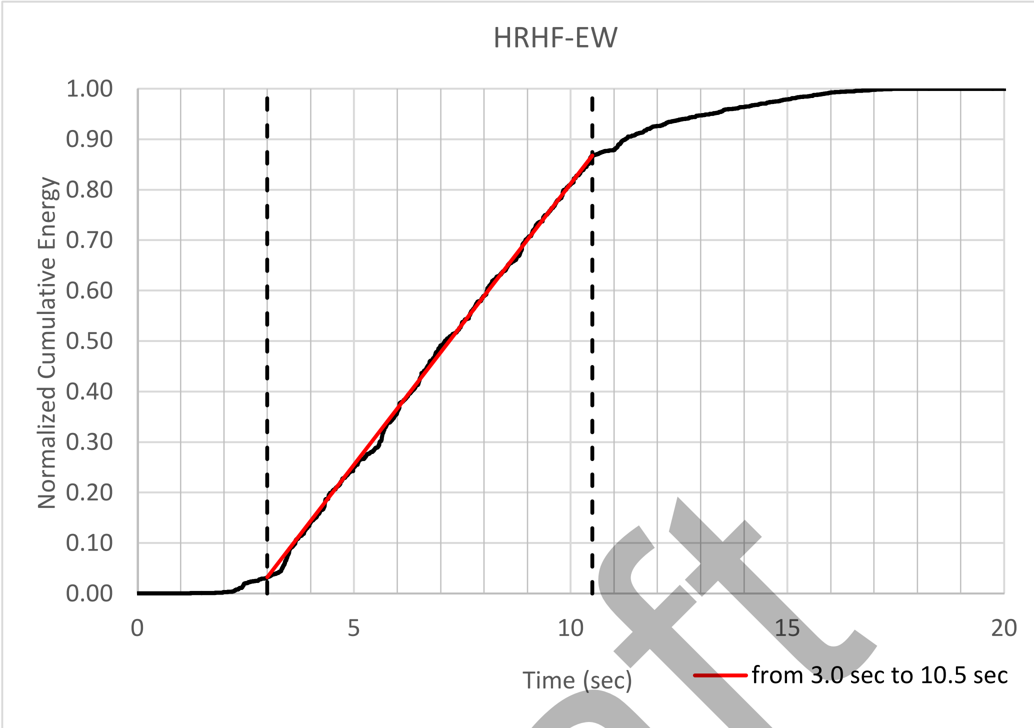

Figure 25 Cumulative Energy (Arias Intensity) Time History for HRHF-EW

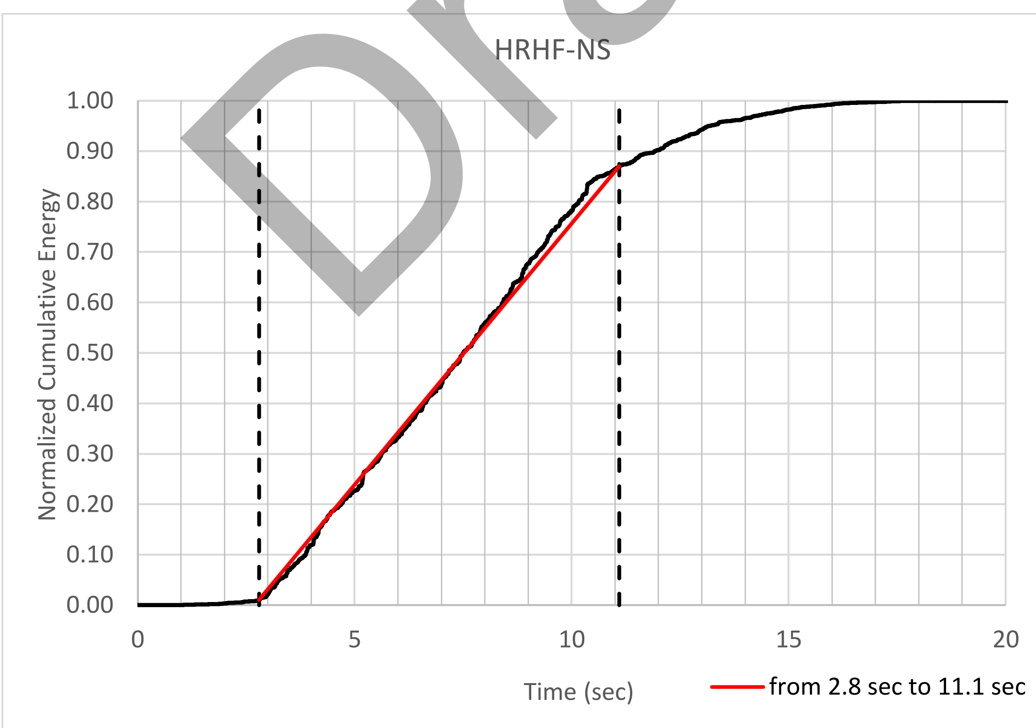

Figure 26 Cumulative Energy (Arias Intensity) Time History for HRHF-NS

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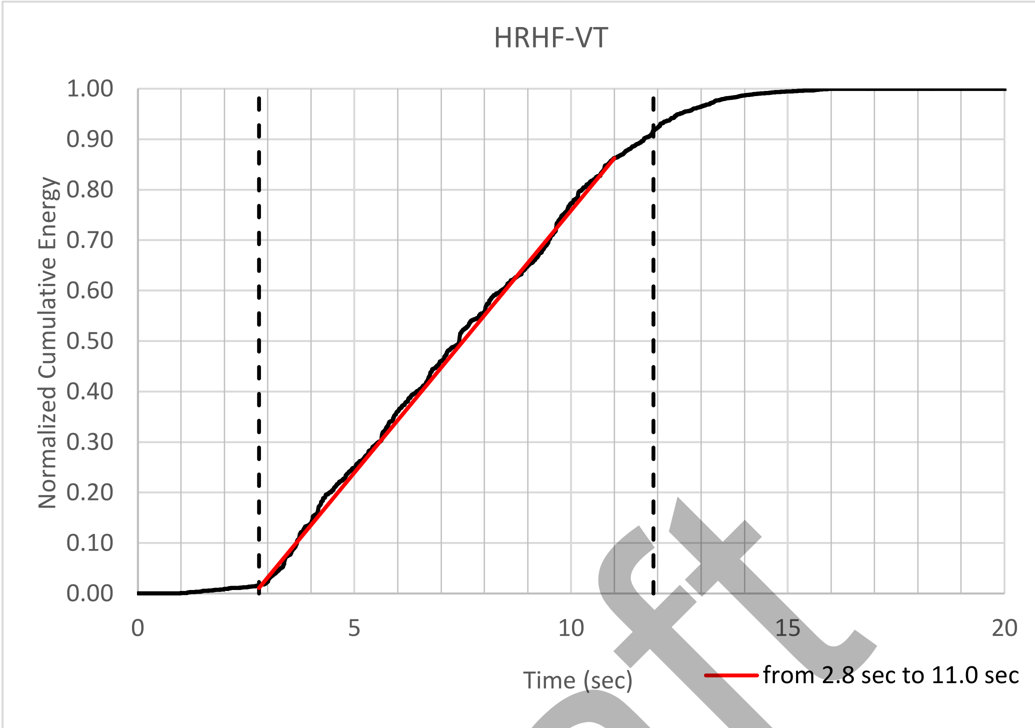

Figure 27 Cumulative Energy (Arias Intensity) Time History for HRHF-VT

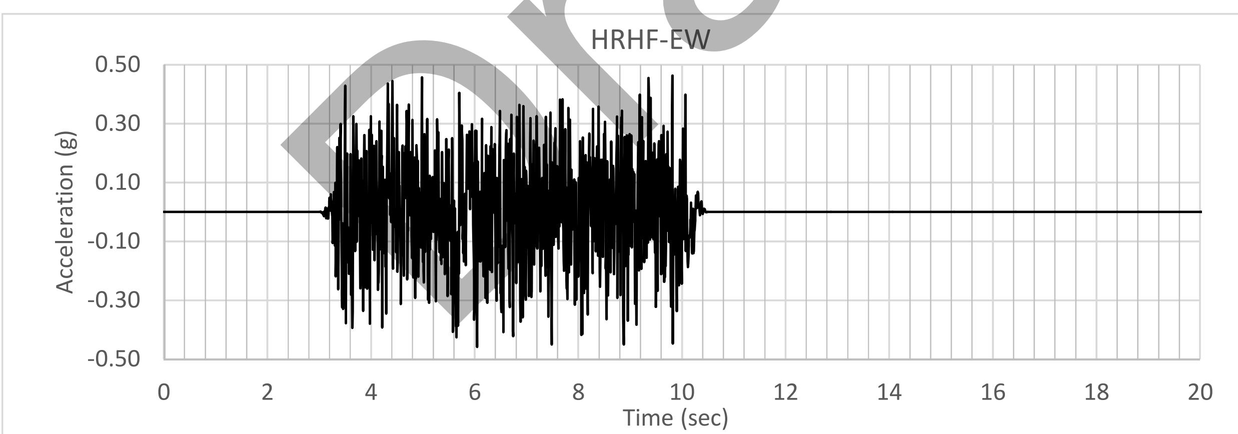

Figure 28 Time History of Truncated Duration from 3.0 sec to 10.5 sec for HRHF-EW

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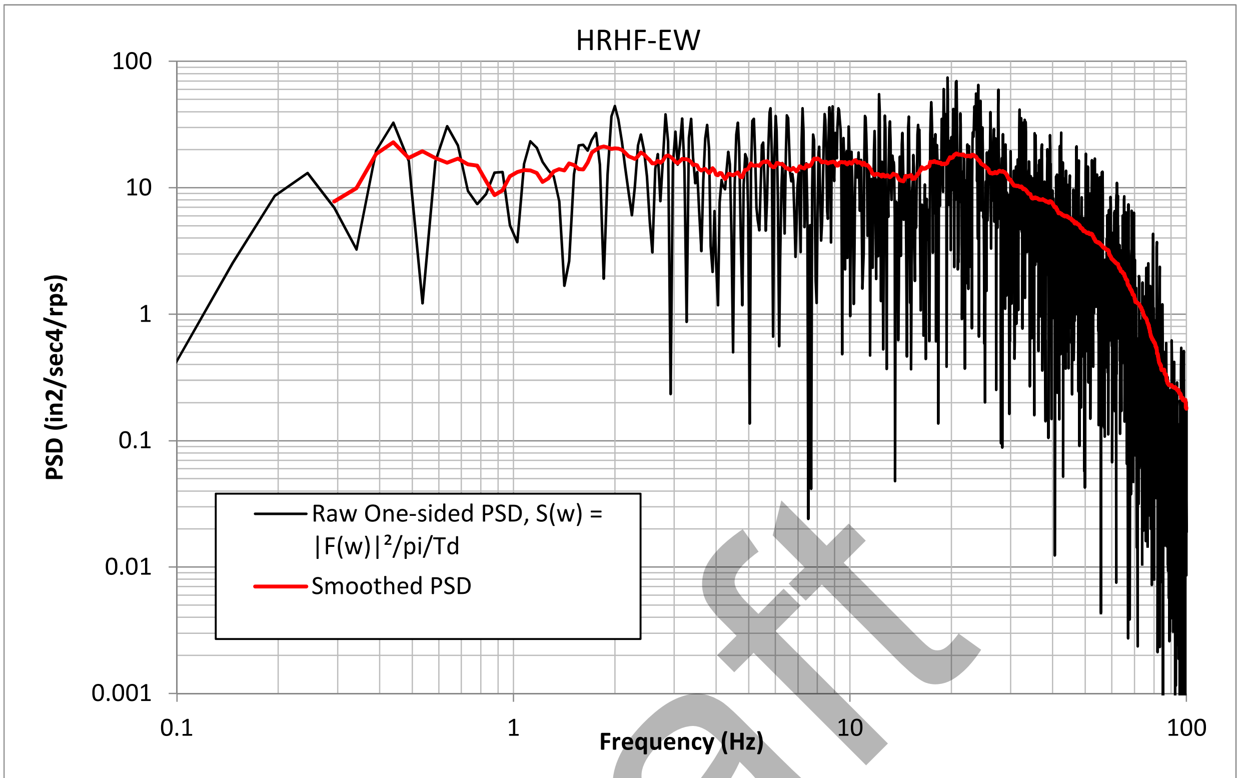

Figure 29 Raw One-sided PSD and Smoothed PSD of Time History of Truncated Duration from 3.0 sec to 10.5 sec for HRHF-EW

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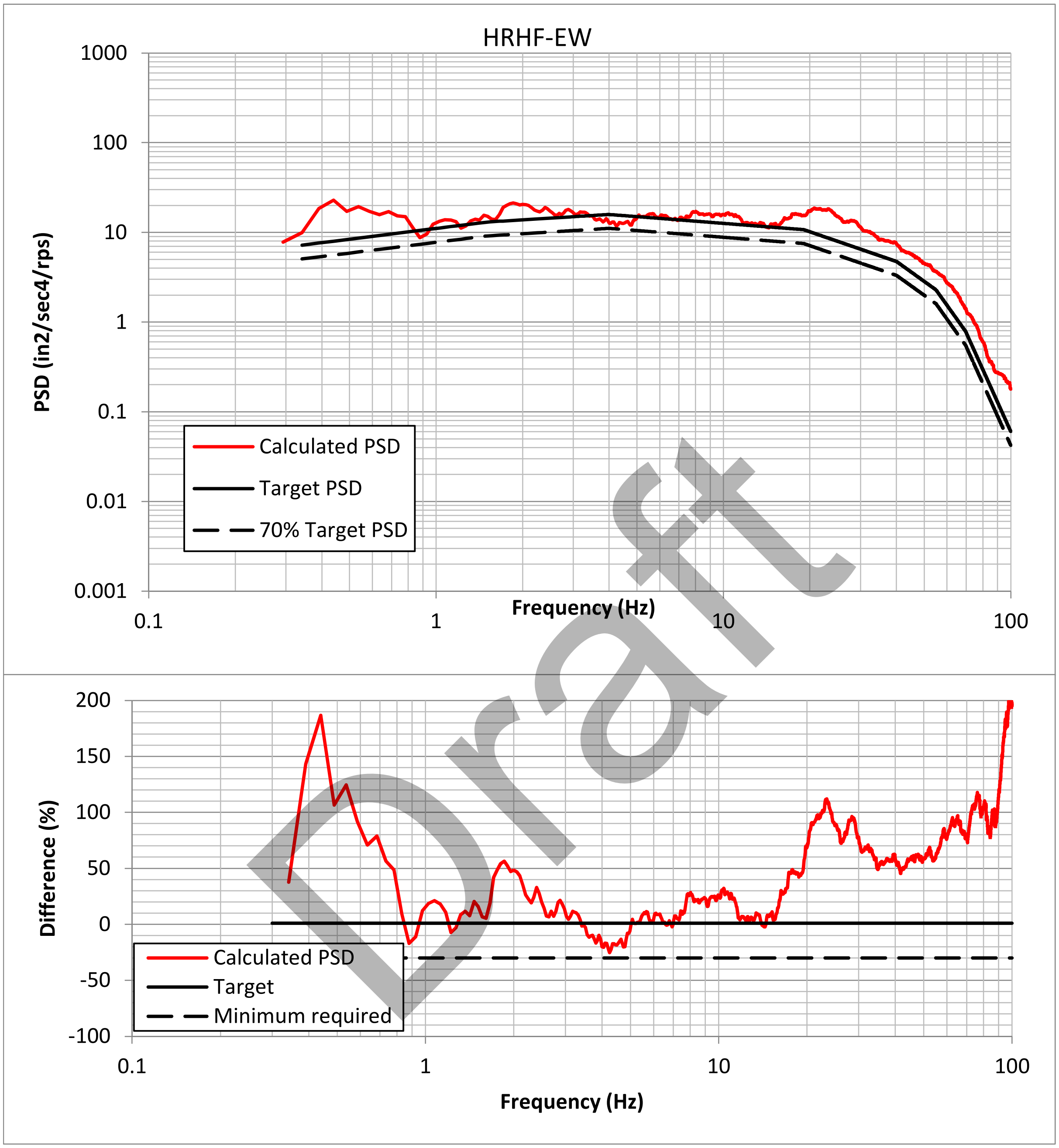

Figure 30 Comparison of Minimum-Required Target PSD for Horizontal Time History and PSD of Time History of Truncated Duration from 3.0 sec to 10.5 sec for HRHF-EW

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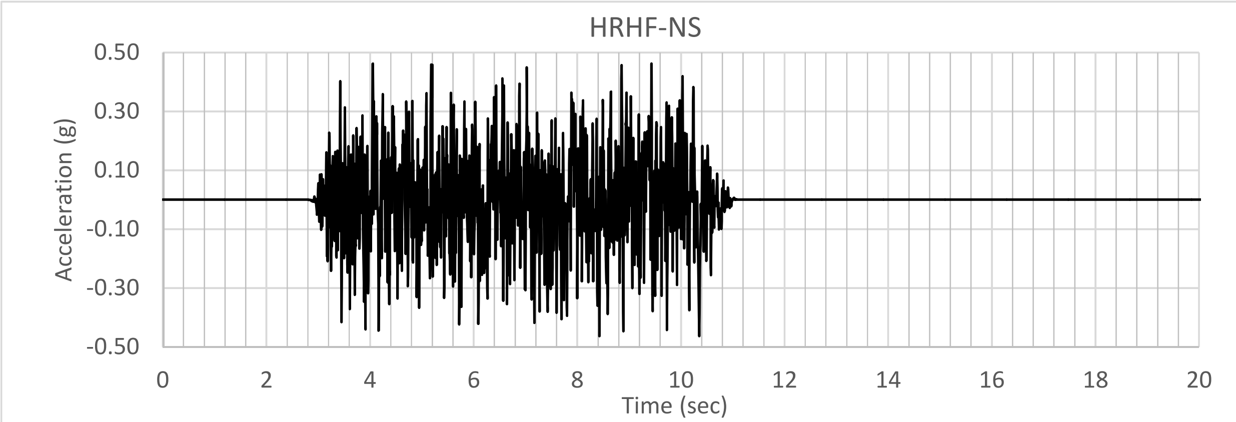

Figure 31 Time History of Truncated Duration from 2.8 sec to 11.1 sec for HRHF-NS

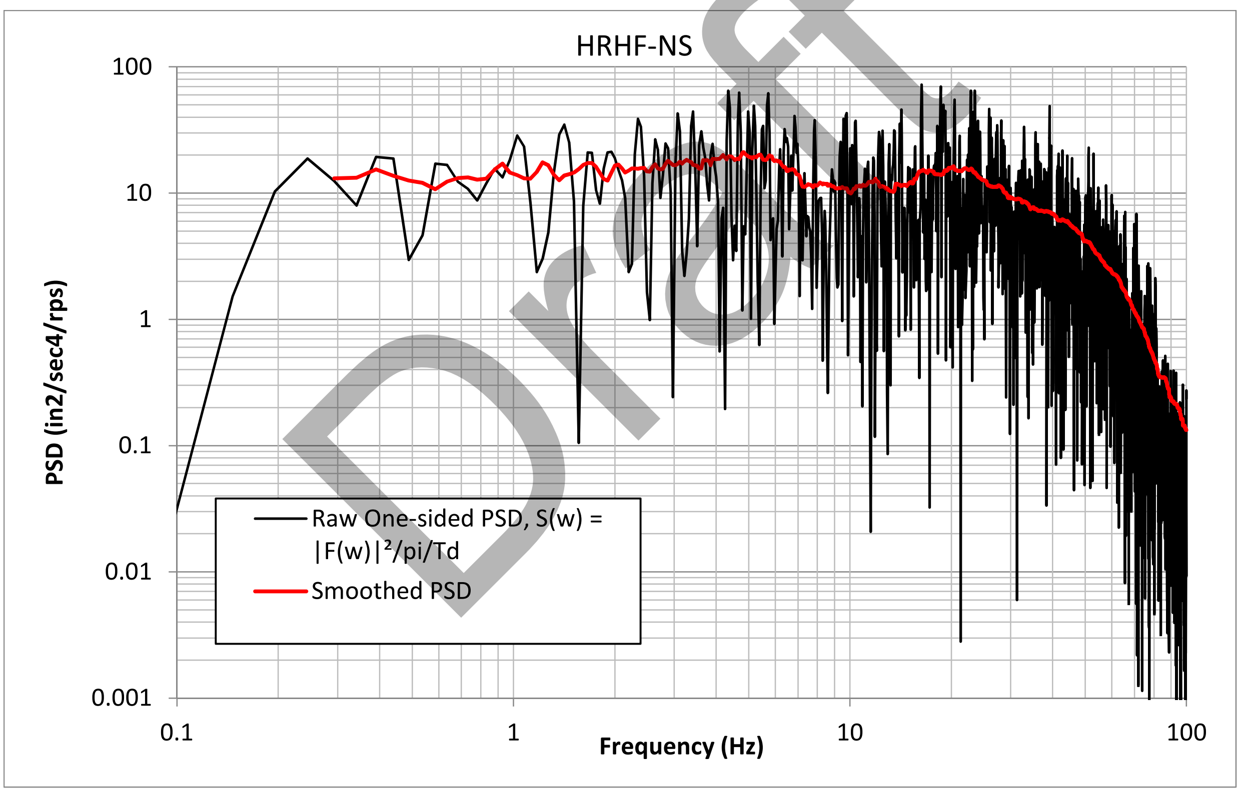

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Figure 32 Raw One-sided PSD and Smoothed PSD of Time History of Truncated Duration from 2.8 sec to 11.1 sec for HRHF-NS

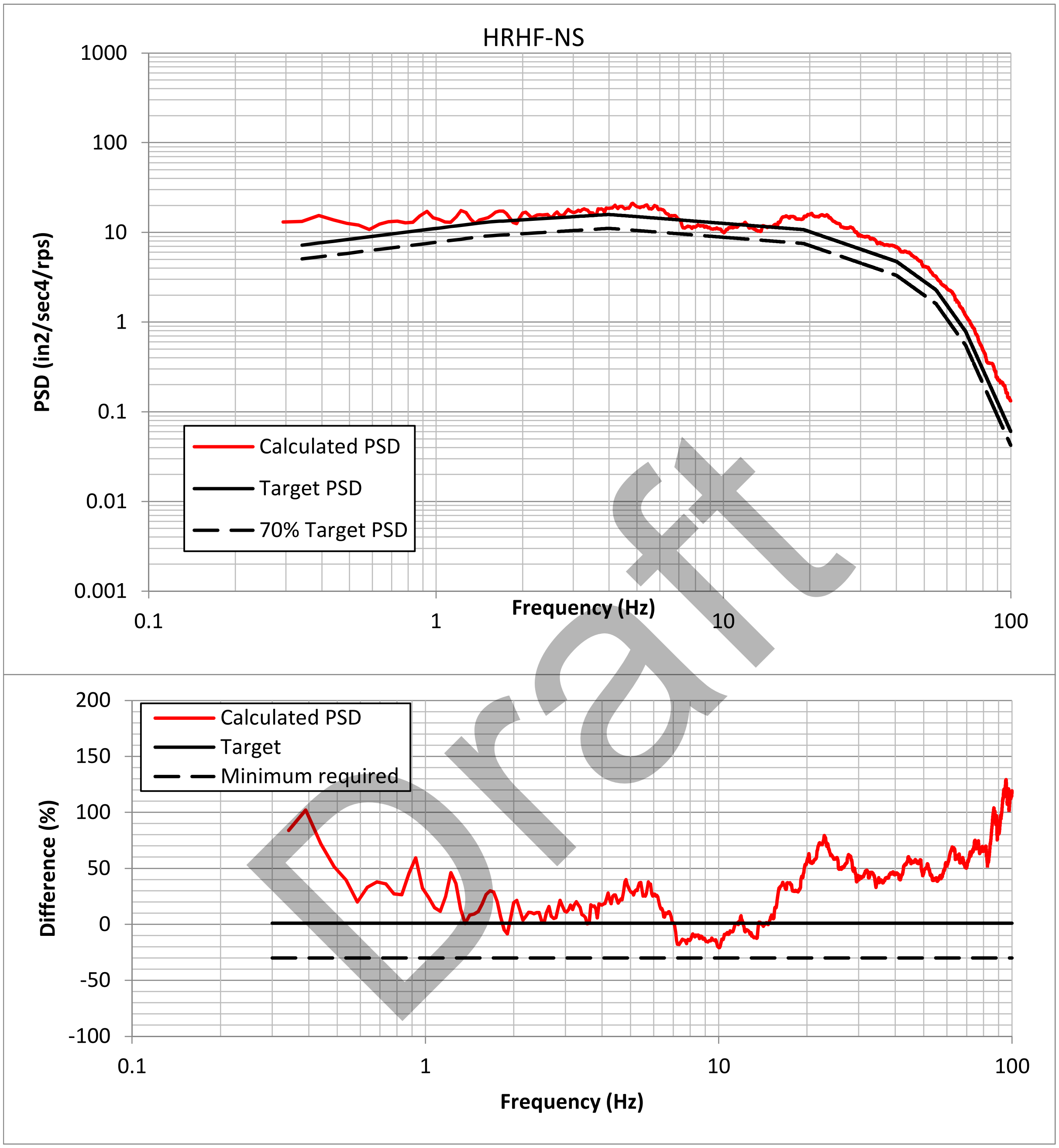

Figure 33 Comparison of Minimum-Required Target PSD for Horizontal Time History and PSD of Time History of Truncated Duration from 2.8 sec to 11.1 sec for HRHF-NS

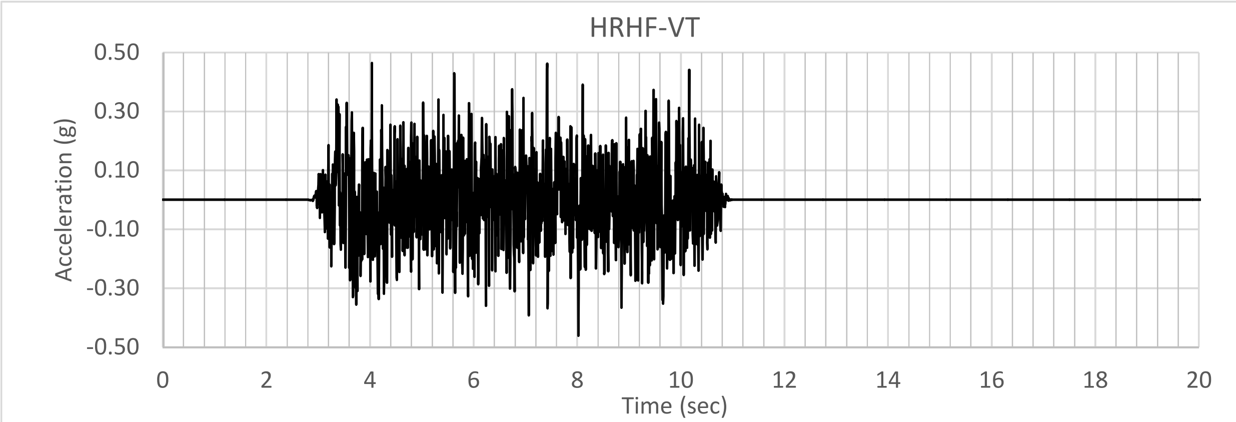

Figure 34 Time History of Truncated Duration from 2.8 sec to 11.0 sec for HRHF-VT

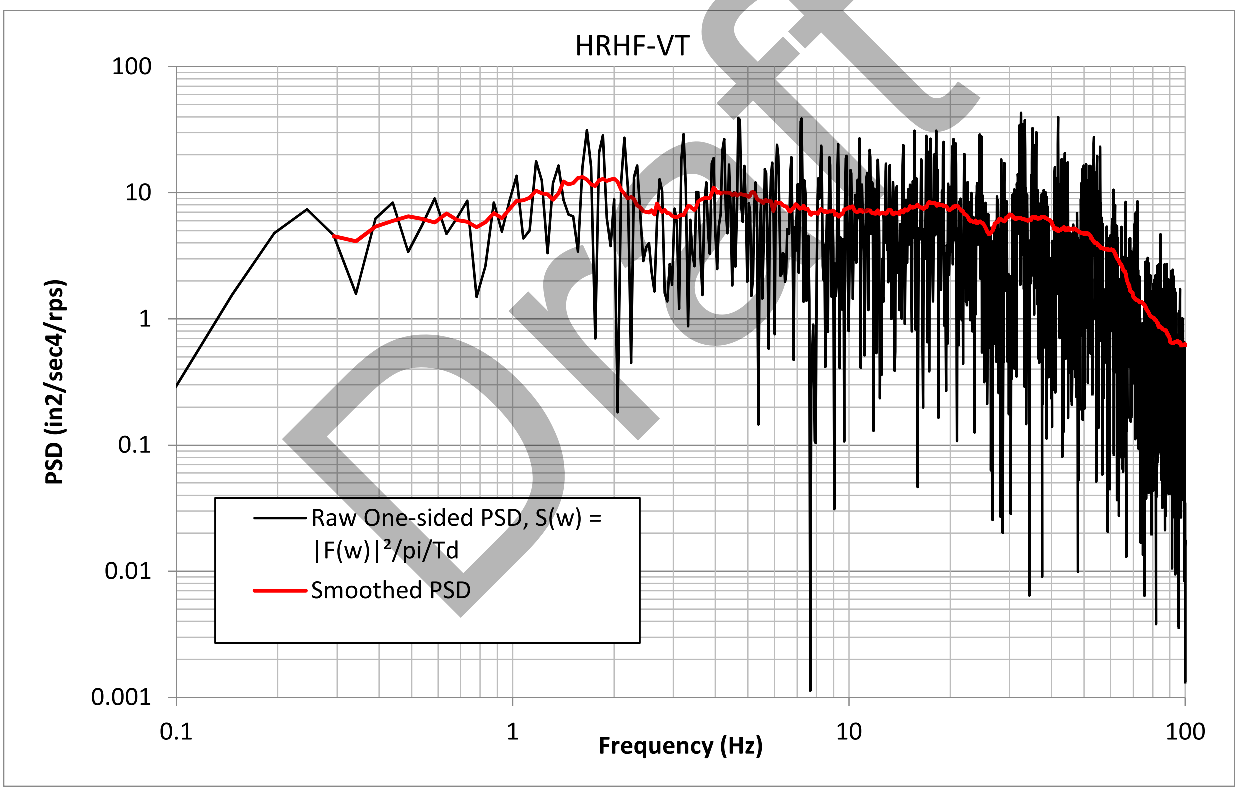

Figure 35 Raw One-sided PSD and Smoothed PSD of Time History of Truncated Duration from 2.8 sec to 11.0 sec for HRHF-VT

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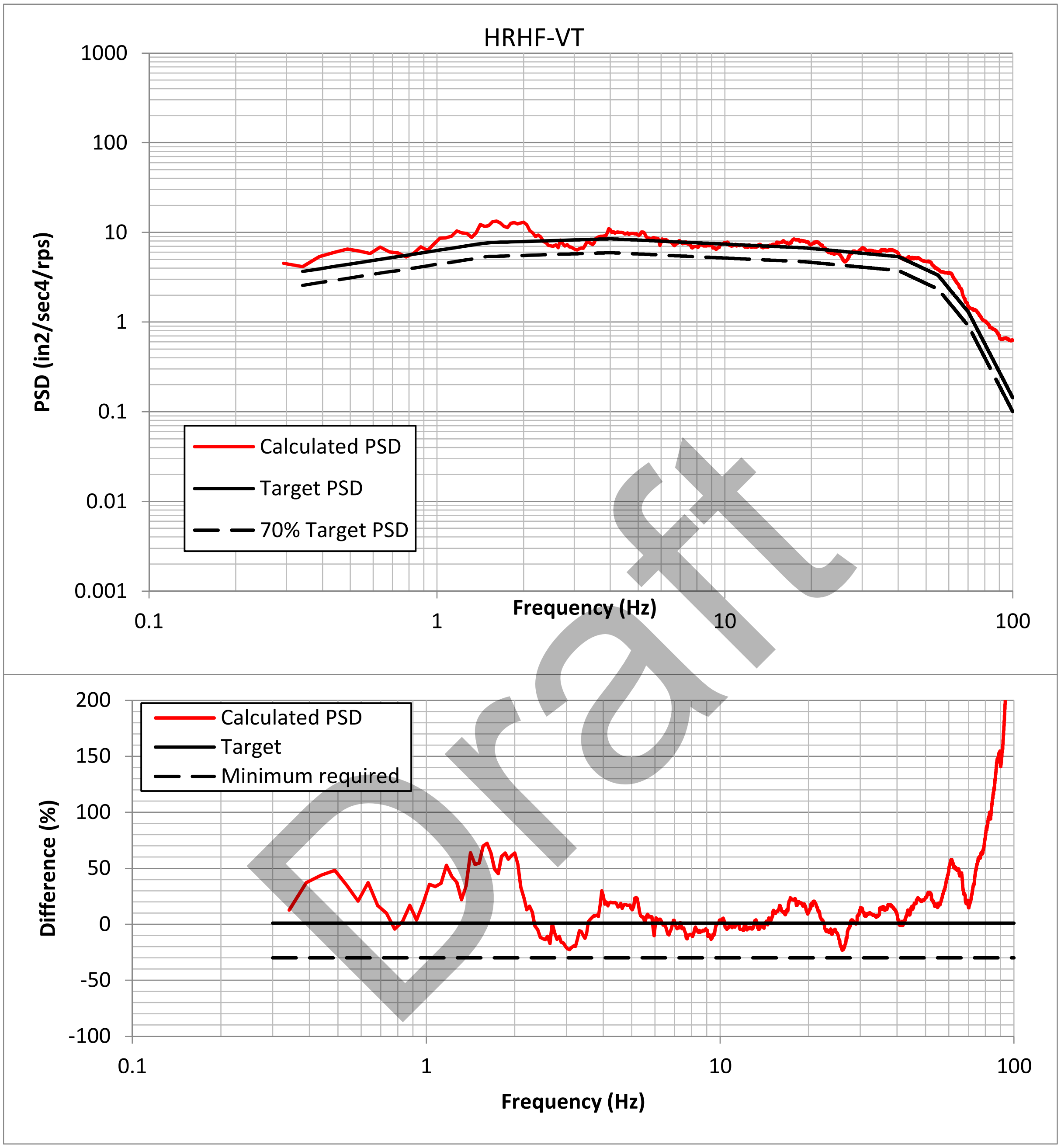

Figure 36 Comparison of Minimum-Required Target PSD for Horizontal Time History and PSD of Time History of Truncated Duration from 2.8 sec to 11.0 sec for HRHF-VT

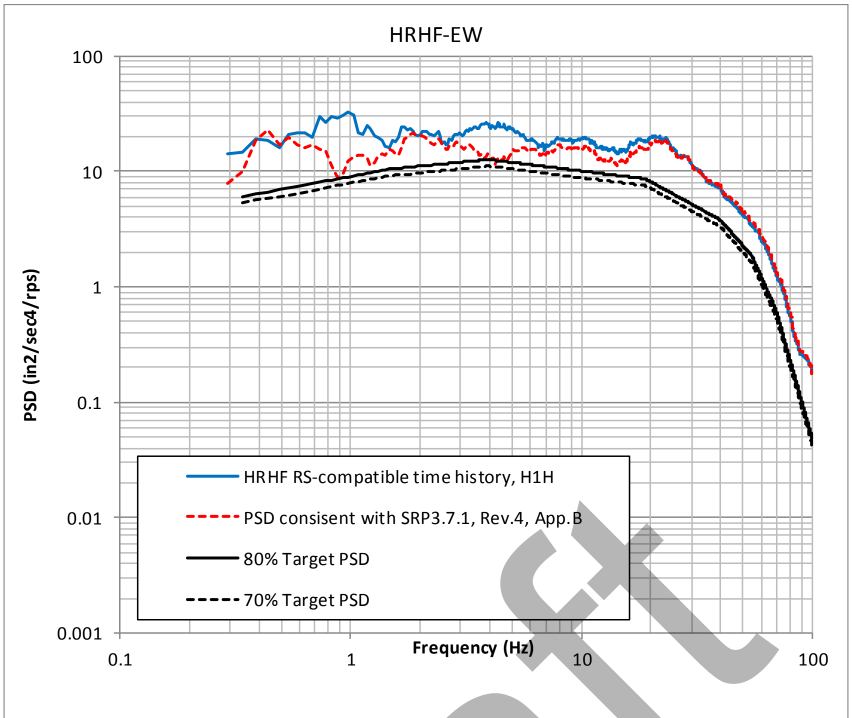

Figure 37 Comparison of PSDs between Time History of Full Duration and Time History of Truncated Duration for HRHF RS-EW

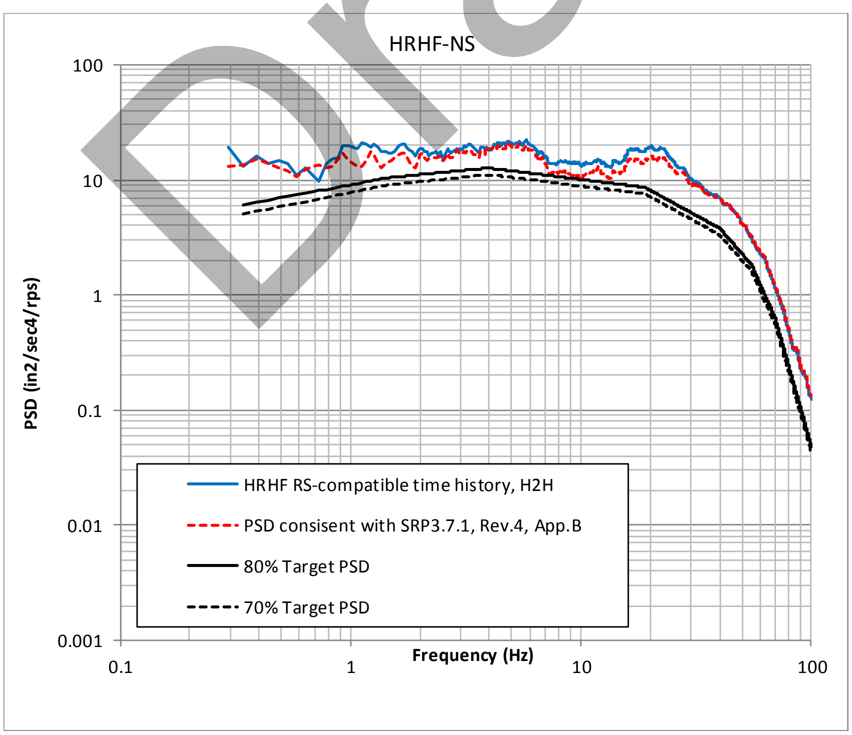

Figure 38 Comparison of PSDs between Time History of Full Duration and Time History of Truncated Duration for HRHF RS-NS

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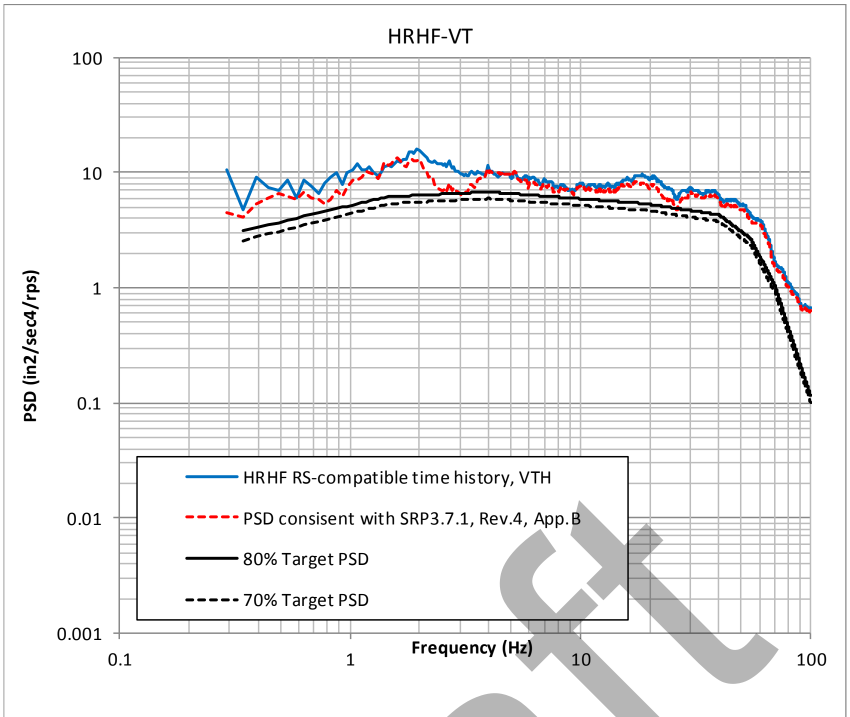

Figure 39 Comparison of PSDs between Time History of Full Duration and Time History of Truncated Duration for HRHF RS-VT

Impact on DCD

DCD Section 3.7.1.1.2, 3.7.1.1.3, Figure 3.7-9 through 3.7-11, and Figures 3.7-20 through 3.7-22 will be revised, as indicated in attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

Technical Report APR1400-E-S-NR-14004-NP, Rev. 1, Section 1.8.3 will be revised, as indicated in the attachment associated with this response.

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times at which the ratios P_1 and P_2 are reached. The ratios P_1 and P_2, and the corresponding over the duration $t_s^i = t_{p2}^i - t_{p1}^i$ can best be fitted by a straight line (i.e., constant energy buildup) having a constant slope $S = \left[E_i\left(t_{p2}^i\right) - E_i\left(t_{p1}^i\right)\right]/\left(t_{p2}^i - t_{p1}^i\right)$. The equivalent stationary duration T_s^i for the entire time history as determined from Eq. (3-3) is the duration over which the total energy of the time history is built up from ~~0 to 100 percent~~ P1=0% to P2=100% with the constant slope S. This procedure of calculating T_s^i is illustrated in Figure 3-27.

(2) Compute the one-sided PSD, $S_i(f)$ of the time history $a_i(t)$ using the following equations:

$$S_i(f) = \frac{\boxed{2}\,|A_i(f)|^2}{T_s^i} \tag{3-4}$$

Where $|A_i(f)|$ is the amplitude of the Fourier spectrum obtained from the following equation:

$$A_i(f) = \int_0^{T_i} a_i(t) e^{-2\pi f t} dt \tag{3-5}$$

Insert page 2

Where T_i is the total duration of the time history $a_i(t)$.

(3) Smooth the time history PSD $S_i(f)$ using the moving average technique over a ±20 percent frequency bandwidth centered at the frequency *f*, in accordance with the guidelines in NUREG/CR-5347 (Reference 24), to give the smoothed time history PSD $\tilde{S}_i(f)$.

The smoothed time history PSD, $\tilde{S}_i(f)$, obtained from step (c) above is then compared with the minimum required target PSD, $\tilde{S}_i(f)$, to check the adequacy of the power content of the generated time history.

1.9 Generation Results

The acceleration time histories generated using the procedure described in Section 3.4 consist of two horizontal (H1H and H2H) and one vertical (VTH) components. Time histories H1H, H2H, and VTH are applied in the horizontal E-W, horizontal N-S, and vertical directions, respectively. The time interval of time history digitization, Δt, is 0.005 second, which corresponds to the highest frequency of interest of 100 Hz.

The horizontal H1H acceleration time history is plotted along with the integrated velocity and displacement time histories in Figure 3-28. The comparison of the time history response spectra with the corresponding horizontal target HRHF response spectra for the corresponding damping values are shown in Figure 3-29. Similar results for the horizontal H2H time history are shown in Figures 3-30 and 3-31. Similar results for the vertical time history VTH are shown in Figures 3-32 and 3-33.

The maximum acceleration (A), maximum velocity (V), maximum displacement (D) and V/A and AD/V^2 ratios of the generated H1H, H2H, and VTH time histories are listed in Table 3-9

To show the statistical independence of the set of time histories, the cross-correlation coefficients of pairs of the HRHF response spectrum-compatible time histories are given in Table 3-10. The values all are below 0.16, thus satisfying the SRP Section 3.7.1 (Reference 15) threshold for statistical independence.

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The discrete form of the mathematical Equation (3-5) is computed using the following discrete equation:

$$|A_i(\omega_n)| = \Delta t\left|\sum_{j=0}^{N-1} a_i\left(t_j\right)e^{-2\pi i(nj/N)}\right| \quad (3\text{-}6)$$

where $\omega_n = n\Delta\omega = 2\pi n\Delta f = \frac{2\pi n}{(N\Delta t)}; n = 0, 1, \ldots, N/2$ and $t_j = j\Delta t, j = 0, 1, \ldots, N-1$.

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In SRP 3.7.1, the requirement of minimum power spectral density (PSD) to prevent the design ground acceleration time histories from having a deficiency of power over any frequency range is described. SRP 3.7.1 specifies that the use of a single time history is justified by satisfying a target PSD requirement in addition to the design response spectra enveloping requirements.

Since the original NRC RG 1.60 horizontal spectrum and the horizontal CSDRS are identical for frequencies less than 9 Hz, no modification to the target horizontal PSD is done in this frequency range.

The time-history simulation method described in NUREG/CR-5347 (Reference 8) is used to develop the CSDRS-compatible horizontal target PSD in the higher frequency range above 9 Hz. The resulting piecewise log-log linear horizontal target PSD developed is given in Table 3.7-3. The minimum required horizontal PSD is then 0.8 times the horizontal target PSD.

The vertical target PSD, compatible with the vertical CSDRS, is obtained from the horizontal target PSD, compatible with the horizontal CSDRS using the following equation:

$$S_V(f) = [\ R_V(f\ ,\ 2\ \%)\ /\ R_H(f\ ,\ 2\ \%)]^2 \times S_H(f)$$

where $R_H(f,\ 2\ \%)$ and $R_V(f,\ 2\ \%)$ are, respectively, the 2 percent damped horizontal and vertical CSDRS values at the frequency (f). The detailed procedure for generating target PSD is described in Technical Report, APR1400-E-S-NR-14001-P (Reference 9). The minimum required vertical PSD is then 0.8 times the vertical target PSD.

The PSDs of the design acceleration time histories are presented in Figures 3.7-9 through 3.7-11. The PSDs of the design acceleration time histories exceed the minimum required PSD throughout the entire frequency range. The PSDs presented are the averaged PSDs obtained over a moving frequent band of ± 20 percent centered at each frequency. The PSD amplitude at frequency (f) has the averaged PSD amplitude between the frequency range of 0.8f and 1.2f as stated in Appendix A of SRP 3.7.1.

The PSDs of the design acceleration time histories in accordance with SRP 3.7.1, Revision 4, Appendix B are computed to further demonstrate satisfying the PSD requirement. As shown in Figure 3.7-9 (b) through 3.7-11(b), the PSDs are reasonable compared with the PSDs consistent with SRP 3.7.1, Revision 4, Appendix B.

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The time histories are developed following the spectrum matching acceptance criteria of Option 1, Approach 1, in Section II of SRP 3.7.1. The comparison plots of the response spectra of the time histories versus the HRHF response spectra for 2, 3, 4, 5, 7, and 10 percent critical dampings are shown in Figures 3.7-17, 3.7-18, and 3.7-19. The figures demonstrate that the time histories envelop the HRHF response spectra for those damping values, satisfying the requirement of SRP 3.7.1 that no more than 5 points fall below and by no more than 10 percent below the HRHF response spectra.

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~~According to SRP 3.7.1, the ratio V/A and AD/V^2 should be consistent with characteristic values for the magnitude and distance of the appropriate controlling events defining the uniform hazard response spectra. The target and target ranges of values for the other design ground-motion time-history parameters are the median (m) values and the median (m) ± one standard deviation (σ) (i.e., m ± σ) ranges. The determination of these target and target ranges of values is based on the methodologies and ground motion databases as described in NUREG/CR-6728. Table 3.7-4 shows a comparison of the ratios V/A and AD/V^2 for the time histories and the guidance in NUREG/CR-6728 and that the ratios are between the target values, target median ± σ.~~

For the development of the HRHF-response spectra-compatible target PSDs in the frequency range from 0.3 to 80 Hz, the time-history simulation method described in NUREG/CR-5347 is used. The resulting piecewise log-log linear horizontal and vertical target PSD developed is given in Tables 3.7-5 and 3.7-6. The minimum required horizontal and vertical PSD is then 0.8 times the horizontal and vertical target PSD.

The PSDs of the acceleration time histories compatible with the HRHF response spectra are presented in Figures 3.7-20 through 3.7-22. The PSDs of the acceleration time histories exceed the minimum required PSD throughout the entire frequency range.

The evaluation methodology and results of the APR1400 for the HRHF seismic input motions are provided in Appendix 3.7B.

3.7.1.2 Percentage of Critical Damping Values

Damping values used for various nuclear safety-related SSCs are based on NRC RG 1.61 (Reference 10). These values are expressed in percentages of critical damping and are given in Table 3.7-7. Damping values of soil to be used in soil-structure interaction

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The PSDs of the acceleration time histories compatible with the HRHF response spectra in accordance with SRP 3.7.1, Revision 4, Appendix B are computed to further demonstrate satisfying the PSD requirement. As shown in Figure 3.7-20 (b) through 3.7-22(b), the PSDs are reasonable compared with the PSDs consistent with SRP 3.7.1, Revision 4, Appendix B.

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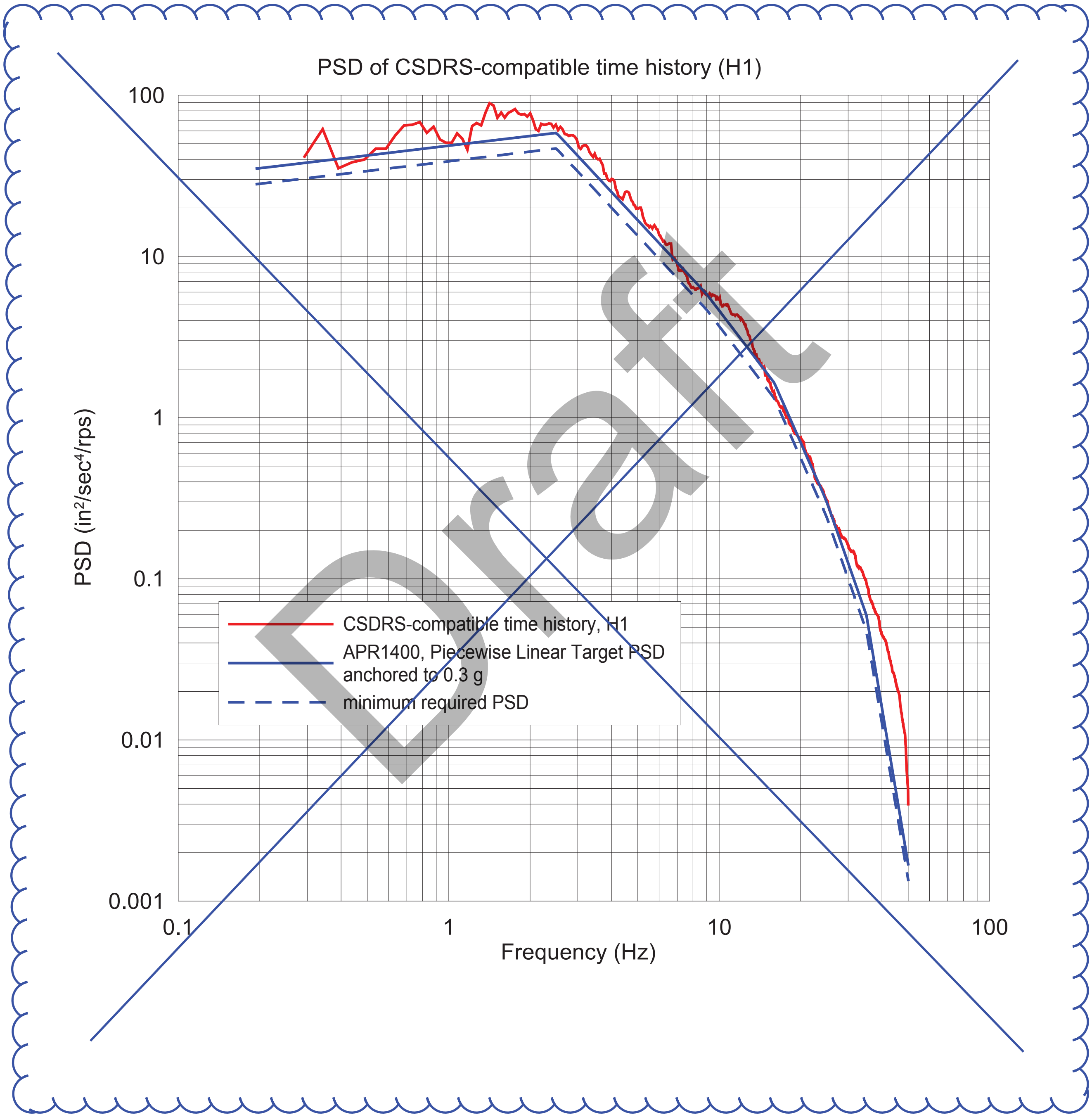

Figure 3.7-9 Comparison of PSD of H1 Design Ground Motion, Target PSD, and Minimum Required PSD

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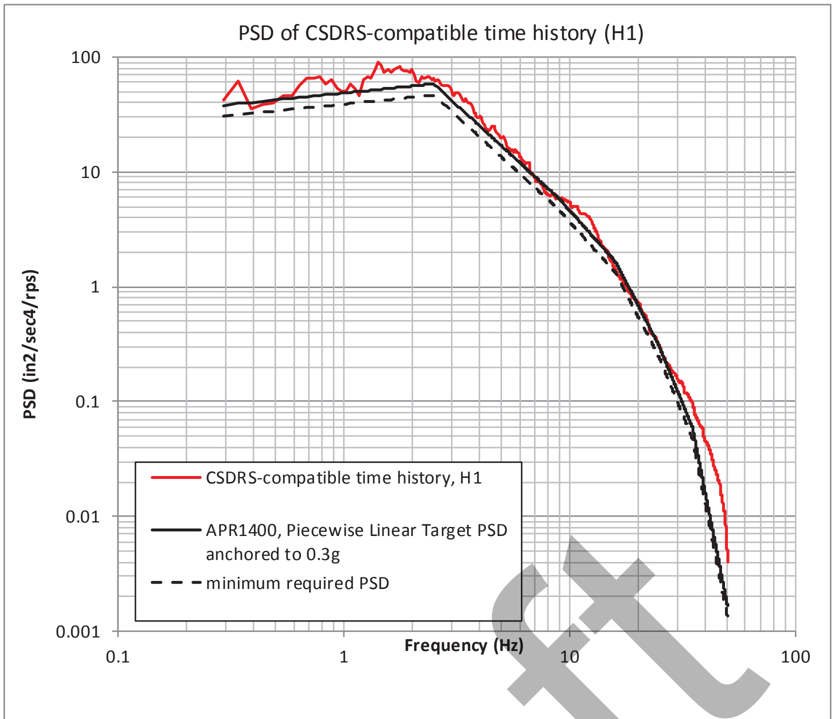
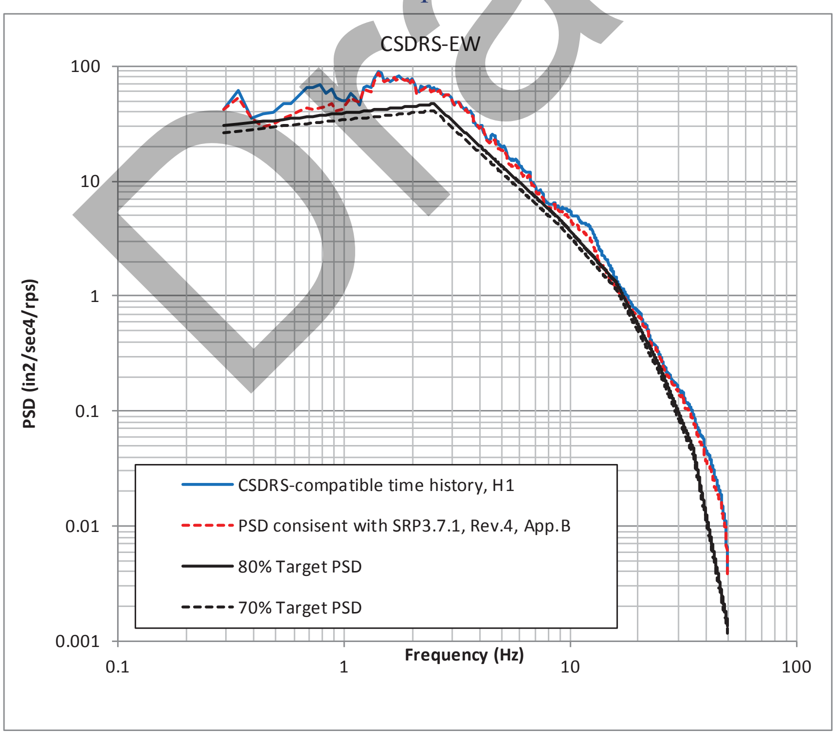


(a) Comparison of PSD of H1 Design Ground Motion and Target PSD and Minimum Required PSD



(b) Comparison of PSD for H1 Design Ground Motion and PSD Consistent with SRP 3.7.1, Rev.4, Appendix B

Figure 3.7-9 Comparison of PSD for H1 Design Ground Motion

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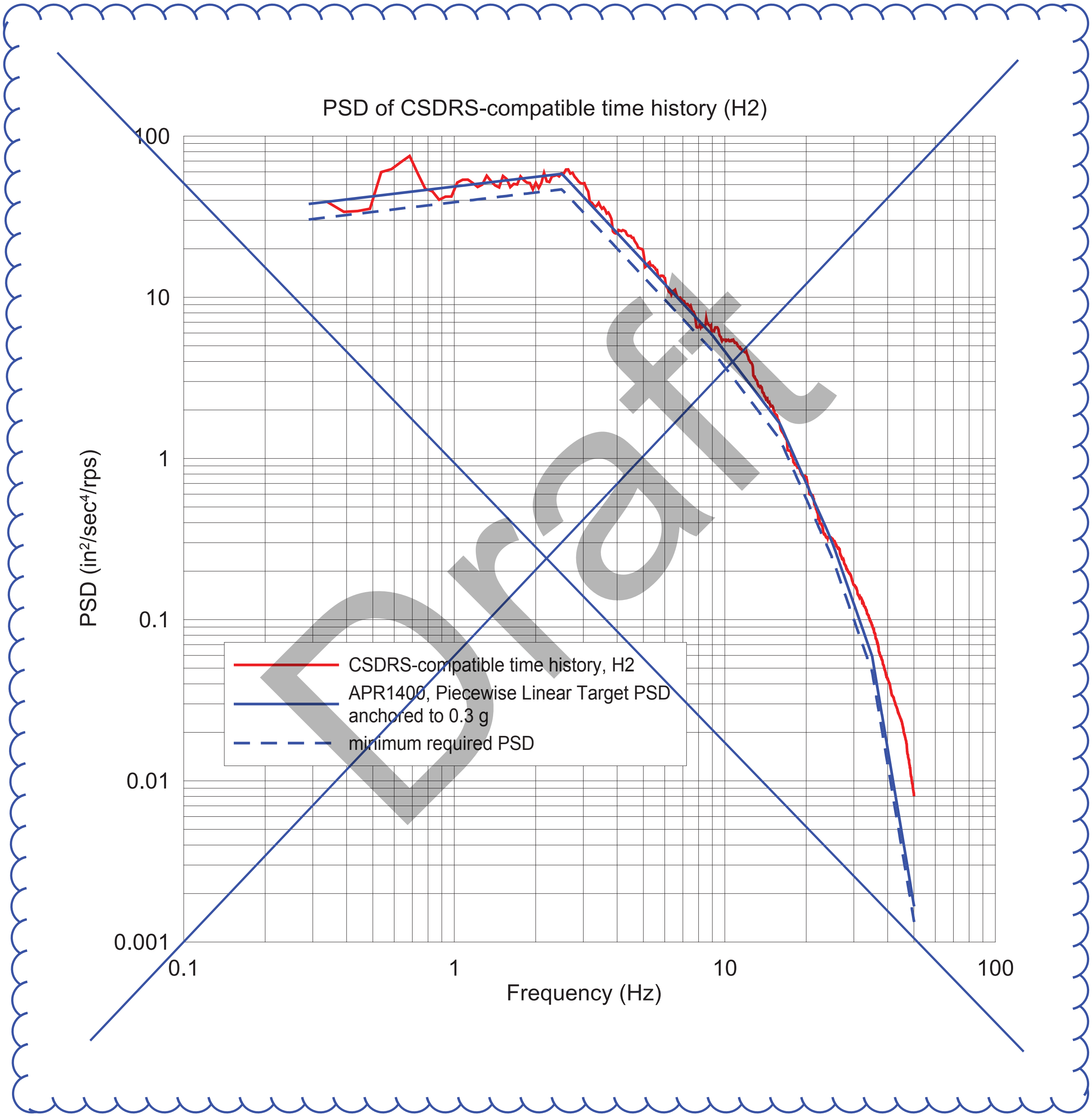

Figure 3.7-10 Comparison of PSD of H2 Design Ground Motion, Target PSD, and Minimum Required PSD

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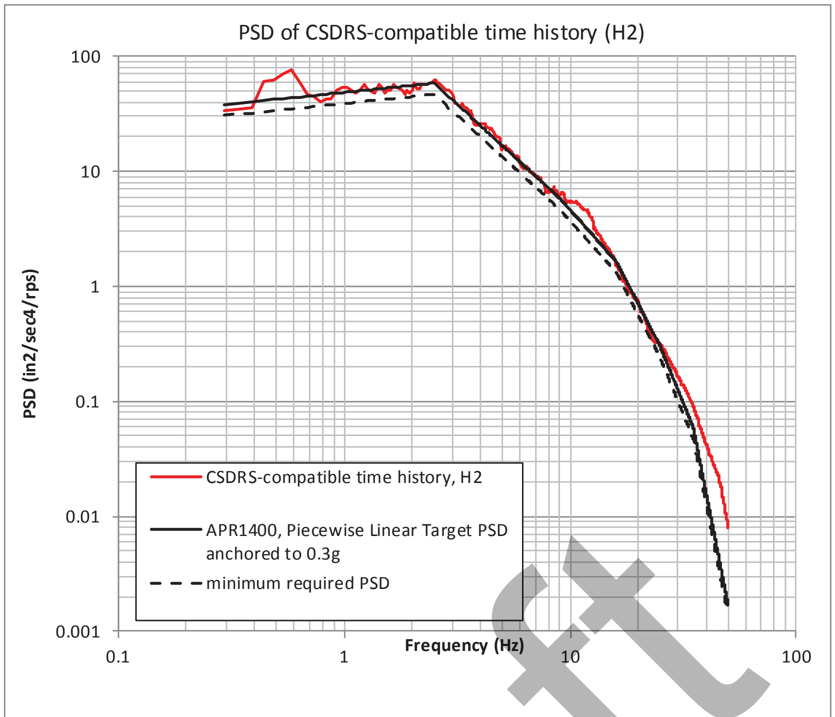
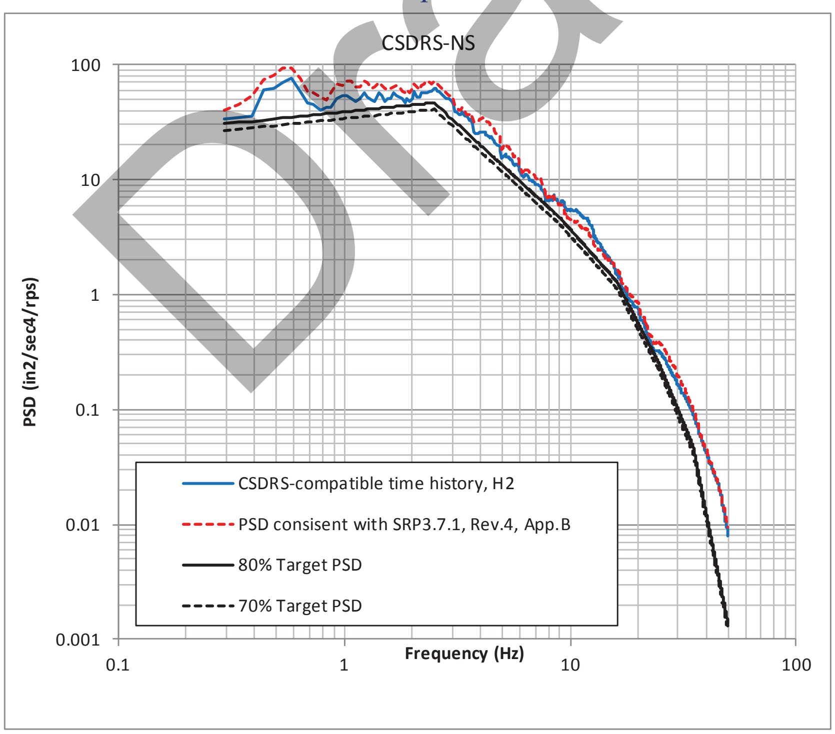


(a) Comparison of PSD of H2 Design Ground Motion and Target PSD and Minimum Required PSD



(b) Comparison of PSD for H2 Design Ground Motion and PSD Consistent with SRP 3.7.1, Rev.4, Appendix B

Figure 3.7-10 Comparison of PSD for H2 Design Ground Motion

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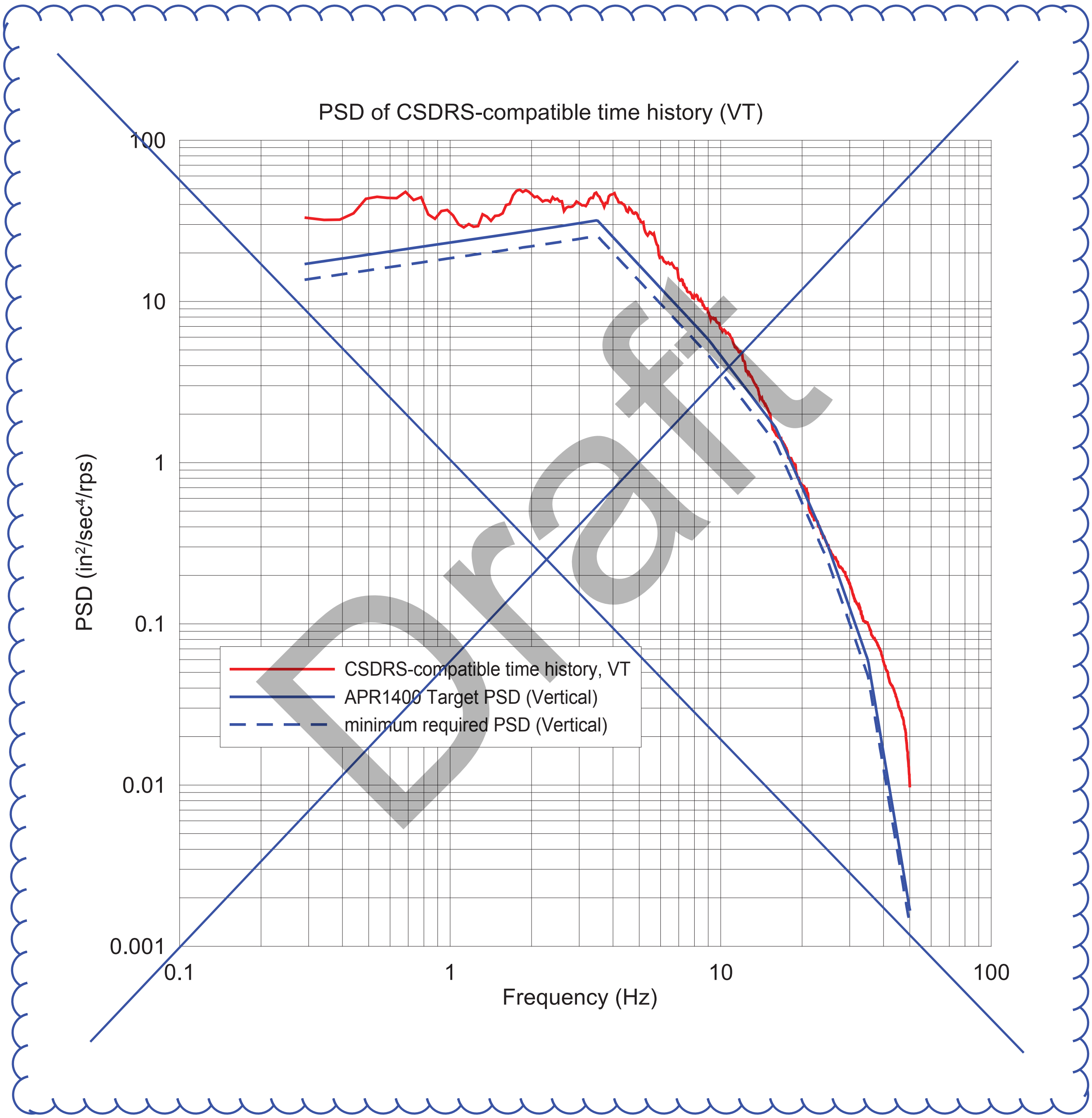
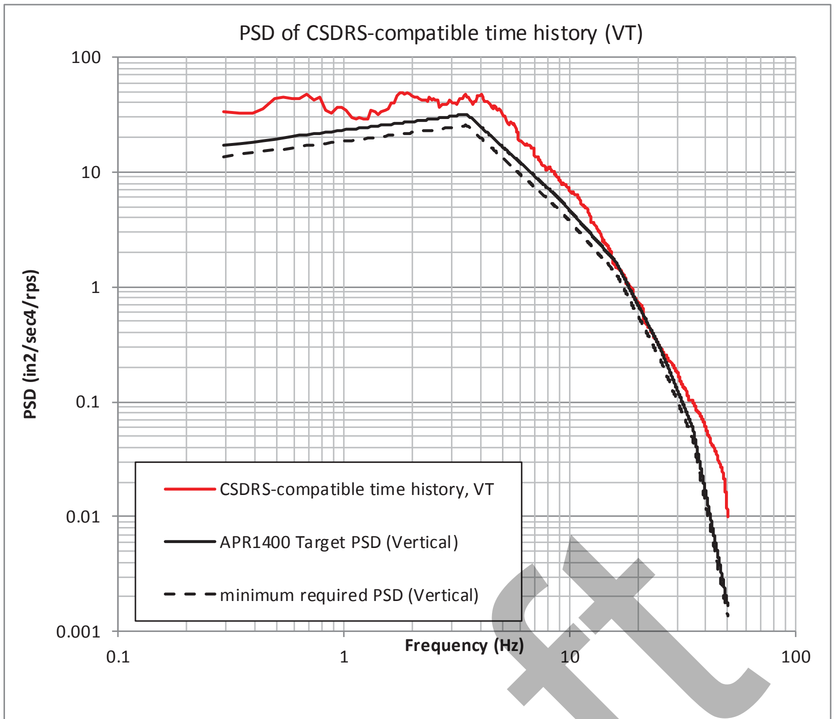
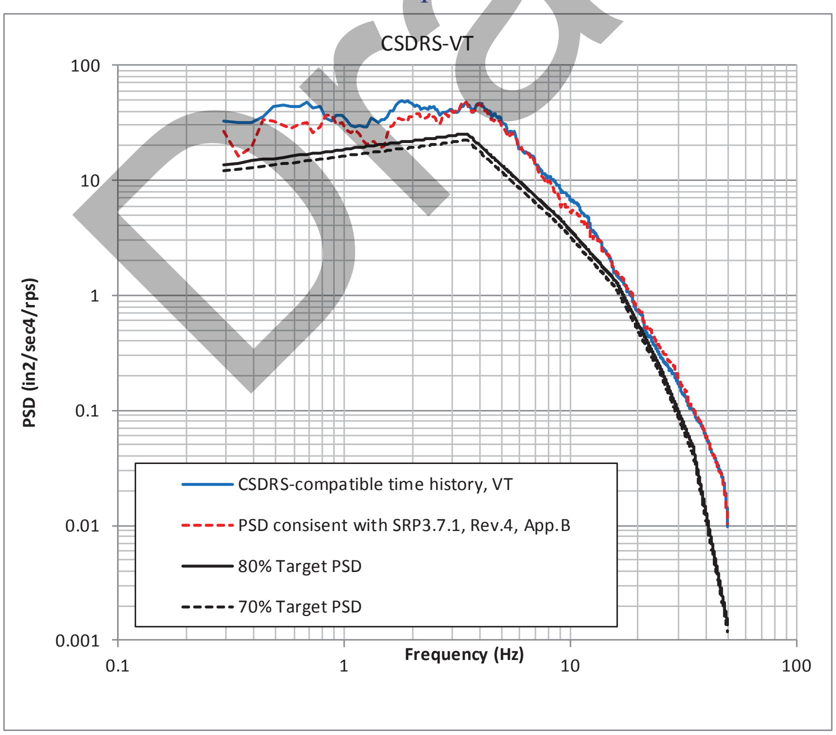


Figure 3.7-11 Comparison of PSD of VT Design Ground Motion, Target PSD, and Minimum Required PSD



(a) Comparison of PSD of VT Design Ground Motion and Target PSD and Minimum Required PSD



(b) Comparison of PSD for VT Design Ground Motion and PSD Consistent with SRP 3.7.1, Rev.4, Appendix B

Figure 3.7-11 Comparison of PSD for VT Design Ground Motion

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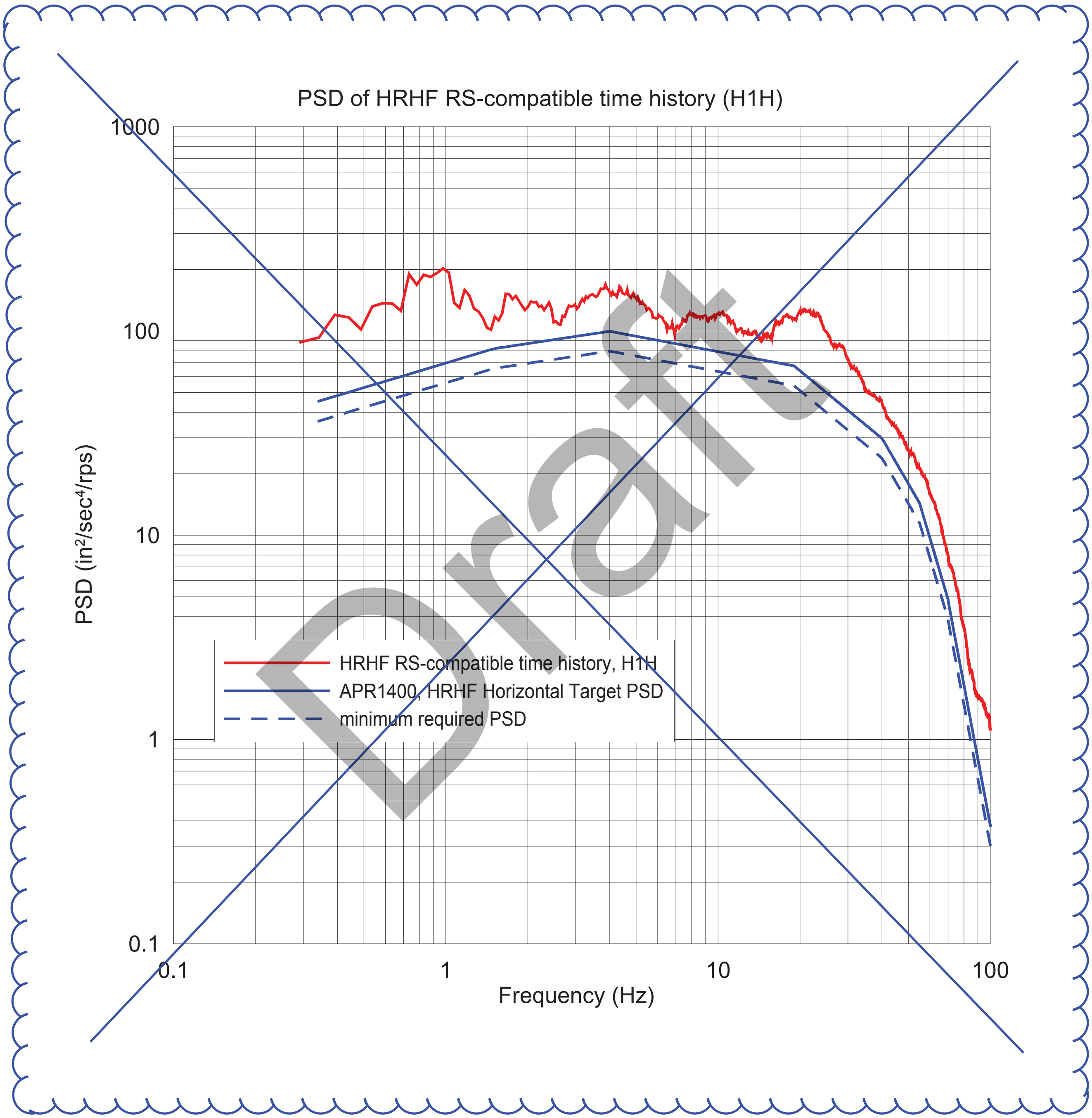

Figure 3.7-20 Comparison of PSD of H1H, HRHF Target PSD, and Minimum Required PSD

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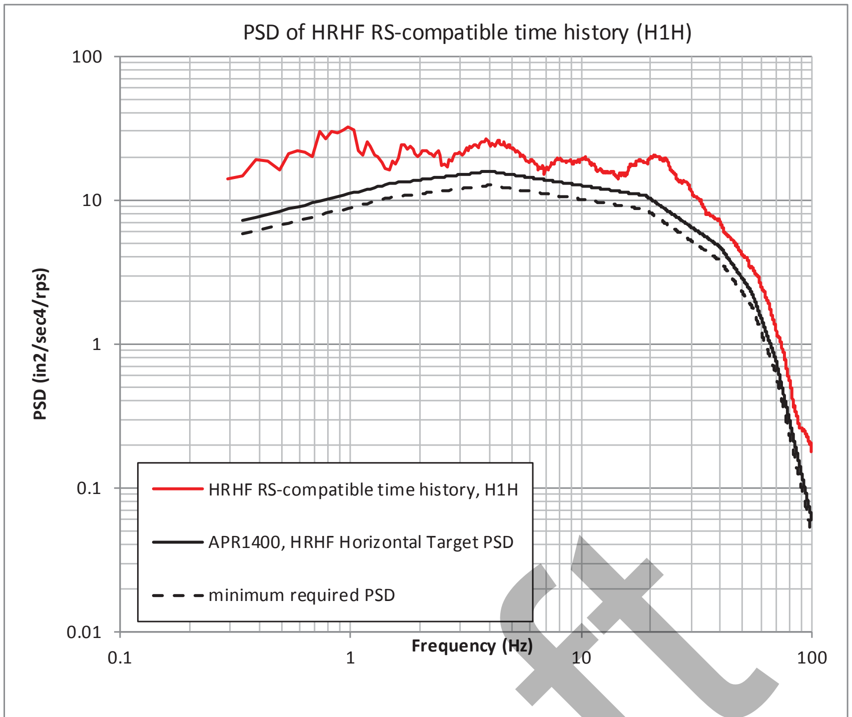
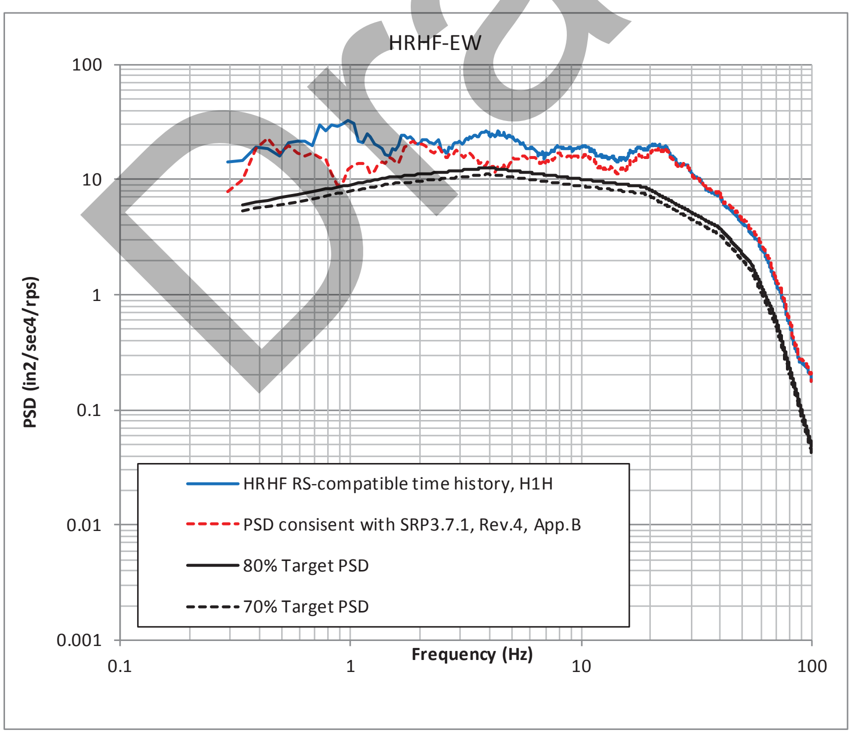


(a) Comparison of PSD of H1H and HRHF Target PSD and Minimum Required PSD



(b) Comparison of PSD for H1H and PSD Consistent with SRP 3.7.1, Rev.4, Appendix B

Figure 3.7-20 Comparison of PSD for H1H

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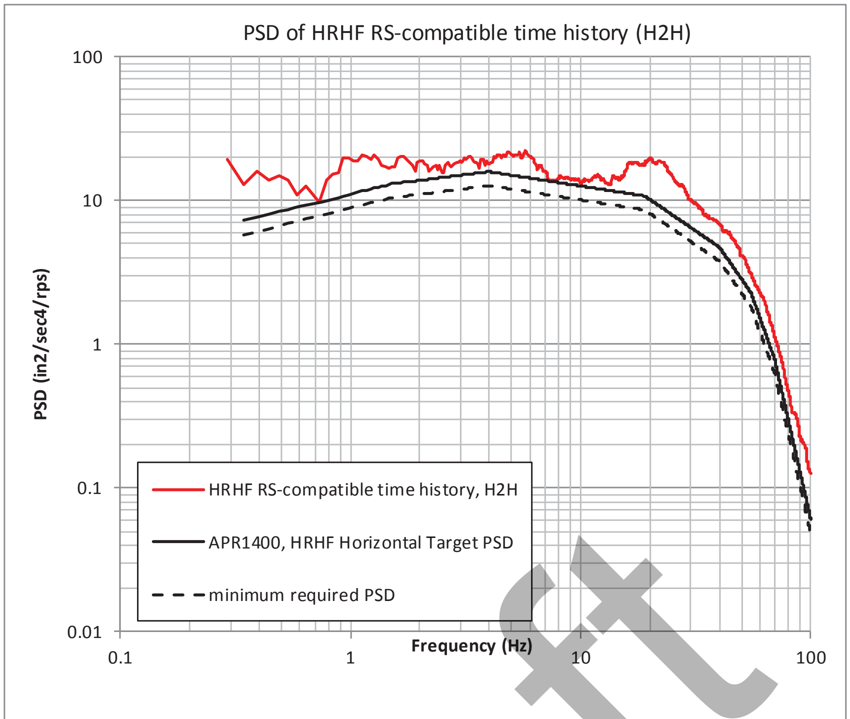
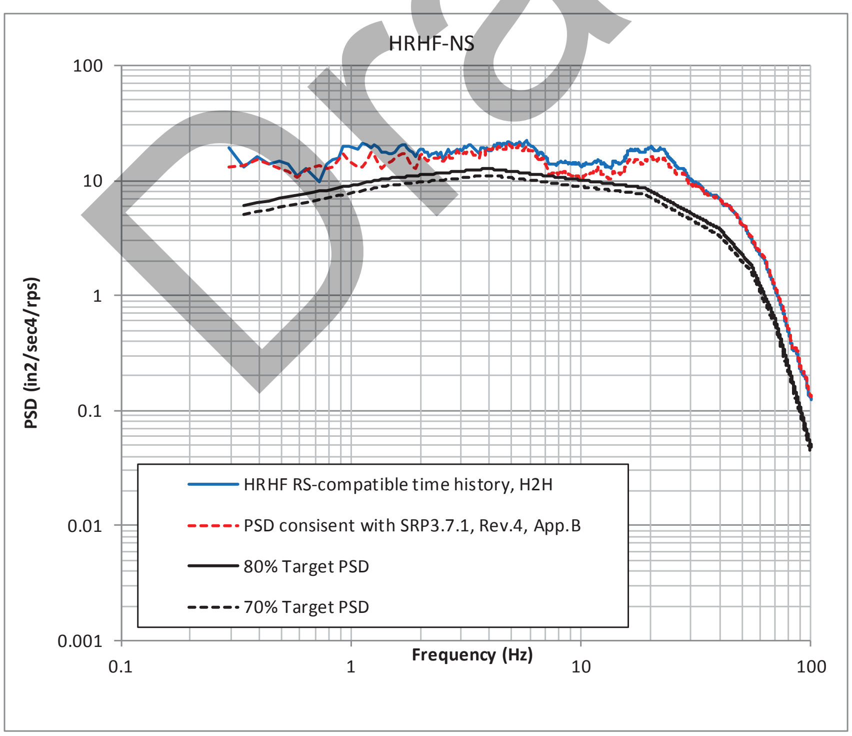
Figure 3.7-21 Comparison of PSD of H2H, HRHF Target PSD, and Minimum Required PSD



(a) Comparison of PSD of H2H and HRHF Target PSD and Minimum Required PSD



(b) Comparison of PSD for H2H and PSD Consistent with SRP 3.7.1, Rev.4, Appendix B

Figure 3.7-21 Comparison of PSD for H2H

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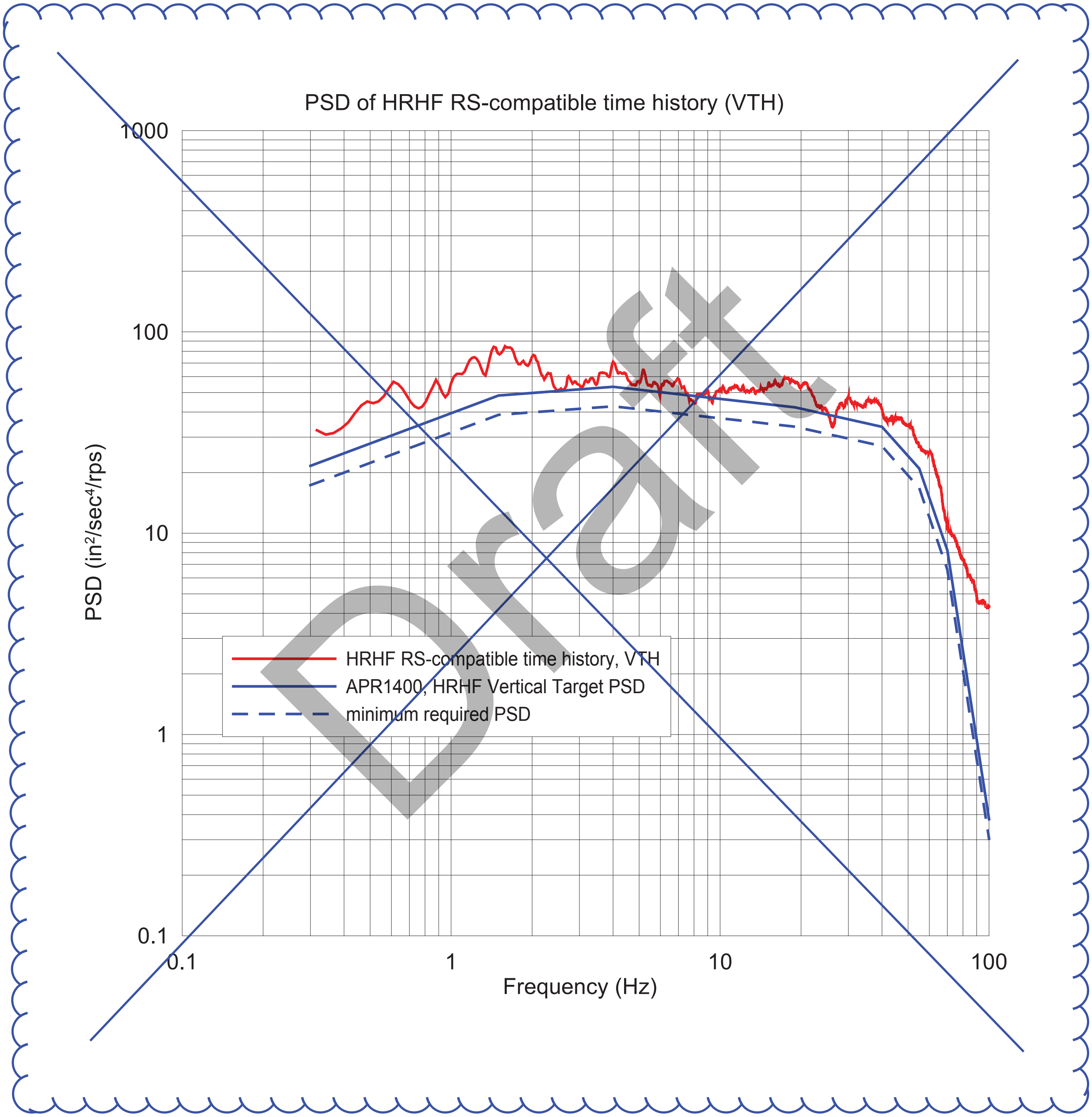

Figure 3.7-22 Comparison of PSD of VTH, HRHF Target PSD, and Minimum Required PSD

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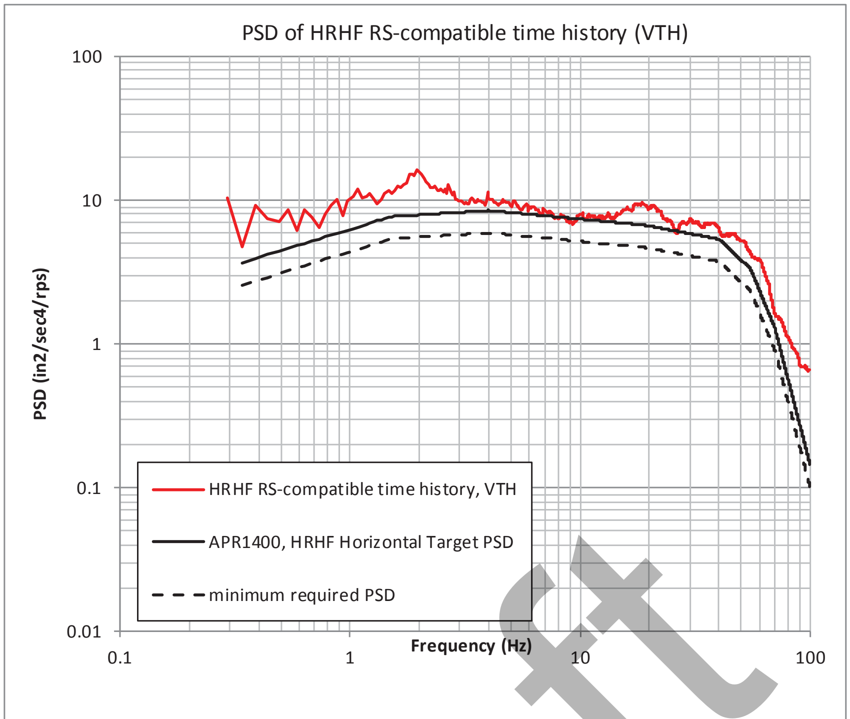
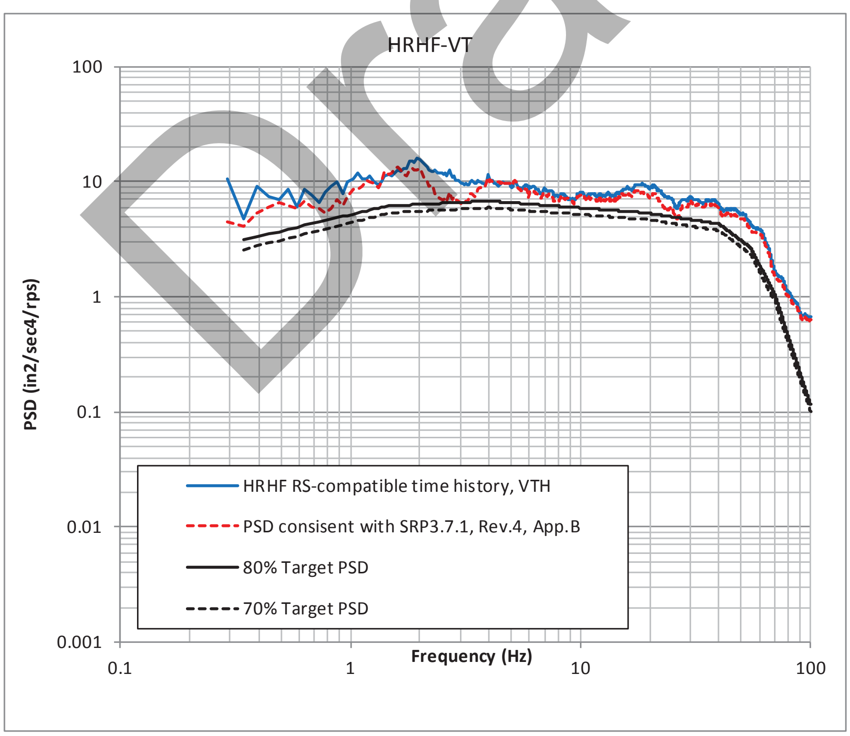


(a) Comparison of PSD of VTH and HRHF Target PSD and Minimum Required PSD



(b) Comparison of PSD for VTH and PSD Consistent with SRP 3.7.1, Rev.4, Appendix B

Figure 3.7-22 Comparison of PSD for VTH

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