ABB
ASEA BROWN BOVERI

March 26, 1992
LD-92-043

Docket No. 52-002

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Structural and Geosciences Engineering

Reference: C-E Letter LD-92-024, dated February 18, 1992

Dear Sirs:

This letter transmits the single remaining outstanding RAI response (#230.1). Although responses have now been submitted for all 1463 RAIs, we will continue to work with NRC staff to resolve any comments and to supplement those responses which referenced future work (e.g., Shutdown Risk and PRA).

Along with the response to RAI 230.1, we are submitting revisions to the responses for two other RAIs from the Structural and Geosciences Engineering Branch (#220.6 and 220.7). The revision to Response 220.6 provides Figure 3.7-2 which was not included in the original response. The revision to Response 220.7 expands the description of how the average power spectral density was calculated.

If there are any questions on the enclosed material, please contact Mr. Stan Ritterbusch at (203) 285-5206.

Very truly yours,

COMBUSTION ENGINEERING, INC.

C. B. Brinkman

C. B. Brinkman
Acting Director
Nuclear Systems Licensing

ser/lw
cc: J. Trotter (EPRI)
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Question 230.1

Section 2.5 - There are many nuclear power plants in the U.S. built on deep soil sites. Justify the argument that soil sites having a total depth to bedrock greater than 300 feet (Figure 2.5-1) are covered by the twelve soil cases analyzed as stated in Page 2.5-2.

Response 230.1

To justify the adequacy of the twelve soil cases for deep soil sites, the trend of spectral amplitudes at the ground surface and foundation level was studied for soil profiles with similar material properties but different depth to bedrock. Spectral accelerations as selected frequencies were plotted as a function of depth of soil to bedrock. Three cases with similar soil material were selected: B.3, C.3 and D.1. Those cases correspond to soil with shear wave velocity of 500 ft/sec at the ground surface, which is gradually increasing with depth. Depth to bedrock is 100 ft. for case B.3, 200 ft. for case C-3 and 300 ft. for case D.1.

Spectral accelerations at selected frequencies are plotted in Figures 230.1-1 and 230.1-2 as a function of soil depth to bedrock. Figure 230.1-1 corresponds to accelerations at the free-field ground surface and Figure 230.1-2 corresponds to spectral accelerations at the free-field foundation level. In both plots it is shown that spectral accelerations show significant decrease for the 300 ft. soil case, which is indicative of the trend that accelerations follow with increasing depth to bedrock. Therefore, deep soil sites are enveloped by the twelve soil cases considered in the soil analyses.

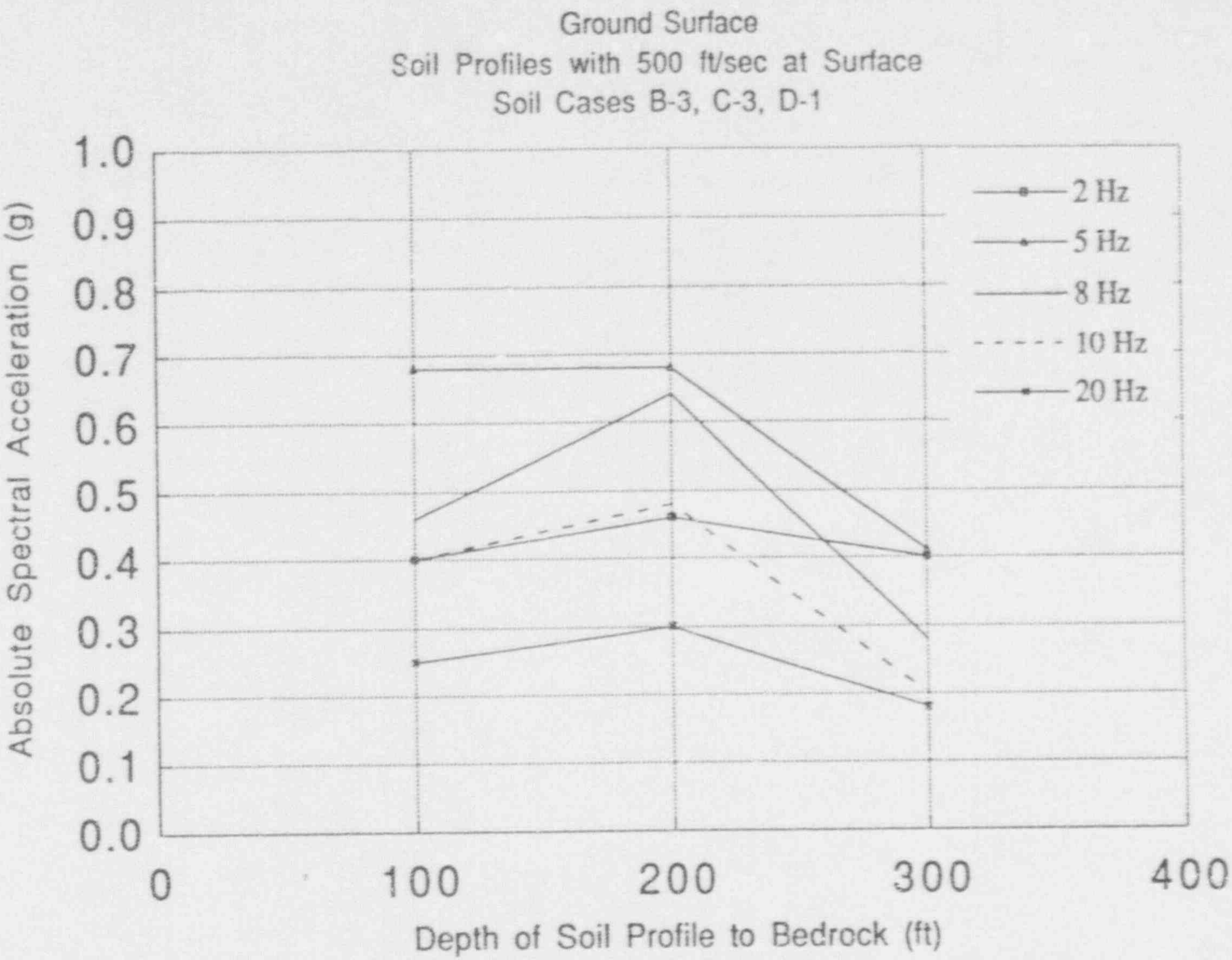

Figure 230.1-1 - Variation of Spectral Accelerations with Depth of Soil to Bedrock (Free-field Ground Surface)

RAI 230.1

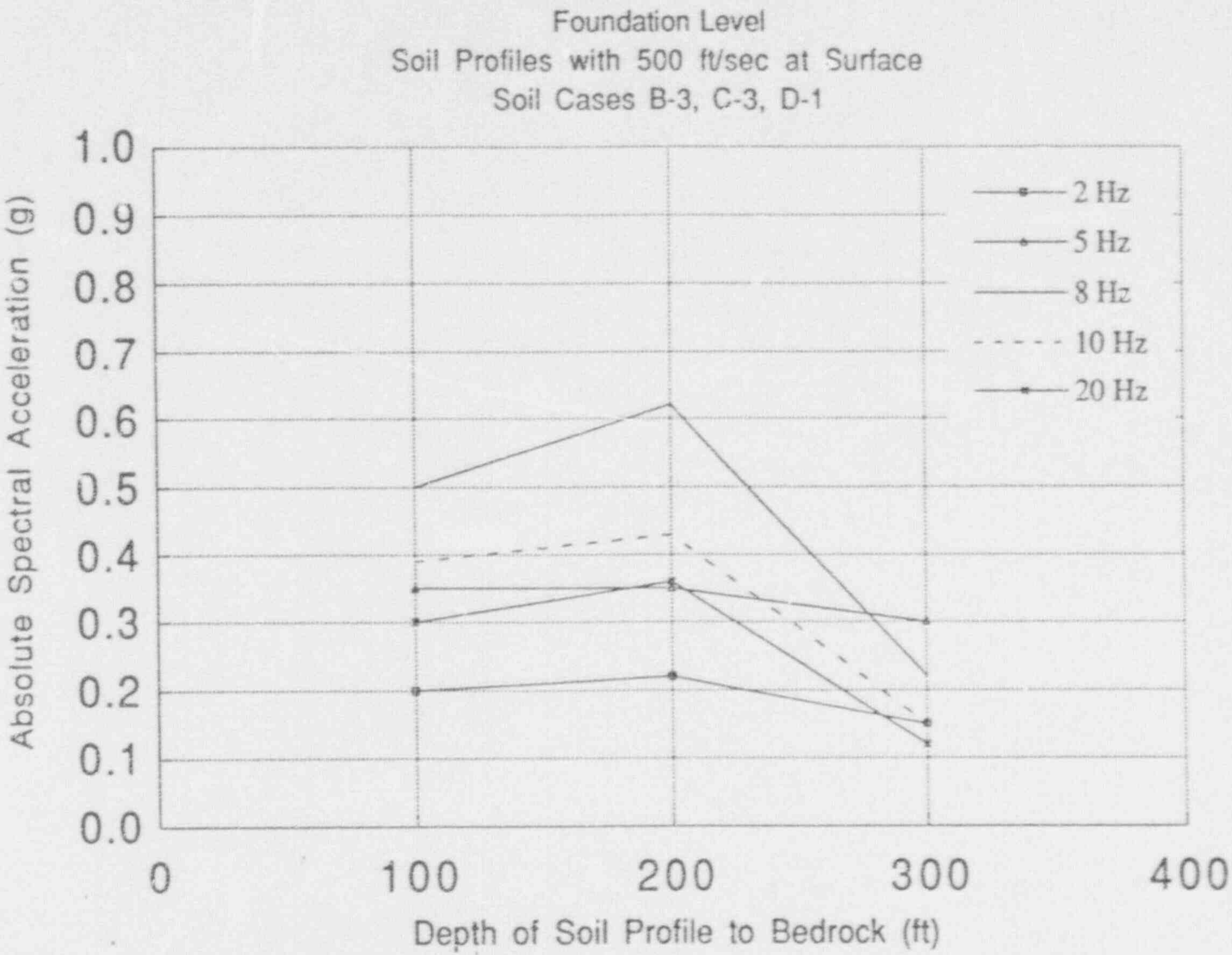

Figure 230.1-2 - Variation of Spectral Accelerations with Depth of Soil to Bedrock (Free-field Foundation Level)

RAI 230.1

Question 220.6

Section 3.7.1.1 - Explain why Figure 3.7-2 is practically identical to Figure 3.7-1. In Case A-1 (Figures 3.7-1 and 3.7-2), the bedrock is at the foundation level. Explain why, in the high frequency range, the horizontal and vertical spectral values converge to 0.5g and 0.3g, respectively in both the cases.

Response 220.6

The contents of Figs. 3.7-1 and 3.7-2 are identical because they both are for the calculated spectral ordinates at the ground surface for Case A-1. This situation has been corrected and the attached figures include the correct information at the ground surface and at the foundation level for Case A-1.

RAI 220.6

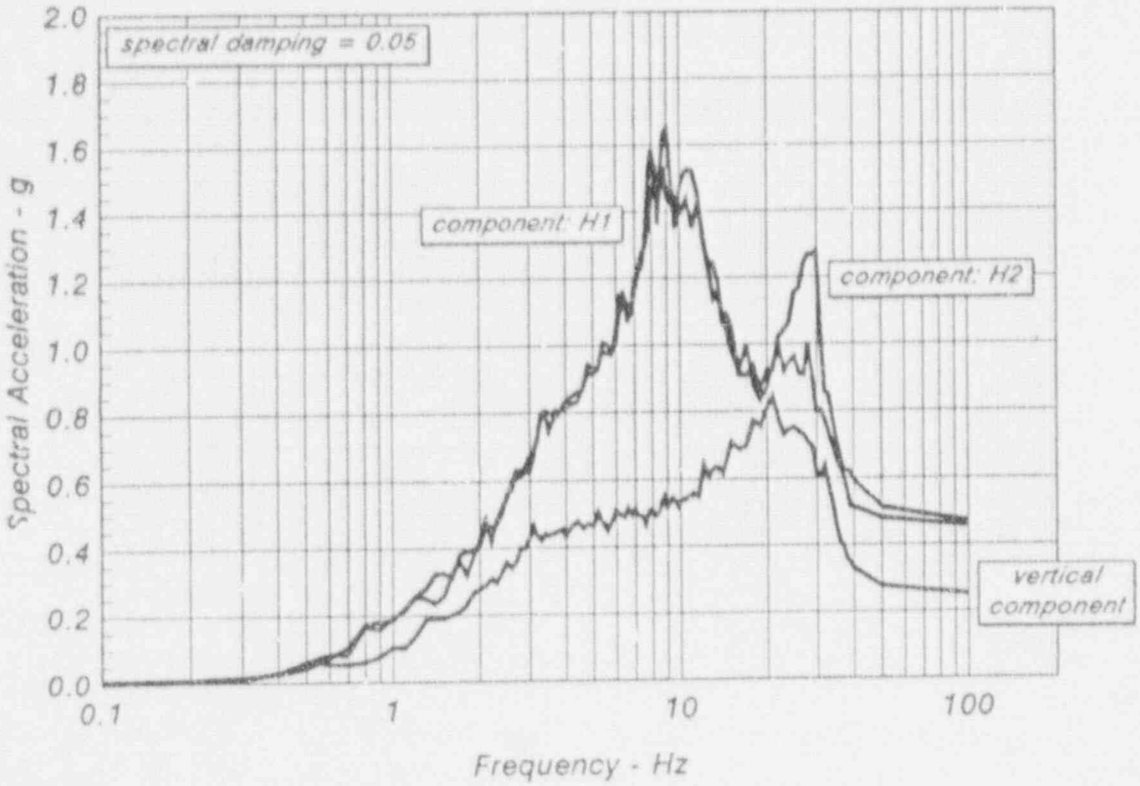

Fig. 3.7-1 Calculated Horizontal & Vertical Spectral Ordinates at the Ground Surface for Case A-1

Q-220.6 - 1

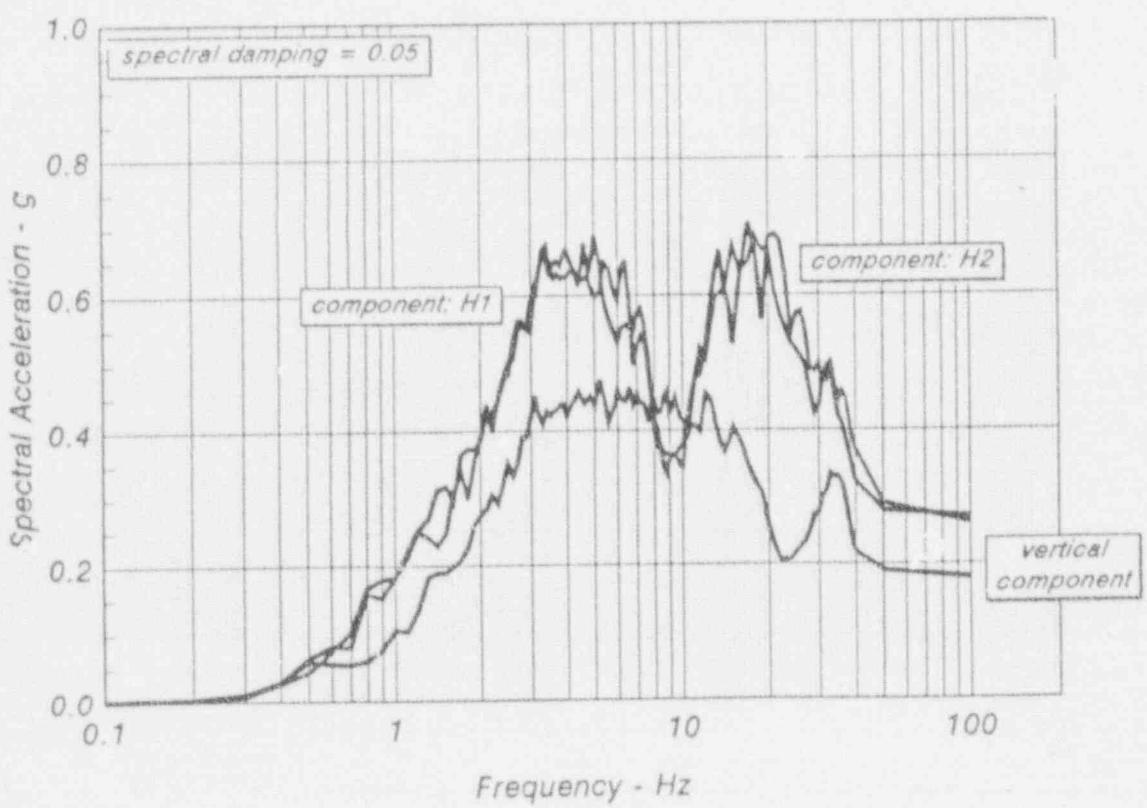

Fig. 3.7-2 Calculated Horizontal & Vertical Spectral Ordinates at the Foundation Level for Case A-1

Q-220.6 - 2

Question 220.7

Section 3.7.1.1 - This section states that "For the time history method of analysis, three design time histories are generated that are consistent with the design rock outcrop spectra at the free field." Explain why these time histories instead of the time histories consistent with the spectra presented in Section 3.7.1.1 are used in the time history method of analysis. Also, compare the PSDs of the 3.7.1.1 spectra with the provisions of Appendix A of SRP 3.7.1.

Response 220.7

The rock outcrop time histories were used only in the fixed-base analysis. The SSI analyses utilized as control motions the response time histories of the soil at the free-field ground surface. These are the time histories that produce the unsmoothed response spectra shown in Figures 3.7-1 to 3.7-24.

CESSAR-DC, Section 3.7.1.2 will be revised in a future amendment to read as follows:

3.7.1.2 Design Time History

"Since the System 80+ Standard Design is designed for generic site conditions, for the time history method of analysis, the generic free-field ground surface time histories are used as control motions in the analyses. In the soil-structure interaction analyses, for each generic site, the corresponding two horizontal and one vertical time histories at the free-field ground surface are used with the SSI model of that site. These time histories produce the unsmoothed response spectra shown in Figures 3.7-1 to 3.7-24. For the fixed-base analysis, the rock outcrop time histories are directly used as the control time histories. The response spectra at 5% damping corresponding to the rock outcrop time histories are shown in Figures 3.7-25 to 3.7-27."

The average PSD of the horizontal free-field ground surface motion corresponding to soil case B3.5 was generated according to the guidelines of SRP, Section 3.7.1, Appendix A. Case B3.5 was selected because it is one of the most critical cases with high amplitude spectra at the soil ground surface.

the average PSD was computed over a frequency band width of ± 20% centered on each frequency. The comparison of the B3.5 PSD with the SRP, 3.7.1, App. A target PSD is shown in Figure 220.7-1. The SRP PSD is normalized to a 0.35g peak acceleration, since 0.35g is the peak acceleration of the B3.5 soil case at the ground surface.

Response 220.7 (cont.)

Figure 220.7-1 shows that the B3.5 PSD conservatively exceeds the SRP PSD at all frequencies above 0.9 Hz. The frequency range below 0.9 Hz has no structural significance. Also, there are softer soil profiles with surface motions that have more power in the frequency range below 0.9 Hz.

RAI 220.7

3.7 SEISMIC DESIGN

3.7.1 SEISMIC INPUT

3.7.1.1 Seismic Input

This section discusses the seismic design parameters and methodologies being used for the design of those systems and subsystems important to safety and classified as Category I in Section 3.2.

The System 80+ Standard Design as defined by CESSAR-DC is not based on a specific site. Generic site conditions were selected to cover a range of possible conditions for the System 80+ sites. More specifically, sets of representative cases from each of four generic site categories were evaluated to create the ground surface and foundation level spectra shown in Figures 3.7-1 through 3.7-24. Out of 12 soil cases analyzed in Section 2.5.2, nine are used in the soil structure interaction (SSI) analysis. The three cases eliminated in the SSI analysis (A1, B3 and D1) were non-governing cases whose soil response levels were enveloped by other cases. See Section 2.5.2 for details of this analysis phase.

The effect of differential seismic displacement on the equipment and supports is included in the analysis as described in Section 3.7.2.1. I

3.7.1.2 Design Time History

Insert →

Delete

~~For the time history method of analysis, three design time histories are generated that are consistent with the design rock outcrop spectra at the free field. The characteristics of each time history are presented in Section 2.5.2.5.1. The response spectra plots for these time histories are shown in Figures 3.7-25 through 3.7-37.~~

3.7.1.3 Critical Damping Values

Damping values used for various nuclear safety-related structures systems and components are based upon Regulatory Guide 1.61 or ASME Code Case N-411-1 (See Figure 3.7-41). These values are expressed in percent of critical damping and are given in Table 3.7-1. When the response spectra method of analysis is used for piping, damping values are based on Code Case N-411-1.

RAI 220.7

Insert

Since the System 80+ Standard Design is designed for generic site conditions, for the time history method of analysis, the generic free-field ground surface time histories are used as control motions in the analyses. In the soil-structure interaction analyses, for each generic site, the corresponding two horizontal and one vertical time histories at the free-field ground surface are used with the SSI model of that site. These time histories produce the unsmoothed response spectra shown in Figures 3.7-1 to 3.7-24. For the fixed-base analysis, the rock outcrop time histories are directly used as the control time histories. The response spectra at 5% damping corresponding to the rock outcrop time histories are shown in Figures 3.7-25 to 3.7-27.

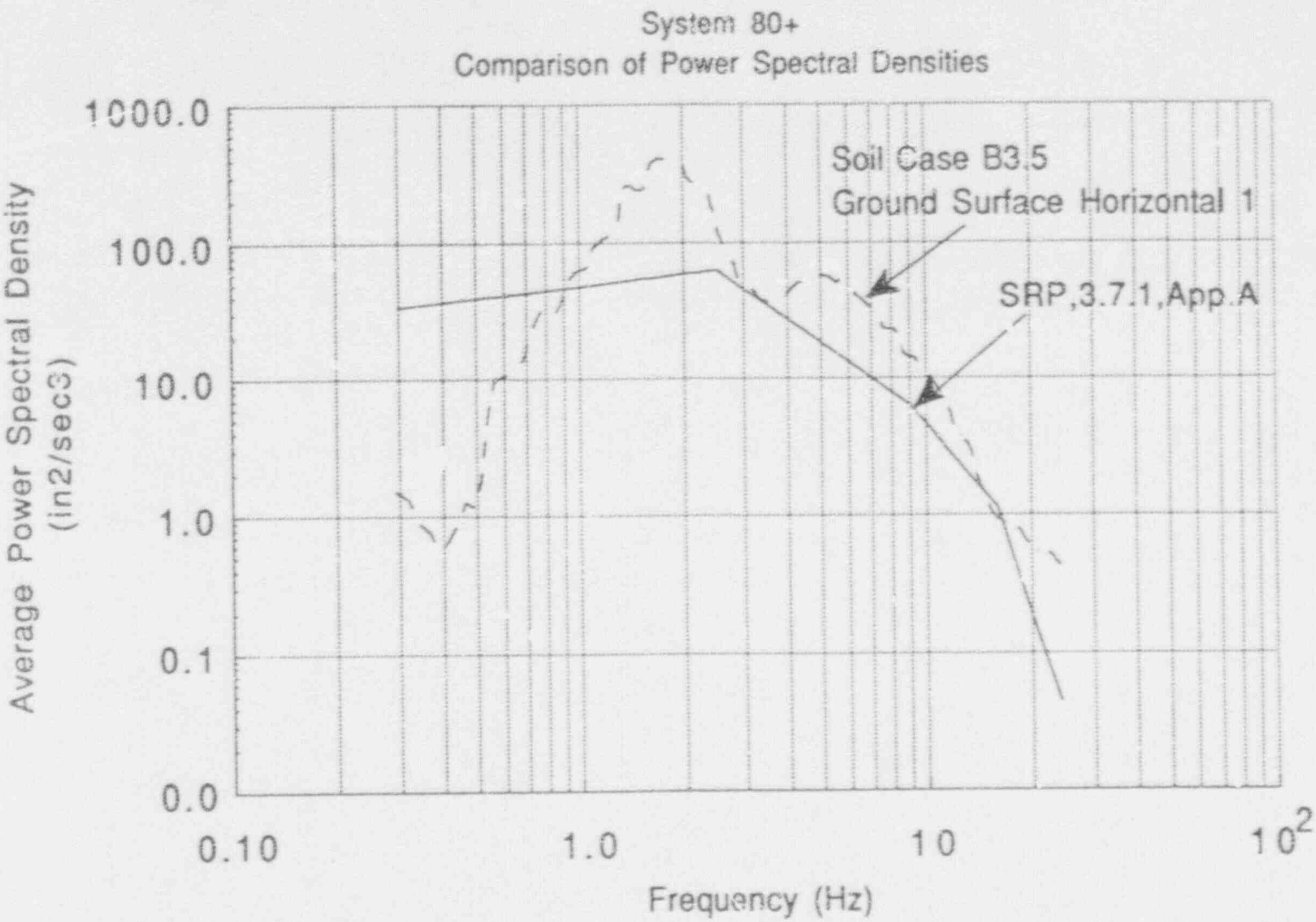

Figure 220.7-1 - Comparison of SRP PSD and Average PSD of Soil Case B3.5

RAI 220.7