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REVIEW OF PROGRESS BY DON BERNREUTER LAWRENCE LIVERMORE LABORATORIES REGARDING SITE SPECIFIC DESIGN SPECTRA FOR THE DIABLO CANYON NUCLEAR POWER PLANT

Four subtasks have been performed:

1. Test of v/a for all components and for vector components of available strong motion seismograms recorded on hard rock.
2. Test of peak v as in (1).
3. Test of spectral shape for various magnitude earthquakes recorded from nearly the same epicenter at the same strong motion seismograph.
4. Test run of SHAKE through geologic section beneath Diablo Canyon beginning with soft mudstone below hard sandstone upper layer.

Summary of results:

1. v/a graphs did not show a strong trend whether plotted as single component values or vector values. See for example figures 1 & 2 for soil only and rock respectively.
2. v vs a graphs, for example, figures 3, 4 & 5, show a trend especially where vector values are plotted. Because peak values seldom occur at the same place in the record, the vector value is assumed to better represent energy in the seismogram but the actual value on a single component is less than the vectored value. The ratio of vector values of velocity at 1g acceleration for rock and soil can be compared to determine the limiting rock velocity compared to previously determined overall limiting velocities. Tentative results are .50/.85 for vectored hard rock velocities over soil velocities, (see figures 4 & 5) or a factor of .58. This value times the previously established single component soil maximum velocity of .48 inches per second yields a possible 28 inches per second upper velocity bound for hard rock. This agrees with the value recommended by Dr. Newmark. Additional analyses and studies to clarify the nature of foundations under strong motion recording stations may modify results.
3. Spectral shapes for various magnitude earthquakes having the same

D/39

or similar epicenter and recorded at the same strong motion seismograph were prepared. Results, for example figures 6, 7 & 8, show that the relative amount of short period vibrations in small earthquakes is much larger than in large shocks. Thus scaling up the response spectra of small shocks to obtain the spectral envelope of large shocks is in error. The large earthquakes have much higher long period spectral responses components but the short period (high frequency) components increase only slightly over that for small shocks. This is an important observation. Data are few but do provide a new technical argument for not increasing high frequency spikes proportionately with magnitudes as implied by USGS Circular 672 which has been recommended as a basis for Diablo Canyon design. These data are directly from the computer with no opportunity for adequate labeling.

44. No computer print-out was supplied for the SHAKE experiment considering mudstone beneath sandstone at Diablo Canyon. A more precise study is expected in the future. Preliminary results, however, indicate that there may be a fortuitous geological situation which will reduce expected shaking levels. The method requires measurements of deeper layer properties, currently unavailable, for accurate results.

Additional computer experiments were performed in comparing Reg. Guide 1.60 spectra with recorded spectral shapes and plots of velocity vs distance by rock type. The initial experiments with the latter data were not conclusive.

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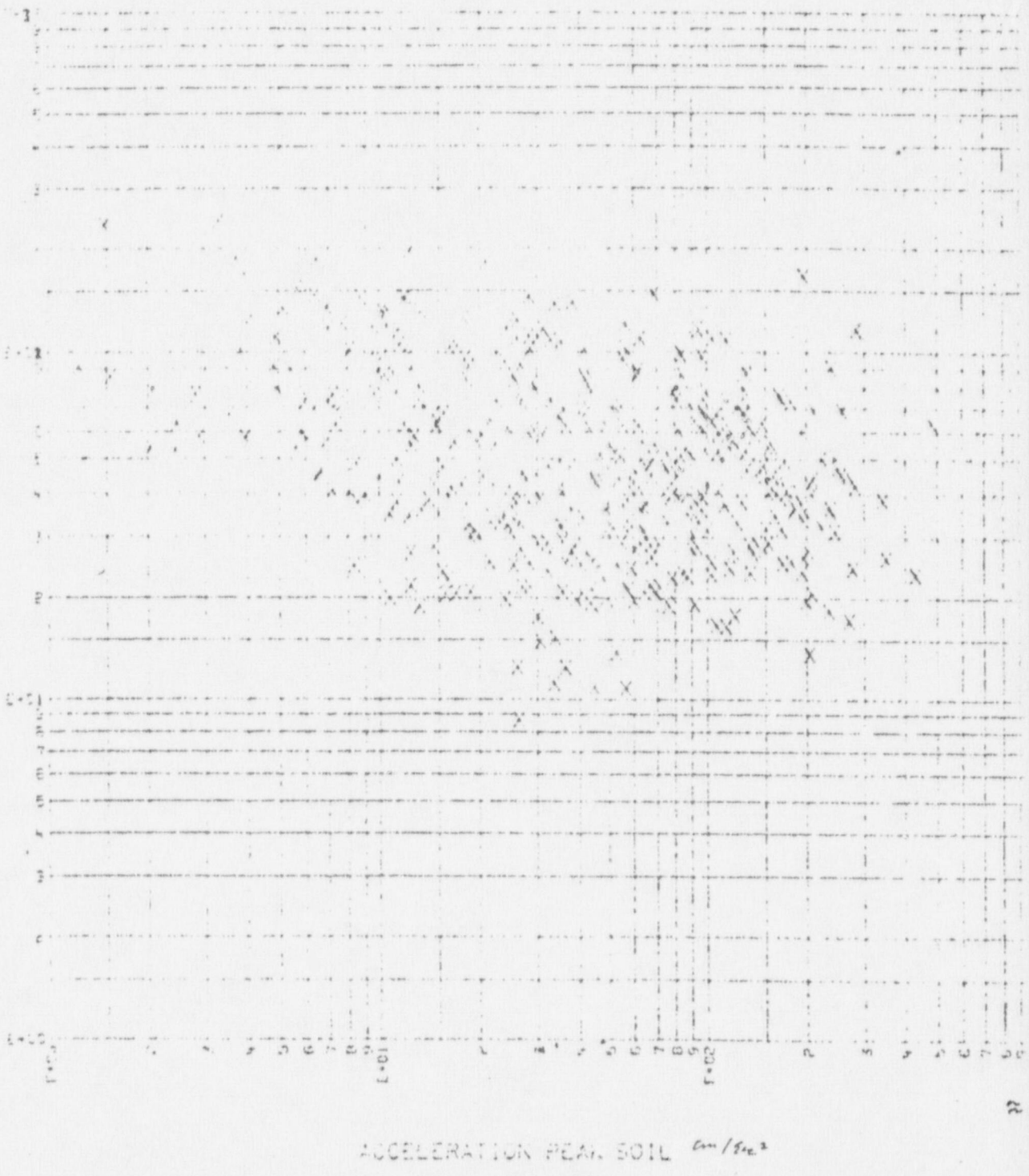

Figure 1. All components of all records plotted for soil and non-hard rock strong motion siesmograph sites. v/a vs a.

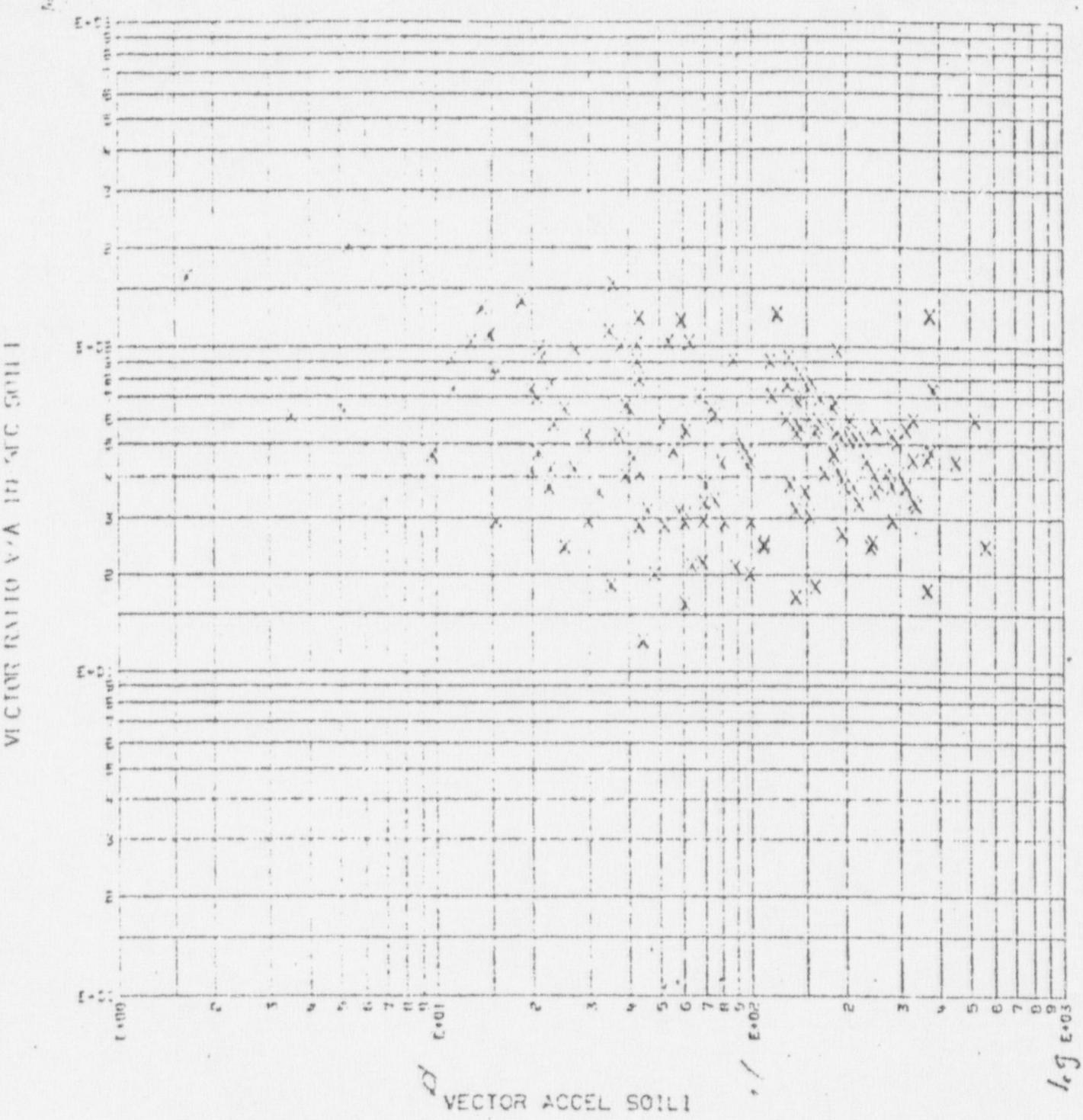

Figure 2. Three component vectored peak v/a values vs a for soil sites only.

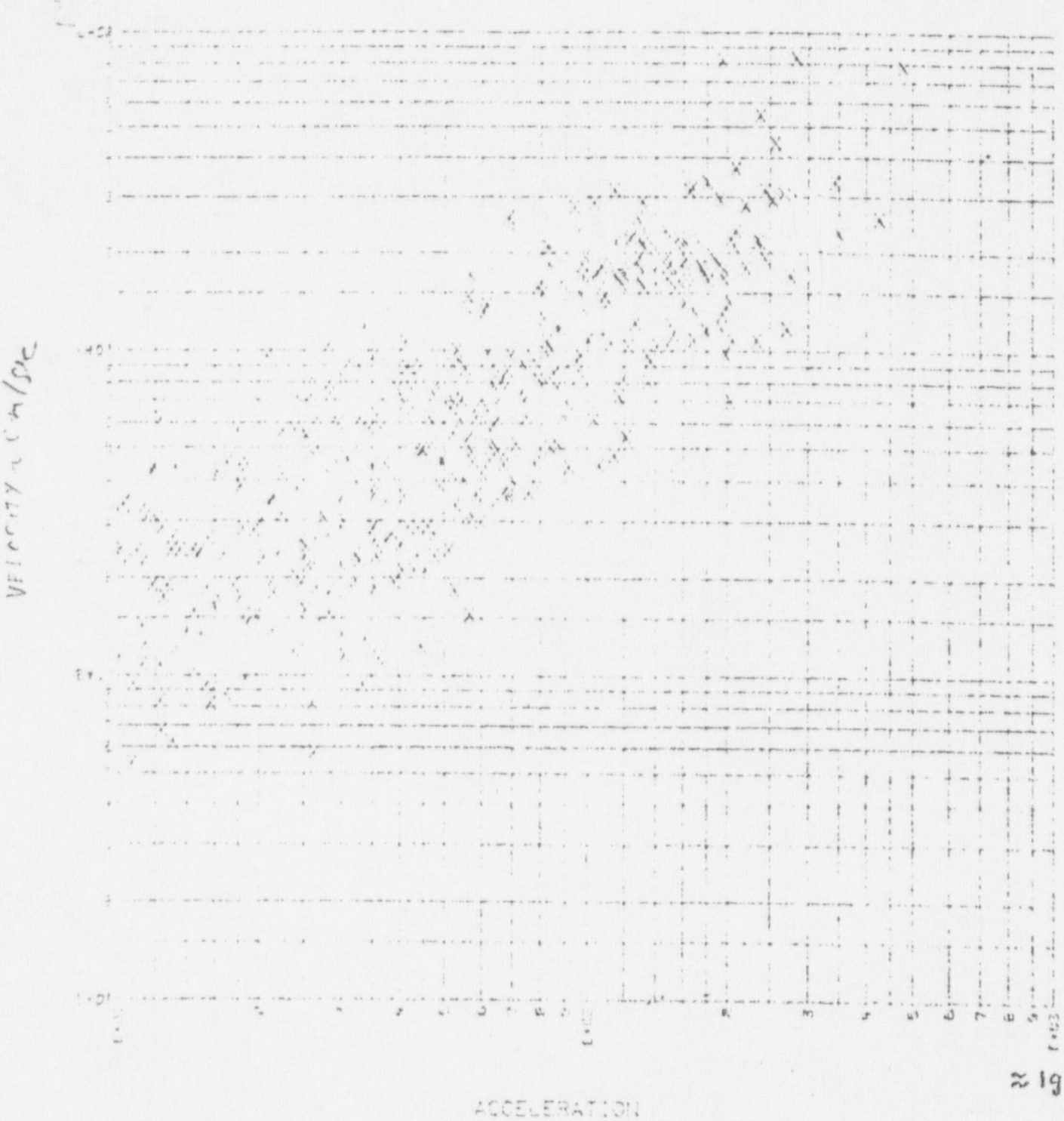

Figure 3. v for each component from all sites vs peak acceleration.

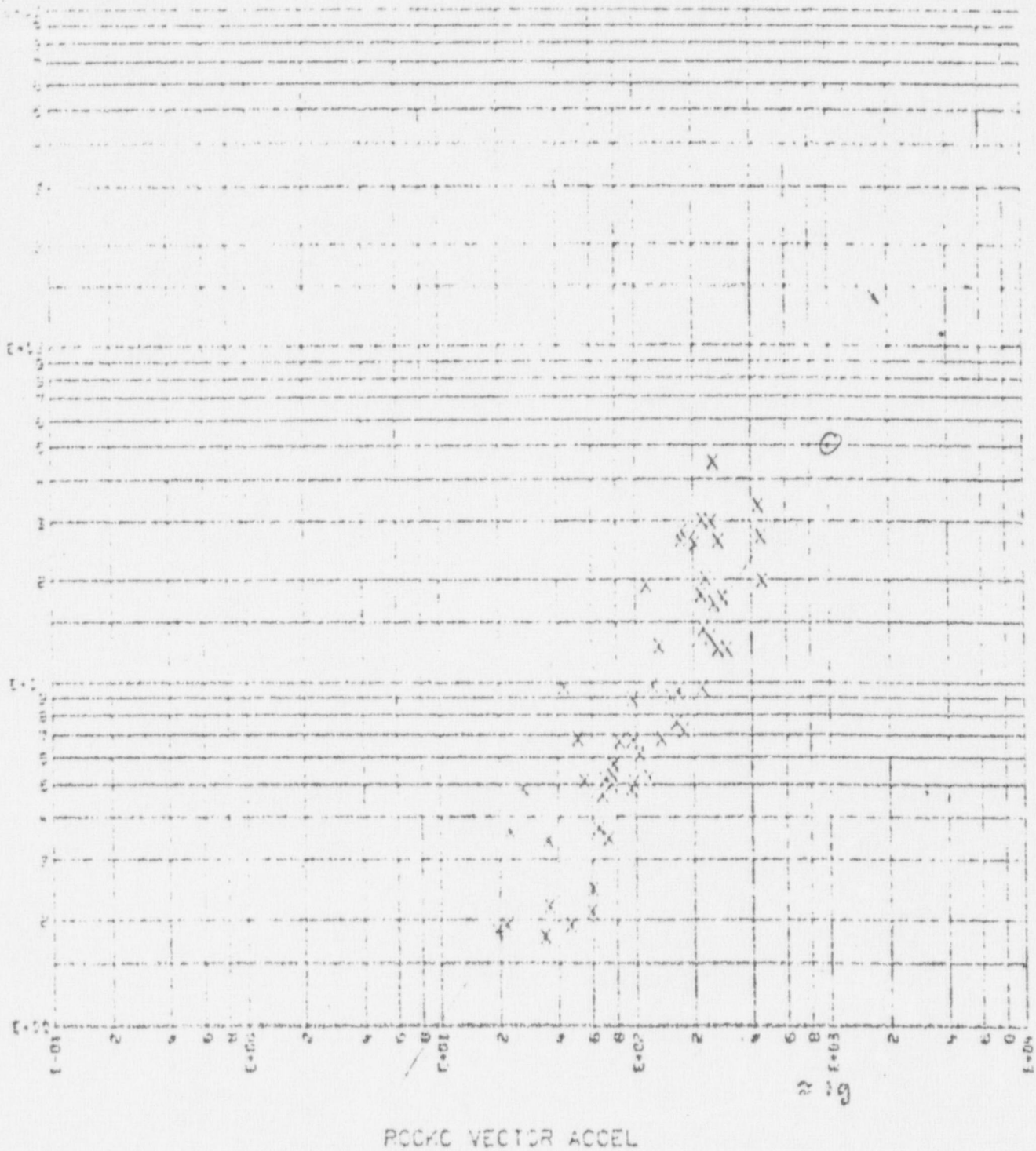

Figure 4. Three component vectored velocity vs acceleration for hard rock sites only. Least squares line recieved by telephone later is plotted approximately.

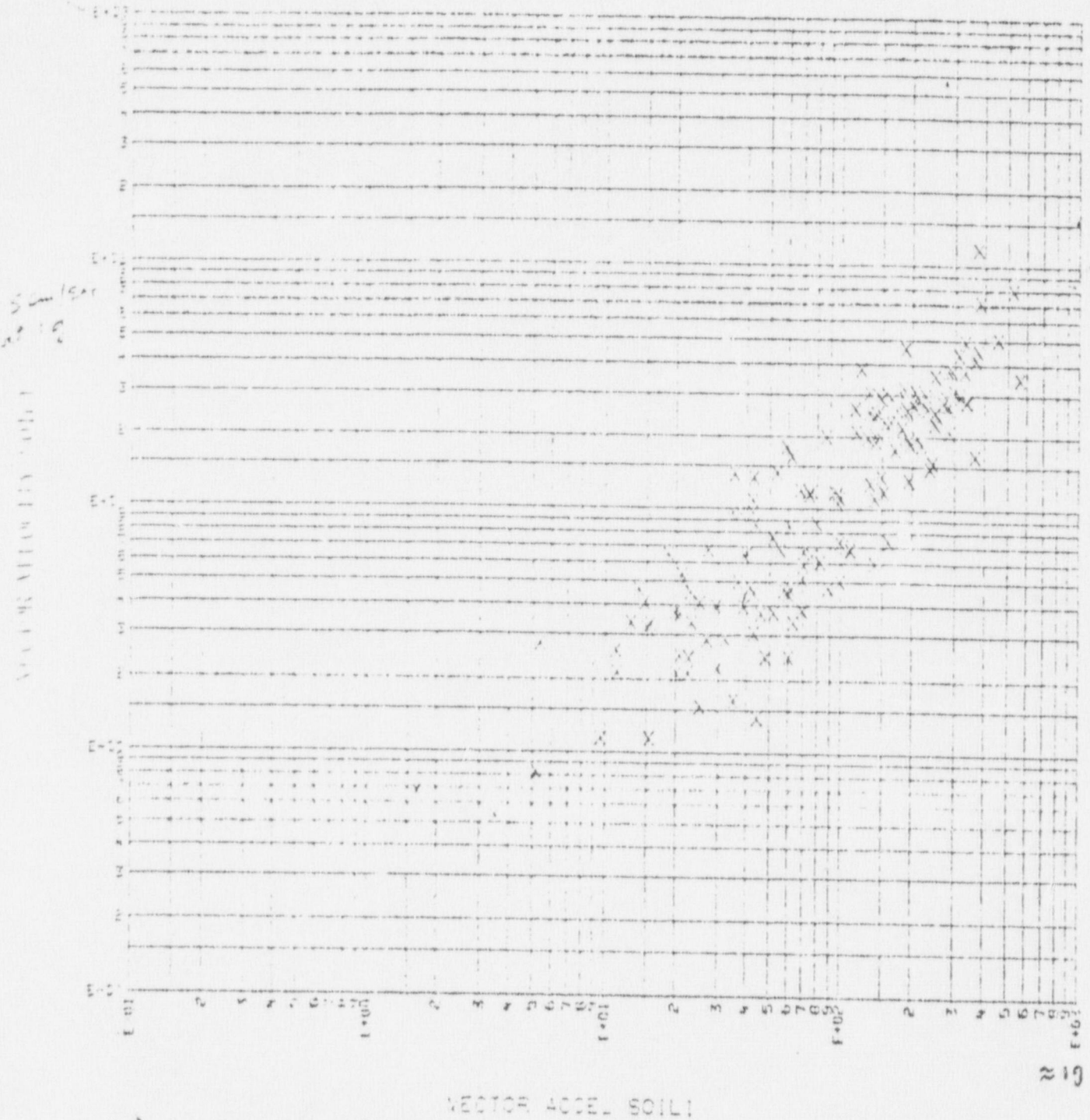

Figure 5. Three component vectored velocity vs acceleration for soil sites only. Least aquares line recieved by telephone later is plotted approximately.

El Centro

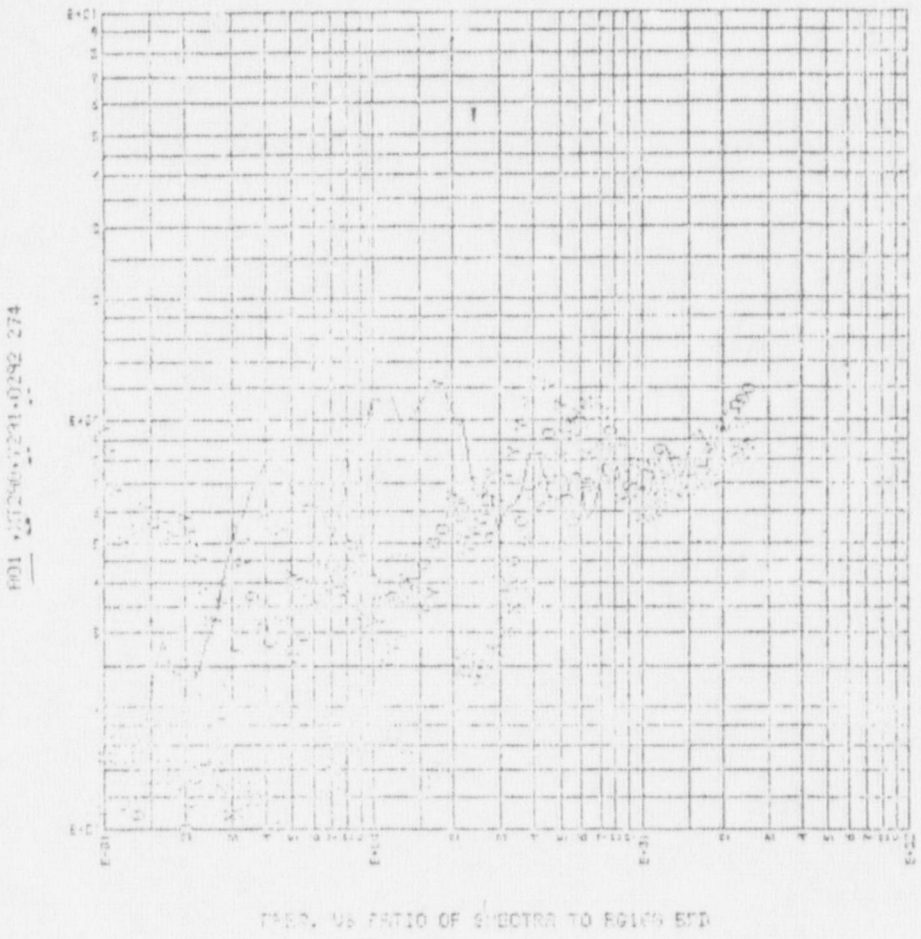

Figure 6. Ratio of main 1940 El Centro response spectra to Reg. Guide 1.60 spectra plus similar plots for smaller shocks of nearly the same epicenter (symbols 0,X & Y). 5% damping.

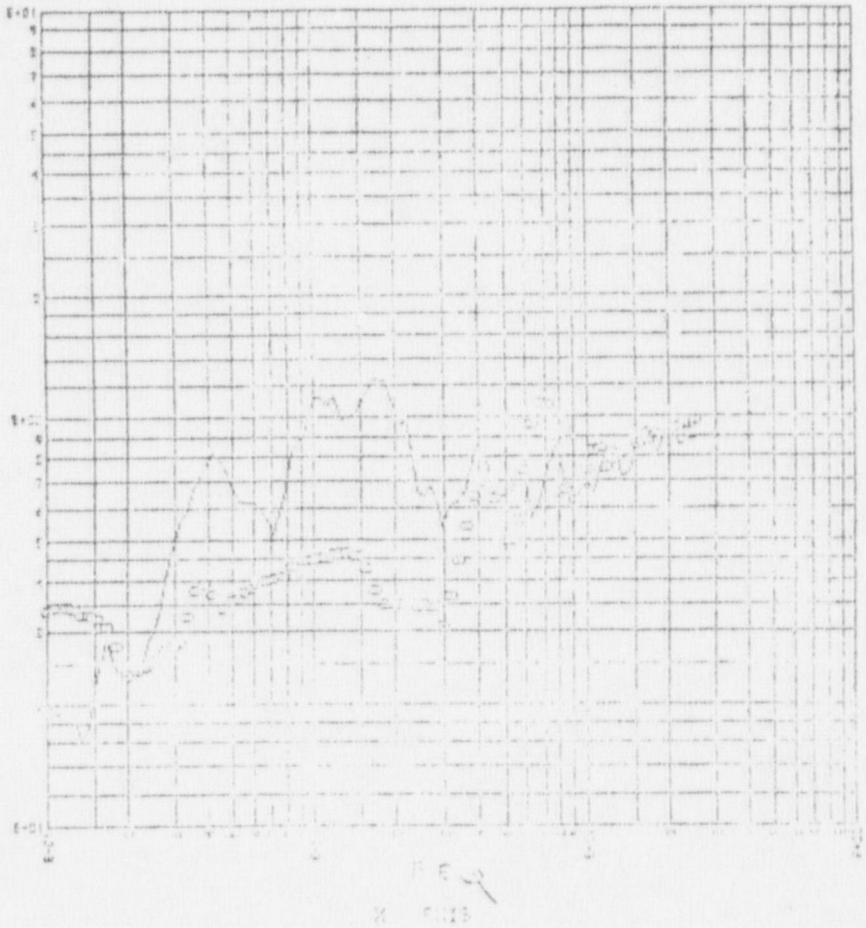

Figure 7. Ratio of main 1940 El Cento response apectra to Reg. Guide 1.60 spectra plus a similar plot for one smaller shock of M=3 at the same location. 5% damping.

C44 & C46 are aftershocks of San Fernando Eq.

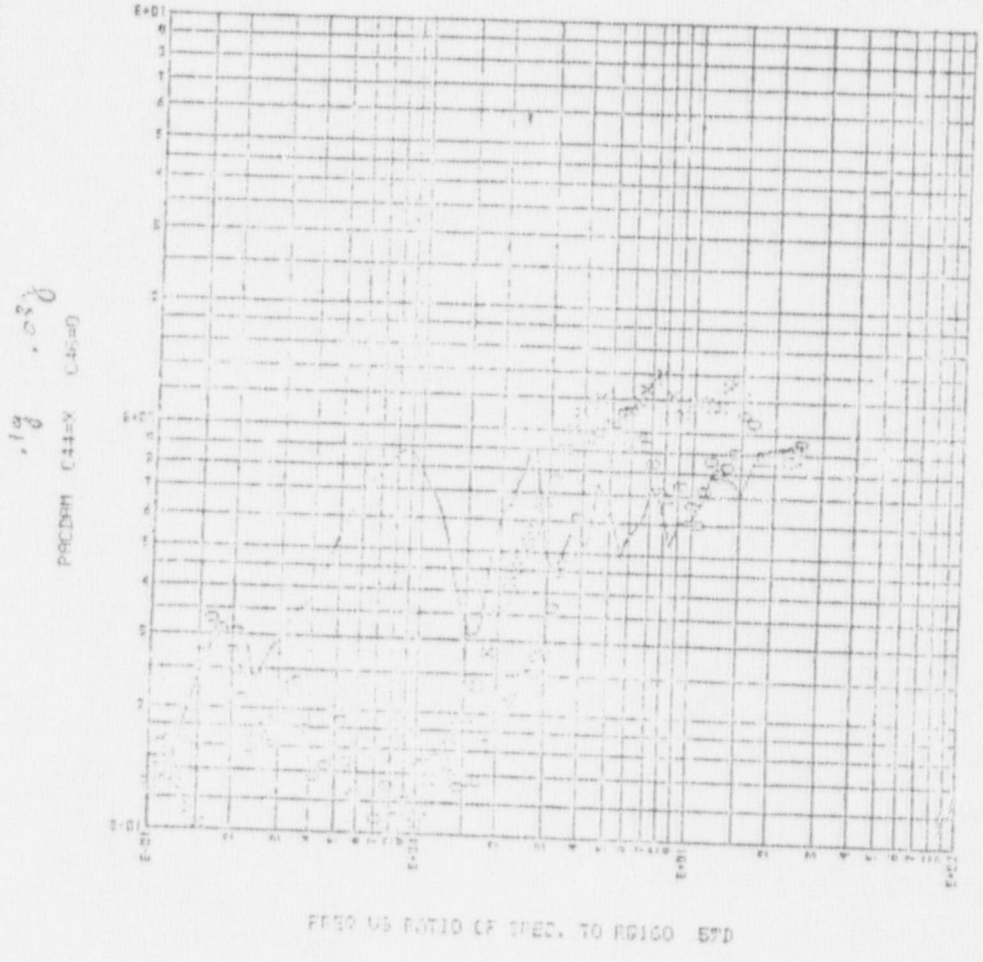

Figure 8. Main San Fernando Shock and two smaller aftershocks depicted as spectral response ratios with Reg Guide 1.60 spectrum at 5% damping