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SUBJECT: Comments on Southern CA Edison presentation at 790918 meeting in Bethesda,MD re facility.Approves estimates of mean level of peak ground motion.Expresses doubt re basing of design on similarity to 1933 Long Beach earthquake.

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October 2, 1979

Dr. Howard A. Levin
Systematic Evaluation Program Branch
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Levin:

The following are my comments on the SCE presentation at the September 18, 1979 meeting in Bethesda, MD on San Onofre Nuclear Generating Station, Unit 1.

As a result of the discussion during the meeting, I sensed a certain reluctance to use the SCE results for SONGS 1 for two reasons: the peak acceleration shows little dependence upon fault length and the computed M_L seems too low for the 40 km fault modeled. It was the contention of SCE that the peak acceleration should have no magnitude dependence when the accelerations are measured close to the fault surface. The tenor of the discussion was the the SCE technique has not been tested enough to place total confidence in it.

Addressing these points, I would like to discuss the magnitude estimate. The SCE model yielded M_L = 5.9 - 6.2 for the mean spectrum and M_L = 6.1 - 6.4 for the mean plus one sigma. These estimates are probably controlled by the rupture closest, or fairly close, to the sire (8 km from the fault). There may be some question of the validity of using the Richter attenuation curve that close to the fault. It seems to me that the application of the Richter magnitude relation so close to the fault may be an extrapolation inward of the local magnitude formula.

SCE argued against computing M_L at distances greater than 8 km from the fault because of the expense and because of the lack of knowledge of crustal parameters at larger distances. This may only be an apparent problem. First, to compute seismograms at distances of 100 km, it is probably not necessary to compute frequencies up to 20 Hz due to Q. One can compute time histories at twice the distance at frequencies up to 10 Hz with the same level of effort used. The Q model used is not too much a problem since the crustal Q should be relatively well known with Q_β approximately 150-200. It seems to me that if magnitude is computed at distances greater than 1 fault dimension away from the fault the magnitude determined will show some dependence upon fault dimension.

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Another reason for computing the magnitude at a larger distance is the chance that M_L may be larger when determined from distant stations than from near stations because the waveforms will have substantially different frequency content. An example of this is the Kanamori-Jennings (1978) estimate of M_L for the 1933 Long Beach earthquake which gave M_L = 6.0 from an accelerograph at a distance of 14 km and an M_L = 6.7 from an accelerograph at a distance of 36 km. However, this was the only case in Kanamori-Jennings which showed this effect.

In addressing the peak acceleration, I would like to point out the similarities of the earthquake modelled and the 1933 Long Beach earthquake. Kanamori and Jennings calculated an M_L = 6.4 for that earthquake. The Woodward-Clyde report, June 1979, estimates a seismic moment of 6.2×10^{25} dyne-cm and a 46 cm offset on a 15 x 30 km fault. Note that these are close to the SCE values of $1.5 + 10^{26}$ dyne-cm for seismic moment, 130 cm offset on a 9 x 40 km fault. The Long Beach earthquake had a peak acceleration of 0.16 g on the S82E and 0.14 g on the N08E components at a distance of 14 km. Note that these accelerations agree well with the SCE theoretical estimates for a receiver at 12 km from a fault (SCE Simulation for SONGS 1, Supplement 1, July 1979, Figures 6-18, 6-19, pp 6-20, 6-21). I think this is a good demonstration of the prediction qualities of the SCE model.

Another example of the appropriateness of the SCE maximum acceleration estimates is seen in comparing Figure J-1 of Woodward-Clyde SONGS 2 and 3, the acceleration-distance relation for magnitude 6.5 earthquakes with the SCE Figures 6-18, 6-19 on pages 6-20, 6-21. The SCE Site SE peak accelerations extrapolate the Woodward-Clyde mean acceleration back to the source very well, e.g. .32 g at 12 km, .47 g at 8 km and .7 g at 4 km. (Obtained from 2% damping curve at 10 Hz.) This comparison again shows how well the SCE technique scales for distance.

The spectra provided by SCE have narrower standard error bands than the Woodward-Clyde report. The Woodward-Clyde report includes all data, without an attempt to rotate the observed peak motions for radial and transverse components. Given their data set, it is easy to see that a root mean square variation of a factor of 1.4 is possible. The scatter in the Woodward-Clyde report might be reduced by plotting maximum vectorial amplitudes and defining the mean as 0.7 of the maximum.

The SCE results seem to do a very good job of estimating the mean level of peak ground motion due to smoothing of response spectra and to the scatter in empirical data, some of which may be due to the random orientation of recording instruments.

Because of these points, I feel somewhat comfortable with the SCE presentation. However, I question whether the design should be based upon similarity to the 1933 Long Beach earthquake, especially when one might want to include conservatism into the result by permitting a somewhat larger earthquake to occur. If SCE were to compute M_L at 50-100 km from the fault, the resulting M_L might reduce criticism of the results. If conservatism is required I would suggest scaling the high frequency portion of the SCE site specific response spectra. On the other hand, the 10 Hz 2% SE component response spectra indicates 0.48 g, which may be acceptable. The SCE response spectra probably should not be used at frequencies greater than 10 Hz since the sampling interval of 0.025 second corresponds to a Nyquist frequency of 20 Hz and the response spectra may be reliable only at frequencies less that 10 Hz.

In conclusion, the SCE response spectra represents motions that can be expected at the site. They do not represent a level which cannot be exceeded, though.

Sincerely,

Robert B Herrmann

Robert B. Herrmann
Associate Professor of Geophysics

RBH:leh