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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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BEFORE THE ATOMIC SAFETY & LICENSING APPEAL BOARD

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OFFICE OF SECRETARY DOCKETING & SERVICE BRANCH

In the Matter of	)	
	)	
PACIFIC GAS AND ELECTRIC COMPANY	)	Docket Nos. 50-275 O.L.
	)	50-323 O.L.
(Diablo Canyon Nuclear Power Plant, Units 1 and 2)	)	

JOINT INTERVENORS'
MOTION TO REOPEN
THE RECORD ON SEISMIC ISSUES

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In the Matter of PACIFIC GAS AND ELECTRIC COMPANY (Diablo Canyon Nuclear Power Plant, Units 1 and 2)	)	Docket Nos. 50-274 O.L. 50-323 O.L.

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The SAN LUIS OBISPO MOTHERS FOR PEACE, SCENIC SHORELINE PRESERVATION CONFERENCE, INC., ECOLOGY ACTION CLUB, SANDRA SILVER, GORDON SILVER, ELIZABETH APFELBERG, and JOHN FORSTER ("Joint Intervenors") hereby request the Atomic Safety and Licensing Appeal Board ("Appeal Board") to reopen the record in order to receive significant new information directly relevant to the seismic safety of the Diablo Canyon Nuclear Power Plant ("Diablo Canyon"). The new information, arising out of recent seismic events and geologic studies, is described in the attached affidavit of Dr. James Neil Brune, Professor of Geophysics at the University of San Diego, and in the documents attached to that affidavit.[1/]

1/ As this Board is aware, Dr. James Brune is a widely recognized expert in the field of earthquake source mechanism and strong motion. In recent years, he has been developing methods [Continued]

The standards applicable to a motion to reopen the record are well established. Such a motion should be granted if (1) it concerns significant new information relevant to safety; (2) the new information, if considered originally, would have changed the result; and (3) the motion is timely. Kansas Gas and Electric Co., et al. (Wolf Creek Generating Station, Unit 1), ALAB-462, 7 NRC 320, 328 (1978); Vermont Yankee Nuclear Power Corporation (Vermont Yankee Nuclear Power Station), ALAB-138, 6 AEC 520, 523 (1973); id., ALAB-167, 6 AEC 1151-52 (1973). Each of these criteria is satisfied in this case, and, accordingly, the Joint Intervenors' motion to reopen the record should be granted.

I. THE NEW INFORMATION IS SIGNIFICANT TO SAFETY AND RAISES TRIABLE ISSUES THAT MANDATE A CHANGED RESULT.

A. Introduction

In ALAB-644 (June 16, 1981), this Appeal Board concluded that the design criteria used in the Diablo Canyon seismic reanalysis meet the requirements of 10 C.F.R. § 100, Appendix A. In so doing, the Appeal Board necessarily concluded that the .75g response spectrum -- the so-called Newmark free field response

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1/ [cont'd]
for using existing strong motion records to estimate strong motion for larger earthquakes in the range of M 6.5 to M 7.5. He has been a Professor of Geophysics at the University of California at San Diego since 1969; from 1973-1976, he served as Associate Director of the Institute of Geophysics and Planetary Physics, UCSD, and from 1974-1976, as Chairman of the Geological Research Division, Scripps Institution of Oceanography, UCSD. He has testified previously in this proceeding and is familiar with the record herein. A further statement of his qualifications, experience, and publications is included as Attachment 1 to his affidavit.

spectrum ("Newmark Spectrum") -- is an appropriate and conservative representation of the forces likely to occur at Diablo Canyon in the event of an M 7.5 earthquake on the Hosgri Fault, the Safe Shutdown Earthquake ("SSE") for the facility. This essential finding has been vigorously disputed by the Joint Intervenors and by the Governor of California.

New information, only recently available, now provides further compelling evidence that the Board's conclusion in ALAB-644 was erroneous. As appears in the attached affidavit of Dr. James Brune, such information -- consisting of (1) ground motion data obtained from recent major earthquakes, (2) geologic data obtained from studies just completed, and (3) recent analyses of focal mechanisms of earthquakes near the central coast of California -- indicates that the levels of ground motion at the Diablo Canyon site associated with an M 6.5 to M 7.5 earthquake are likely to exceed the maximum values assumed by the Board in its approval of the facility's seismic design. More specifically, it includes data from recent earthquakes of significantly lower magnitude than the Diablo Canyon SSE, but which generated accelerations in the frequency range of interest that substantially exceed the Newmark Spectrum, including -- during the April 24, 1984 Morgan Hill, California earthquake -- the highest horizontal accelerations ever recorded for any earthquake. These data establish that, contrary to the Board's conclusion in ALAB-644, the Bond's Corner record from the 1979 Imperial Valley earthquake and the Pacoima Dam record for the 1971 San Fernando earthquake do not represent "distorted responses," ALAB-644, at 94. To the contrary, those records, together with the new data discussed in the attached affidavit of Dr. Brune, indicate that the Newmark Spectrum is not conservative but rather significantly understates the expected ground motion at Diablo Canyon caused by an earthquake in the range of M 6.5 to 7.5 on the Hosgri Fault.

Further, recent data also belie the Appeal Board's characterization of the phenomena of "focusing" and "high stress drop" as "speculative" and its consequent rejection of the contention by the Joint Intervenors and the Governor that those phenomena are likely to increase significantly the ground forces of a major earthquake on the Hosgri Fault. ALAB-644, at 87-88. A recent paper prepared by the United States Geological Survey ("USGS") concludes that the April 1984 Morgan Hill, California earthquake clearly exhibited the effects of focusing or high stress drop, leading to the unprecedented recorded peak horizontal acceleration of 1.29g. Because the M 6.1 Morgan Hill earthquake is a much smaller earthquake than the M 7.5 SSE predicted at Diablo Canyon, the occurrence of such phenomena during a major earthquake on the Hosgri Fault is likely to result in forces significantly greater than the .75g peak acceleration assumed for the facility.

Recent geologic data and focal mechanism studies, which describe the type of faulting and earthquake movement expected in the region of the central California coast, unanimously indicate that, contrary to the Board's explicit finding, ALAB-644, at 74, 88, the Hosgri Fault is not primarily of the strike-slip variety but is characterized by thrust motion and may actually dip under and even closer to the plant site than previously assumed. Consequently, it is likely to generate forces two to three times greater than that anticipated in the event of a strike-slip quake of the same magnitude. Such evidence further bolsters the Joint Intervenors' contention in this proceeding that, far from being conservative, the seismic design criteria for Diablo Canyon approved by this Board in ALAB-644 are inadequate and do not meet regulatory requirements.

Finally, studies of recent earthquakes in the central California coastal region confirm the Joint Intervenor's contention that Diablo Canyon is located in an area of high seismicity, a fact in direct conflict with the Board's conclusion that the plant is sited in an area of "low to moderate seismicity." ALAB-644, at 174-175. Since 1978, four earthquakes with magnitudes greater than 5.0 have occurred in the tectonic province near the Hosgri Fault, and since 1980 two of these have occurred on either side of the Diablo Canyon site. Still more recently, on June 20, 1983, an M 4.7 earthquake occurred on the Hosgri Fault near the epicenter of the 1980 Pt. Sal earthquake. Thus, according to Dr. Brune, in light of this recent direct evidence of high seismicity, "it would be no surprise to have an earthquake of much larger size, as large as the Diablo Canyon design earthquake (M=7.5) at any time."

B. Specific Evidence

The extensive new evidence on which these conclusions are based is summarized in the attached affidavit of Dr. Brune.

The evidence arises out of a number of studies completed by state, federal, and private experts only within the past several months, studies analyzing data obtained from a number of recent major earthquakes near Morgan Hill, California (1984), Pt. Sal, California (1984), Coalinga, California (1983), and the Mexicali Valley in northern Baja California (1980). In addition, the evidence is derived from recent studies of the focal mechanisms of earthquakes near the central California coast, all of which indicate a much greater component of thrust faulting than previously assumed in the area of interest to Diablo Canyon.[2/]

2/ Specifically, the studies relied upon by Dr. Brune include the following:

(a) California Department of Conservation, Division of Mines and Geology, "CDMG Strong-Motion Records From the Morgan Hill, California Eqrthquake of 24 April 1984," Report OSMS 84-7 (May 21, 1984);

(b) California Department of Conservation, Division of Mines and Geology, "Plots of Accompany Tape MORGANHILL84-INTERIM, A Partial Sedt of Strong Motion Data from the Morgan Hill, California Earthquake of April 24, 1984" (July 5, 1984);

(c) Bakun, _et al_., "The 1984 Morgan Hill, California Earthquake: A Preliminary Report" (Preprint submitted to Science Magazine) (1984);

(d) Crouch _et al_., "Post-Miocene Compressional Tectonics Along the Central California Margin" (Preprint) (1984);

(e) Anderson and Simons, "The Mexicali Valley Earthquake of 9 June 1980." Newsletter, EERI, v.16, at 79-105 (1982);

(f) Munguia and Brune, "Simulations of Strong Ground Motion for Earthquakes in the Mexicali-Imperial Valley" (Preprint) (March 1984);

(g) Eaton, "Focal Mechanisms of Near-Shore Earthquakes Between Santa Barbara and Monterey, California," Open-File Report 84-477, U.S. Department of the Interior Geological Survey (1984);

(h) Minster and Jordan, "Vector Constraints on Quaternary Deformation of the Western United States East and West of the San Andreas Fault" (Preprint) (1984);

(i) Stein and King, "Seismic Potential Revealed By Surface Folding: 1983 Coalinga, California, Earthquake," Science, v.224, at 869-871 (May 25, 1984).

This new information clearly indicates that, contrary to the regulatory requirements of Appendix A, the free field response spectrum for the Diablo Canyon SSE does not include "the maximum vibratory accelerations at the site throughout the frequency range of interest. . . ." Appendix A V(a)(1)(iv).

(a) The recordings obtained from the April 24, 1984 Morgan Hill, California earthquake establish that the horizontal accelerations significantly exceeded those predicted by the Board for the M 7.5 Diablo Canyon SSE. Although a number of important recordings were obtained, most notable was the peak acceleration of 1.29g at Coyote Lake, the highest horizontal accelerations yet recorded for any earthquake. This result, generated by only an M 6.1 earthquake, is flatly inconsistent with the Board's conclusion that .75g is the likely peak acceleration in the event of the M 7.5 Diablo Canyon SSE. According to Dr. Brune:

> The peak horizontal acceleration recorded at the Halls station (de-focused) was .31g; the peak horizontal acceleration at the Coyote Lake station (focused) was 1.3g, the highest horizontal accelerations yet recorded for any earthquake, even though the magnitude of the earthquake was only 6.1. This constitutes definitive evidence that horizontal ground accelerations in the direction of rupture propagation can be much higher than predicted by average or 84th percentile curves based on the small amount of data presently available for moderate earthquakes. This peak horizontal acceleration value of 1.3g is much higher than the 84th percentile horizontal acceleration predicted by the recent U.S. Dept. of the Interior's Geological Survey (USGS) curves of Joyner and Boore (1981) for a magnitude of 6.1 at a distance of 5 km. . . . Since a larger earthquake would have a larger average slip along the rupture

surface, the potential for even higher horizontal accelerations clearly exists.

* * *

Response spectra for the Coyote Lake recording (see Attachment III) are close to and exceed the Newmark design spectral for Diablo Canyon (shown in Rothman and Kuo, 1980, testimony before Appeal Board) in the period range .1 to 1 second. For larger earthquakes with larger average fault slip, the potential for considerably greater response spectra obviously exist. (Brune Affidavit, at 3-4.) (Emphasis added.)

Thus, the Morgan Hill earthquake has provided direct evidence that the Newmark Spectrum underestimates the forces expected to occur in the event of the Diablo Canyon SSE, and, thus, that the seismic design for the facility does not meet regulatory requirements.

(b) This new data confirms recent calculations of response spectra for the Victoria record of the M 6.4 Mexicali Valley, Baja California earthquake of June 9, 1980. These recent calculations, recently accepted for publication in the Geophysical Journal of the Royal Astronomical Society (1984), indicate that, once again, the peak recorded horizontal accelerations -- .85-.89g -- exceeded the Newmark spectrum, at a level comparable to the .82g Bond's Corner accelerations recorded during the 1979 Imperial Valley earthquake. Contrary to this Board's characterization of the Bond's Corner record as "distorted," ALAB-644, at 88, the MV80 Victoria record indicates that such high accelerations may in fact be "quite common":

Response spectra for the N40°W component published by Simons (Figure 5-5) exceed the Bonds Corner record for IV79 in the period

> range .1 to .2 seconds. As noted in testimony of Rothman and Kuo, submitted for the 1980 Appeal Board Hearings, the response spectra for the Bonds Corner record exceeded the design response spectra for Diablo Canyon. Response spectra for the N50°E component shown in Munguia (1983) and Munguia and Brune (1984) are comparable to those for the N40°W component. These response spectra indicate that for $M \sim 6$ - 6-1/2 earthquakes, response spectra exceeding the Newmark design spectra may be quite common. The probability of recording such high response spectra would obviously be higher for a M = 7.5 earthquake than for an M_S = 6.4 earthquake. (Brune Affidavit, at 13). (Emphasis added.)

Similarly, the peak vertical accelerations recorded at Victoria for MV80 far exceed those predicted by the Newmark Spectrum for Diablo Canyon, exceeding 1.0 g at several time points. According to Dr. Brune:

> This recording confirms that vertical accelerations over 1 g (also recorded in the Gazli, Russia earthquake of May 17, 1976, M_S = 7.2), are not unexpected for earthquakes of this magnitude range and would be even more probable for an $M_S \sim 7.5$ earthquake than for an M_S = 6.4 earthquake. The vertical response spectra for the Victoria MV80 record greatly exceed the vertical design response spectra for Diablo Canyon at periods near .1 seconds. (Brune Affidavit, at 14[3/])

Thus, together with the records obtained from the recent Morgan Hill earthquake and the Bond's Corner record from the IV-79 earthquake, these data clearly suggest that the Newmark Spectrum substantially underestimates the force of an M 7.5 event on the Hosgri Fault.

3/ The Victoria records for MV80 also undermine the simulation procedures proposed by Dr. Gerald Frazier and suggest that the model predictions for Diablo Canyon were considerably underestimated. *See* Brune Affidavit, at 14-16.

(c) The data obtained from the Morgan Hill earthquake also establish that the Board's characterization of focusing or high stress drop as "speculative" was erroneous. Indeed, the Morgan Hill data suggests clearly that focusing of seismic energy in the direction of rupture propagation was in part responsible for the large horizontal accelerations -- 1.29g -- at the Coyote Lake station. As stated in a recent USGS publication submitted for publication in <u>Science</u> (Bakun, <u>et al</u>.), the forces were highly focused in the direction of fault rupture:

> Unilateral rupture propagation toward the southeast, and an energetic late source of seismic radiation located near the southeast end of the rupture zone, contributed to the highly focused pattern of strong motion, including an exceptionally large horizontal acceleration of 1.29 g at a site on a dam abutment near the southeast end of the rupture zone.
>
> * * *
>
> Ground accelerations were generally larger south of the rupture zone than north (17). <u>These observations are consistent with pronounced focusing of seismic energy to the southeast of the rupture zone</u>. This observed directivity in the seismic radiation (18) is additional evidence for the predominantly unilateral southeast rupture expansion inferred from the aftershock distribution southeast of the epicenter of the main shock. (Brune Affidavit, at 5-6.) (Emphasis added.)[4/]

These results have direct implications for the Diablo Canyon proceeding, in which this Board rejected the testimony that such phenomena as "focusing" or high stress drop events could result

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4/ Peak horizontal ground velocities generated by the Morgan Hill earthquake a so indicated the effects of focusing. <u>See</u> Brune Affidavit, at 4.

in exceptionally high accelerations at the site in the event of the SSE. According to Dr. Brune:

> I believe the evidence from the Morgan Hill earthquake and the quotes from the Bakun et al. paper, indicate that high accelerations resulting from rupture focusing (directivity) and high stress drop events should not be classified as "speculative." Although they have a lower probability of occurrence than values predicted by 84th percentile regression curves, they should be taken into account in design of sensitive structures. Both of these physical effects have been observed in other earthquakes and neither can be excluded from being possible on faults near Diablo Canyon, and thus there is no way to preclude the possibility of such high accelerations, and indeed considerably higher accelerations, occurring at the Diablo Canyon site. It should be noted that although there is no strict one-to-one correspondence of earthquake ground acceleration, focusing, and high stress drop with earthquake magnitude, there is nevertheless a higher probability for such phenomena as earthquake magnitude increases, and thus the probability that such phenomena might be associated with the M = 7.5 design earthquake for Diablo Canyon is considerably greater than for an M = 6.1 earthquake. (Brune Affidavit, at 6.) (Emphasis added.)

Such evidence contrasts sharply with the Board's prior dismissal of the phenomenon virtually out of hand. The possibility of focusing, demonstrated at Morgan Hill, further undermines this Board's approval of the Newmark Spectrum at Diablo Canyon.

(d) The Board's assumption about the nature of the Hosgri Fault has been discredited as well by recent studies and the June 20, 1984 Pt. Sal earthquake, all of which provide evidence of thrust faulting in the vicinity of the Hosgri Fault. Recognizing that thrust faults may result in higher ground accelerations than strike-slip faults, this Board found that the Hosgri Fault is expected to exhibit a strike-slip motion and, consequently, would be unlikely to generate forces higher than those recorded at Pacoima Dam, caused by thrust faulting. ALAB-644, at 74, 88.

Three independent studies utilizing differing techniques have now concluded, however, that the region of the Hosgri Fault is characterized by a major component of thrust faulting. In a study done for Nekton, Inc., based on seismic reflection data, Crouch et al. suggest that, rather than a strike-slip fault, the Hosgri Fault may be characterized by thrust and may dip landward with a relatively shallow dip under the plant itself. Thus, the Hosgri Fault may be far closer to the Diablo Canyon site and, consequently, the plant may be subject to greater forces than predicted by the Board in ALAB-644. According to Dr. Brune:

> Evidence for thrust faulting on the Hosgri Fault is presented in a recent paper by Crouch et al. (1984) who suggested that the Hosgri fault may dip landward with a relatively shallow dip (Attachment V). Such a landward dip would place the Diablo Canyon site closer to the Hosgri Fault, and thus closer to the source of radiation of seismic energy. This could considerably increase expected peak accelerations.
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> * * *
>
> Although the exact dip of the Hosgri fault under Diablo Canyon has not been determined, based on the Crouch et al. paper, it is possible that the fault could be less than 3 km beneath the Diablo Canyon site. Furthermore, since the fault presumably could extend, dipping, many kilometers further to the east, a rupture could

> initiate at depth tens of kilometers to the east of the site and propagate up-dip, focusing energy toward the site and causing much higher accelerations than previously anticipated. (Brune Affidavit, at 7-12.)[5/]

Similar evidence regarding thrust faulting near Diablo Canyon has been presented recently by the USGS in Open File Report 84-477 and by Minster and Jordan in a paper published simultaneously with the Crouch paper discussed above. (Brune Affidavit, at 18.) This consensus is important for Diablo Canyon because the potential size of the earthquake forces may be significantly increased. As recognized by Stein and King in a paper recently published in Science (1984):

5/ This new evidence of thrust faulting and proximity to the Diablo Canyon site, when considered with the direct evidence of focusing or high stress drop from the Morgan Hill earthquake, cannot be reconciled with the following findings by this Board in ALAB-644:

> Our review of the record on this question leads us to conclude that focusing of earthquake motion due to a rupture on the Hostri Fault does not present a credible likelihood of exceeding the Diablo Canyon seismic design spectrum. We are guided to this result primarily by the fact that the focused motion must travel some 20 km to reach the site and that the damaging higher frequencies of this motion will be preferentially attenuated in travelling this distance. (ALAB-644, at 82.) (Footnote omitted.)
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> * * *
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> As with his focusing testimony, we believe the Board did not err in disregarding Dr. Brune's position on stress drop as speculative. Knowledgeable witnesses testified that there are no indications of high stress drop regions on the Hosgri Facult, emphasizing (among other things) that were it to rupture, the fault is expected to exhibit a strike slip-dip slip motion rather than a thrust motion, the latter being the accepted cause of the highest stress drop values. (Id. at 88.) (Footnote omitted.)

> [B]ecause the peak ground motion associated with thrust earthquakes appears to be two to three times higher than observed for normal slip events of the same size (3), active folds should be recorded as sites of critical earthquake risk. (Brune Affidavit, at 19.)

Finally, the likelihood of thrust faulting has implications also for the "tau effect" relied upon by the Appeal Board in ALAB-644 to reduce the foundation acceleration at Diablo Canyon. ALAB-644, at 114 et seq. According to Dr. Brune, "[a] high stress drop event directly beneath the site could lead to a relatively uniform wave front of energy arriving verticially beneath the plant, thus minimizing any reduction in foundation acceleration due to the [tau] effect." (Brune Affidavit, at 11-12.) (Emphasis added.)

(e) In light of this evidence of thrust faulting in the vicinity of the Hosgri Fault, a recent study of the seismic potential of surface folding relating to the 1983 Coalinga earthquake bears on the extent of the seismic hazard at Diablo Canyon. Analysis of three large earthquakes during the past 20 years -- Coalinga (1983 - M 6.5); El Asnam, Algeria (1980 - M 7.3); and Niigata, Japan (1964 - M 7.5) -- indicates that they each occurred on thrust faults concealed beneath active folds. Consequently, as Dr. Brune states, the new evidence that the Hosgri Fault may also be a concealed thrust fault is especially important:

> This new evidence for the existence of concealed thrust faults capable of generating earthquakes of at least M = 7.5 has an important bearing on the seismic hazard evaluation of the Diablo Canyon site.

> Because of the recent evidence of thrust faulting in this region given by Crouch et al. (1983), the hidden subsurface slip on these faults may be much greater than that directly manifested at the surface. There is no known reason why concealed thrust faulting of the type observed for the Coalinga earthquake could not occur near the Diablo Canyon site. Because of this, without detailed study, it is not possible to eliminate the possibility of a concealed thrust fault even closer to the Diablo Canyon than suggested by Crouch et al. The folds and minor faults indicated in the Preliminary Geologic Map offshore from the San Luis Range, South-Central California by H.C. Wagner (Plate 2, USGS Open-File Reprt 74-252) could be indications of concealed thrust faults with surface projections as close as 2-3 km offshore from the Diablo Canyon site, and dipping under the plant to even closer distances. (Brune Affidavit, at 19-20.) (Emphasis added.)

Thus, the 1983 Coalinga earthquake, occurring on a reverse fault concealed beneath active folds, provides a recent illustration of the possibility that further major faulting may lie concealed directly under or adjacent to the Diablo Canyon site.

(f) The Appeal Board's finding that Diablo Canyon is sited in an area of "low to moderate seismicity" has proven erroneous in light of the number of significant earthquakes that have occurred since 1978 along the coast of California in the tectonic province near the Hosgri Fault. Based upon the recently issued Open File Report 84-477 that describes six such earthquakes, Dr. Brune concludes:

> The magnitude and numbers of events by themselves dramatically testify that the coastal region including the Hosgri fault is one of high seismicity: four of the earthquakes had magnitudes greater than 5.0 and all have occurred since 1978, a period of less than 10 years. The two events on

> either side of the Diablo Canyon site both had magnitudes greater than 5 and occurred since 1980, the most recent in 1983. (Brune Affidavit, at 16-17.)

Still more recently, on June 20, 1984, another earthquake occurred on the Hosgri line, estimated at M 4.7:

> Recently another earthquake (not listed in the Eaton publication) has occurred with epicenter near that for the 1980 Pt. Sal Earthquake. This most recent event occurred on June 20, 1983 and preliminary parameters are M 4.7, Latitude 34° 57.92'N, Longitude 120° 44.25'W, and depth 9.4 km (J.P. Eaton, personal communication). The preliminary fault plane solution indicates predominantly thrust faulting, but with a somewhat larger component of strike-slip motion than the 1980 Point Sal earthquake. The epicenter is only a few kilometers from the 1980 earthquake and emphasizes the continuing high activity in the region of the Hosgri fault. (*Id.*)[6/]

According to Dr. Brune, given this recent evidence of high seismicity, an earthquake as large as the Diablo Canyon SSE must be expected:

> With this continuing level of activity in the magnitude 4-1/2 to 5-1/2 range, it would be no surprise to have an earthquake of much larger size, as large as the Diablo Canyon design earthquake (M = 7.5) at any time. *Efforts to describe the region as one of very low probability for such earthquakes fly in the face of the direct evidence of recent high seismicity*. (Brune Affidavit, at 16-17.) (Emphasis added.)

This consistent pattern of major seismic activity in the region of the Hosgri Fault belies this Board's characterization of the region as one of "low to moderate seismicity," ALAB-644, at

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6/ *See also* attached newspaper report of the June 20, 1984 earthquake.

174-75, and, with it, any assumption that the Diablo Canyon SSE occurring on the Hosgri Fault is not truly credible. To the contrary, according to Dr. Brune, these recent events indicate that such an earthquake could occur "at any time."

The significance of this new information -- direct empirical evidence contrary to critical elements of this Board's decision in ALAB-644 -- is manifest. It establishes that forces significantly greater than those assumed to be the maximum for the Diablo Canyon SSE can be expected, even for earthquakes of far less magnitude than M 7.5, perhaps as a result of focusing or other similar phenomena. It establishes also that because the Hosgri Fault now appears to dip under the plant itself, the consequences of an earthquake on the fault may be more severe than anticipated, as a result of thrust, rather than strike-slip faulting. And it establishes that the area in which the plant is sited is characterized by consistent seismic activity, thereby heightening the probability that the Diablo Canyon SSE can and will occur. Such evidence raises grave doubt about the validity of the Appeal Board's approval of the seismic design of Diablo Canyon, and, absent significant evidence to the contrary, it clearly mandates a changed result. Accordingly, this motion to reopen the record should be granted.

II. THIS MOTION IS TIMELY.

This motion to reopen the record has been timely filed. Dr. Brune's affidavit, upon which the motion is based, was prepared on July 10, 1984. The principal seismic events giving rise to the motion occurred only recently -- the Morgan Hill earthquake on April 24, 1984; the Pt. Sal earthquake on the Hosgri Fault on June 20, 1984 -- and the data and numerous studies relied upon by Dr. Brune have become available, with just one minor exception, only within the past several months. See list of studies, supra note 2. Thus, this is plainly an instance in which the motion and the safety significant and material information on which it is based have been promptly submitted to the Board. Unquestionably, therefore, this motion is timely.

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III. CONCLUSION

For the reasons set forth above and in the attached affidavit and exhibits, the Joint Intervenors request the Appeal Board to reopen the record in order to receive new information material to the resolution of the critical seismic issues in this proceeding.

Dated: July 16, 1984

Respectfully submitted,

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STATE OF CALIFORNIA

ss.

COUNTY OF SAN DIEGO

JAMES N. BRUNE, being of legal age and duly affirmed, deposes and says as follows:

1. I am Professor of Geophysics at the University of California at San Diego. My educational background includes a Bachelor of Science degree in Geological Engineering from the University of Nevada and a Ph.D. in Seismology from Columbia University. I have carried out a number of studies relating to earthquake source mechanism and strong motion in recent years. I and my students have been developing methods for using existing strong motion records to estimate strong motion for larger earthquakes: M = 6-1/2 to 7-1/2. My studies are being funded by grants from the National Science Foundation. Hence, I am very familiar with current and previous investigations of earthquake source mechanisms

and strong motion data. My qualifications, experience, and a list of publications are described in detail in Attachment I.

2. The purpose of my affidavit is to describe recently obtained earthquake strong motion data and geologic data which are important to the consideration of the seismic safety of the Diablo Canyon Nuclear Plant. This new data illustrate physical phenomena which in the past have been considered speculative by some persons and thus dismissed as of little importance in siting of nuclear power plants. I believe the new data must be thoroughly assessed before firm conclusions can be drawn concerning the probable ground motion to be expected near earthquakes of the magnitude of the design earthquake for Diablo Canyon.

3. (a) The acceleration, velocity, displacement and response spectra records for the closer stations recording the Morgan Hill, California earthquake of April 24, 1984 (M = 6.1) have recently been released by the California State Department of Conservation's Division of Mines and Geology (CDMG). The original accelerograms are published in CDMG OSMS 84-7 (Attachment II). The instrument-corrected, band-passed acceleration velocity and displacement records, along with compiled response spectra, have also been released by CDMG (Attachment III). The peak accelerations are recorded in Table III of OSMS 84-7 (Attachment II) along with epicentral distances and distances to the nearest point on the fault inferred from the aftershock distribution. The most remarkable record is the record from the Coyote Lake Dam instrument which recorded a peak acceleration of 1.29 g (1.304 g in more recent measurement of Attachment III) at an inferred fault distance of "5?" km.

(b) A number of recordings were obtained which have an important bearing on the peak horizontal accelerations which might occur at the Diablo Canyon Nuclear Power Plant. There are recording sites very near the fault trace. One site is located such that the main rupture along the fault was away from the station (Halls Valley), i.e. the energy was de-focused by rupture propagation, and another was located such that the main rupture proceeded towards it, i.e. the energy was focused by rupture propagation (Coyote Lake). The peak horizontal acceleration recorded at the Halls station (de-focused) was .31 g; the peak horizontal acceleration at the Coyote Lake station (focused) was 1.3 g, the highest horizontal accelerations yet recorded for any earthquake, even though the magnitude of the earthquake was only 6.1. This constitutes definitive evidence that horizontal ground accelerations in the direction of rupture propagation can be much higher than predicted by average or 84th percentile curves based on the small amount of data presently available for moderate earthquakes. This peak horizontal acceleration value of 1.3 g is much higher than the 84th percentile horizontal acceleration predicted by the recent U.S. Dept. of the Interior's Geological Survey (USGS) curves of Joyner and Boore (1981) for a magnitude of 6.1 at a distance of 5 km. (Regression curves for ground acceleration and velocity, and response spectra, do not show a strong dependence of distance between 0 and 5 km, and thus there is no reason to expect at the present time that the high values recorded near the fault for this earthquake could not occur at distances of 5 km.) Since a larger earthquake would have larger average slip along the rupture surface, the potential for even higher horizontal accelerations clearly exists.

The exact rupture mechanism for the Morgan Hill earthquake will not be established for some months, as detailed modeling of the strong motion records is carried out. Thus, although it is clear that focusing by rupture propagation played an important role in the asymmetric radiation of high frequency energy from the earthquake, it is also possible that other factors as yet not understood, also played a significant role.

Of particular importance is the possibility that a relatively concentrated high stress drop rupture occurred near the southern end of the rupture zone, resulting in energetic radiation of high frequency seismic energy, and thus contributing to the high acceleration value of 1.3 g recorded at the Coyote Lake station. At the present time, it has not been precisely established to what extent the high acceleration value is a result of focusing by rupture propagation, higher stress drop, or other as yet unknown factors.

(c) Peak horizontal ground velocities at the Halls Valley and Coyote Lake stations (see Attachment III) are 39.6 cm/sec and 79.7 cm/sec respectively, also indicating the effects of focusing by rupture propagation and/or high stress drop. For larger earthquakes with larger average fault slip, the potential for even larger peak ground velocities obviously exists.

(d) Response spectra for the Coyote Lake recording (see Attachment III) are close to and exceed the Newmark design spectral for Diablo Canyon (shown in Rothman and Kuo, 1980, testimony before Appeal Board) in the period range .1 to 1 second. For larger earthquakes with larger average fault slip, the potential for considerably greater response spectra obviously exists.

4. A recent paper submitted by the USGS for publication in Science Magazine, gives a preliminary interpretation of the data from the Morgan Hll earthquake: "The 1984 Morgan Hill, California, earthquake: A preliminary report," by W.H. Bakun et al. (Attachment IV). The abstract of this paper states:

> "Unilateral rupture propagation toward the southeast, and an energetic late source of seismic radiation located near the southeast end of the rupture zone, contributed to the highly focused pattern of strong motion, including an exceptionally large horizontal acceleration of 1.29 g at a site on a dam abutment near the southeast end of the rupture zone."

Details of the earthquake, its magnitude (6.1), epicenter, aftershock distribution, minimum rupture length, geodetic displacements, etc. are described in the main body of the text. The text notes that:

> "Not only was severe damage limited to the vicinity of the Morgan Hill, but the largest horizontal accelerations were recorded near there as well (Figure 3)."

The town of Morgan Hill is located about 5-7 km from the fault trace. The report goes on to note that:

> "Ground accelerations were generally larger south of the rupture zone than north (17). These observations are consistent with pronounced focusing of seismic energy to the southeast of the rupture zone. This observed directivity in the seismic radiation (18) is additional evidence for the predominantly unilateral southeast rupture expansion inferred from the aftershock distribution southeast of the epicenter of the main

shock."

The Bakun et al. report also notes evidence for

"an energetic source of seismic radiation (Figure 3) near the southeast end of the rupture zone, [suggesting that] fault complexities mark the places where stress might be concentrated [and] the nature of the complexity might be used to identify those places on the fault zone, like the southeast end of Anderson Reservoir that are likely to generate energetic strong ground motion."

I believe the evidence from the Morgan Hill earthquake and the quotes from the Bakun et al. paper, indicate that high accelerations resulting from rupture focusing (directivity) and high stress drop events should not be classified as "speculative," although they have a lower probability of occurrence than values predicted by 84th percentile regression curves, they should be taken into account in design of sensitive structures. Both of these physical effects have been observed in other earthquakes and neither can be excluded from being possible on faults near Diablo Canyon, and thus there is no way to preclude the possibility of such high accelerations, and indeed considerably higher accelerations, occurring at the Diablo Canyon site. It should be noted that although there is no strict one-to-one correspondence of earthquake ground acceleration, focusing, and high stress drop with earthquake magnitude, there is nevertheless a higher probability for such phenonoma as earthquake magnitude increases, and thus the probability that such phenomena might be associated with the M = 7.5 design earthquake for Diablo Canyon is considerably greater than for an M = 6.1 earthquake.

We must be wary of discounting important factors such as rupture focusing and high stress drop on the basis of one earthquake which does not exhibit these effects, as for example the Imperial Valley, California 1979 earthquake (IV79), which did not exhibit clear effects of focusing (although it may have exhibited the effect of a concentrated high stress drop in the high accelerations recorded at the Bonds Corner station). We simply do not have enough of a data base to discount these obvious physical mechanisms.

5. Evidence for thrust faulting on the Hosgri fault is presented in a recent paper by Crouch et al. (1984) who suggested that the Hosgri fault may dip landward with a relatively shallow dip (Attachment V). Such a landward dip would place the Diablo Canyon site closer to the Hosgri fault, and thus closer to the source of radiation of seismic energy. This could considerably increase expected peak accelerations. It should be noted that this geometrical change is more effective in increasing expected accelerations than moving the site closer to the surface trace of a vertical fault since, in the latter case, the site is not much closer to the source of energy release, which may be at several kilometers depth. Thus the fact that regression curves generally do not indicate strongly increasing accelerations with decreasing distance, from 5 to 1 km, should not be taken to indicate that a thrust fault dipping under a site would not be expected to generate higher accelerations, because in the latter case the source of energy release is considerably closer to the site. This point is immediately obvious if a dipping fault is plotted on the diagram of pp. 41-42. of the Appeal Board decision (Figure 1). Although the exact dip of the Hosgri fault under Diablo Canyon has not been determined, based on the Crouch et al.

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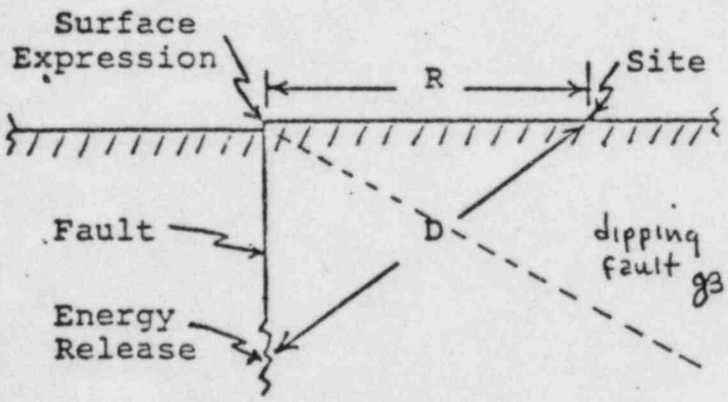
Tr. 8637. This simply reflects the geometry of the situation. If, for a vertical fault, energy is released at 10km below the earth's surface, the total distance (D) of a point on the earth's surface to the energy release is related to the distance (R) to the surface expression of the fault in the following way:

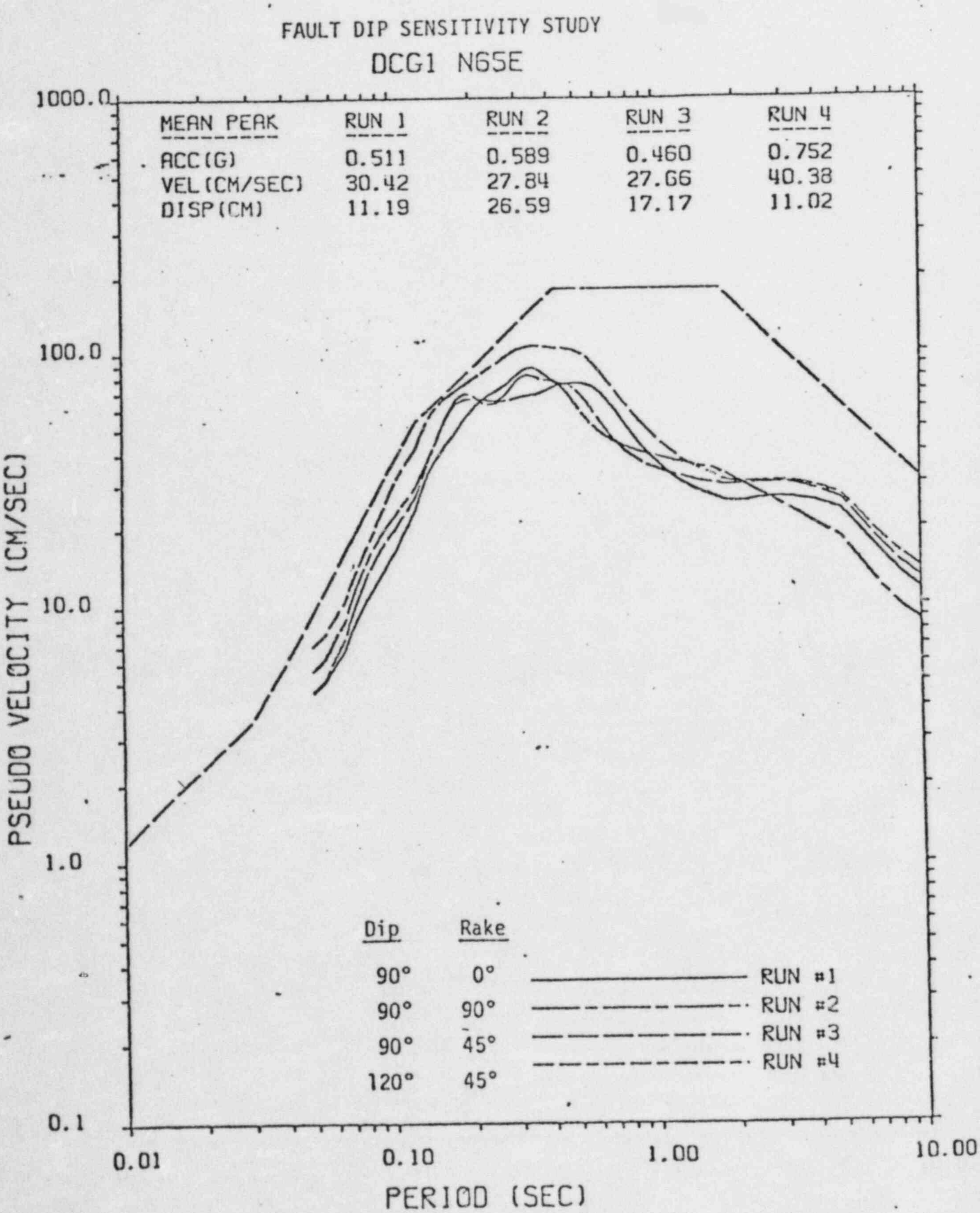
R	D
0	10km
3	10.4
7	12
10	14
15	18
30	31
100	101



Within R = 0 to 10, there is only a modest change in D; For R greater than 10, R and D become nearly the same. For a very short rupture (i.e., the length of rupture much less than R or D), the values R and D represent the epicentral and hypocentral distances, respectively.

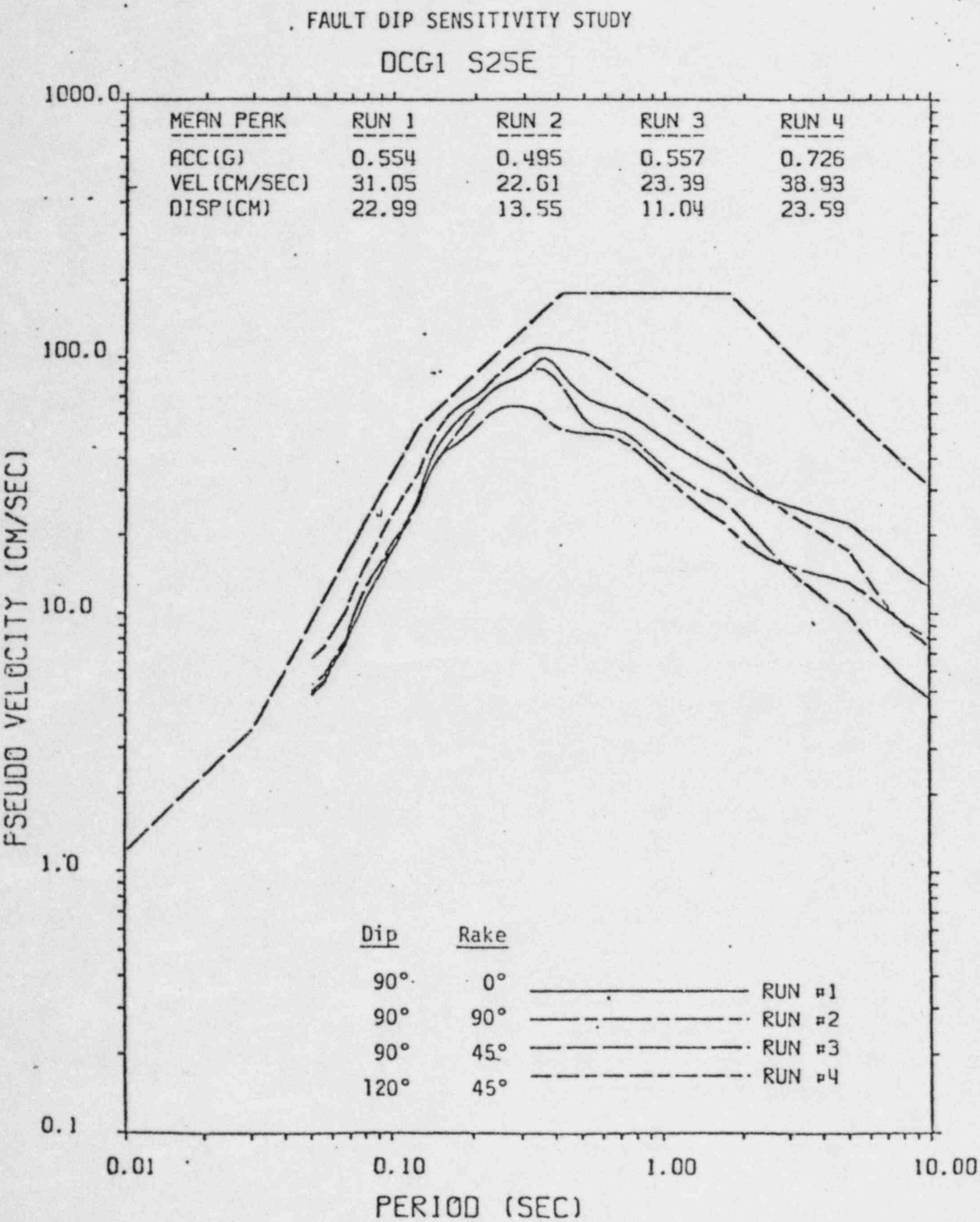
FIGURE 1 - from footnote #66 of June 16, 1984 decision of Atomic Safety and Licensing Appeal Board in the matter of Pacific Gas & Electric Company (Diablo Canyon Nuclear Power Plant, Units 1 & 2), pp. 41-42.

FIGURE 2b - from Governor Brown's exhibit R-10



Gov. Brown Ex. R-10

FIGURE 2a - from Governor Brown's Exhibit R-10



paper, it is possible that the fault could be less than 3 km beneath the Diablo Canyon site. Furthermore since the fault presumably could extend, dipping, many kilometers further to the east, a rupture could initiate at depth tens of kilometers to the east of the site and propagate up-dip, focusing energy toward the site and causing much higher accelerations than previously anticipated.

Evidence that thrust faults may result in higher ground accelerations has been noted at some length in the Appeal Board decision (pp. 74,88). Evidence presented in the Appeal Board hearings in testimony by Dr. Gerald Frazier (see Figure 2 from Gov. Brown's Exhibit R-10) indicated that for a dip of 60° to the east on the Hosgri fault, the peak accelerations could be considerably increased over those expected for a 90° dipping fault. Since the actual dip on the Hosgri could be considerably shallower than 60°, perhaps even 30°, the predicted acceleration could be even greater. Although the absolute values of acceleration predicted by the Frazier modeling has been discounted as unreliable by the staff and Appeal Board, the modeling could nevertheless be useful in predicting _relative_ values due to geometrical effects such as those due to distance from the source of energy release in question here. The Frazier modeling did not consider the case of _up-dip_ rupture along a _thrust_ fault with consequent focusing as postulated above, a situation which would be expected to cause considerably higher accelerations.

The possibility of a source of thrust faulting directly beneath the Diablo Canyon site also has implications concerning the τ effect considered in the Appeal Board hearings. A high stress drop event directly beneath the site could lead to a relatively uniform wave front of energy arriving vertically beneath the plant, thus minimizing any reduction in foundation acceleration due to the τ effect.

6(a) Recent calculations of acceleration, velocity, and response spectra have been published for the Victoria record of the Mexicali Valley, Baja California, earthquake of 9 June 1980 (MV80; Anderson and Simons, editors, 1982, Attachment VI). Sections of the publication describe various parameters, geologic effects and damage for this earthquake, which had a local magnitude, M_L, of 6.1 and a surface wave magnitude, M_S, of 6.4. Of particular interest to the seismic hazard at Diablo Canyon is the Victoria record, described in section 5 by Richard Simons. His discussion considers only the vertical and N40°W components. Results for the other horizontal component, N50°E, have been published in the Ph.D thesis of Luis Munguia (1983) and in a recent paper accepted for publication in the Geophysical Journal of the Royal Astronomical Society (1984): "Simulations of Strong Ground Motion for Earthquakes in the Mexicali-Imperial Valley" by Luis Munguia and James Brune (Attachment VII). Although it is possible that special conditions as yet unknown may have affected the Victoria recordings (e.g. special soil conditions or soil-foundation interaction effects), there is at the present time no reason to believe this recording site is atypical of other Imperial Valley - Mexicali sites. The Victoria station was located within a few kilometers of the trace of the Cerro Prieto fault, and it is believed that the rupture passed by the station. The geology and tectonics of the Cerro Prieto fault are very similar to those for the Imperial fault, site of the Imperial Valley 1979 earthquake, which was the earthquake of main concern in the Appeal Board Hearings of 1980. The Victoria record had some data dropouts in it, as described by

Simons, and the process of recovery has been somewhat tedious and thus results have been delayed. Some sections of the record were not recorded, so that it is possible that ground accelerations in the missing sections were even larger than recorded maximum values.

(b) Peak recorded horizontal accelerations on the Victoria record for MV80 were .85-.89 g for the N 40°W component and .98 g for the N 50°E component, both larger than any horizontal accelerations recorded for the IV79 earthquake, but comparable to the peak accelerations recorded on the Bonds Corner recorded for IV79 (.82 g). Peak horizontal accelerations of over .7 g occur over a time span of several seconds on the horizontal records.

(c) Response spectra for the N40°W component published by Simons (Figure 5-5) exceed the Bonds Corner record for IV79 in the period range .1 to .2 seconds. As noted in testimony of Rothman and Kuo, submitted for the 1980 Appeal Board Hearings, the response spectra for the Bonds Corner record exceeded the design response spectra for Diablo Canyon. Response spectra for the N50°E component shown in Munguia (1983) and Munguia and Brune (1984) are comparable to those for the N40°W component. These response spectra indicate that for $M \sim 6 - 6\text{-}1/2$ earthquakes, response spectra exceeding the Newmark design spectra may be quite common. The probability of recording such high response spectra would obviously be higher for a $M = 7.5$ earthquake than for an $M_S = 6.4$ earthquake.

(d) Peak vertical accelerations recorded at Victoria (Simons, Fig. 5.1) for MV80 exceed 1 g at several time points on the records over a time period of about two seconds. The maximum peak cannot be determined with certainty since the instrument had a full scale of ±1 g and accelerations over 1 g "clipped." Thus the true peak vertical acceleration was an unknown amount over 1 g. (Interpolation by cubic splines gives a highest peak of 1.27 g, and a second-highest peak of 1.13 g; from John Anderson;, personal communication.) This recording confirms that vertical accelerations over 1 g (also recorded in the Gazli, Russia earthquake of May 17, 1976, M_S = 7.2, are not unexpected for earthquakes of this magnitude range) and would be even more probable for an M_S = 7.5 earthquake than for an M_S = 6.4 earthquake. The vertical response spectra for the Victoria MV80 record greatly exceed the vertical design response spectra for Diablo Canyon at periods near .1 seconds.

(e) The Victoria records for MV80 throw into question the earthquake simulation procedures presented in the testimony of Gerald Frazier, since peak accelerations and response spectra for the Victoria records greatly exceed the predictions of that simulation technique for the Imperial Valley, a region with structure very similar to that for the Mexicali Valley (See TERADELTA supplement III, submitted by Dr. Gerald Frazier in hearings related to the San Onofre Nuclear Generating Station). Figure 3 (Fig. 5-28 from supplement III of the Tera Delta simulation studies) shows that the Bonds Corner record for IV79 greatly exceeds the Model Mean for the "refined earthquake model." The Victoria MV80 response spectra, as noted above, is even higher than the Bonds Corner Response spectra. Since Diablo Canyon site specific results were in some cases quite close to the Newmark design response spectra (See Figure Frazier VII-5, horizontal component N65^{o}E), increasing these site specific results by the amount with which the MV80

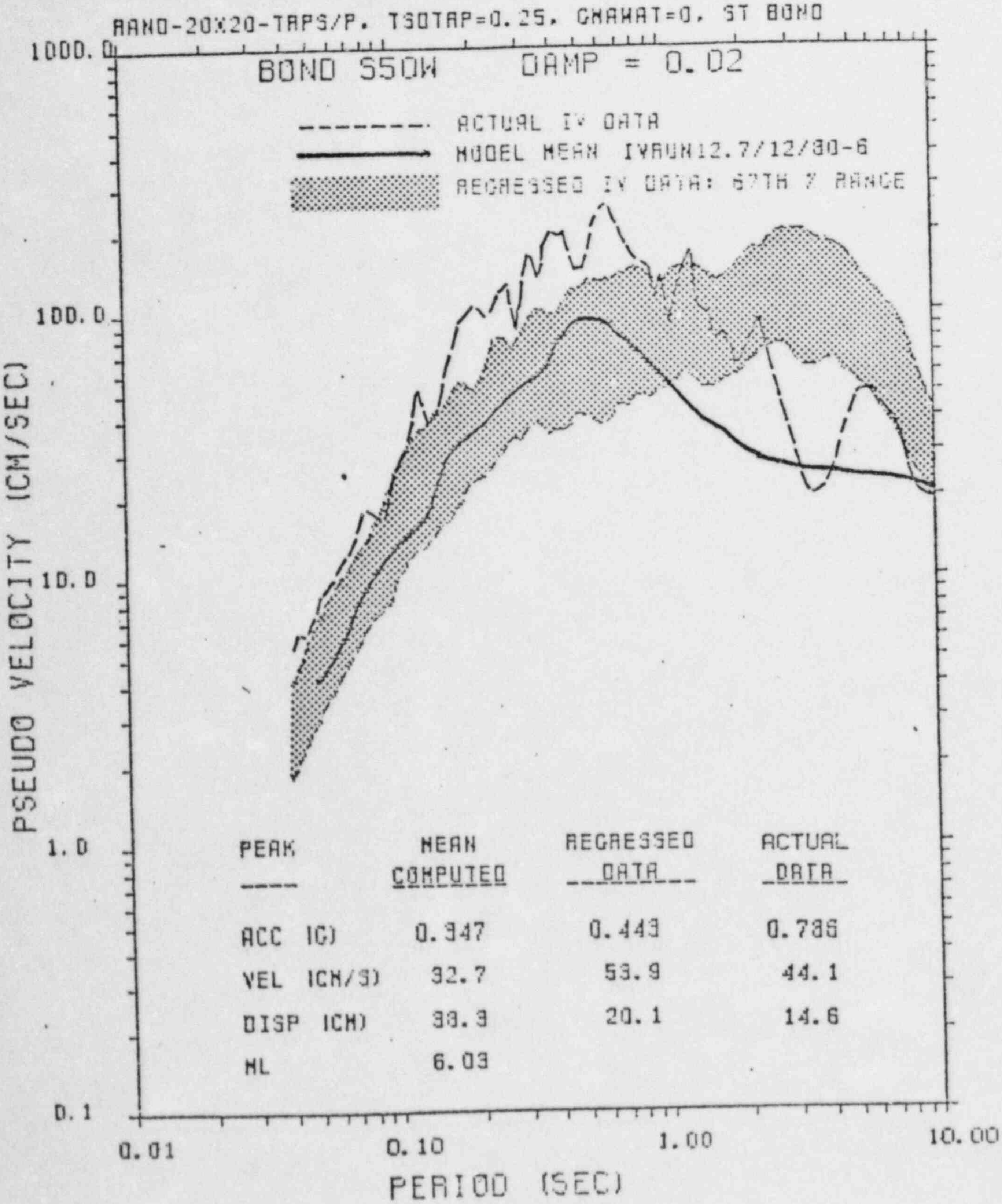


Figure 5-28. Computed results using refined earthquake model compared with Imperial Valley station data as well as regressed data for the horizontal S50W component at station Bond's Corner.

response spectra exceeded the validation predictions would cause the Newmark spectra to be considerably exceeded. The discrepancy would be further increased if some increase in response spectra were taken into account in going from M_S = 6.4 (MV80) to M_S = 7.5.

Although the appeal board did not give much weight to Frazier modeling results, I believe that these results, if properly scaled to explain the MV80 response spectra, provide further evidence that the Newmark design spectra could be exceeded by an M = 7.5 earthquake on the Hosgri fault.

7(a) A recent Open File Report from the USGS: "Focal Mechanisms of Near Shore Earthquakes Between Santa Barbara and Monterrey, California" by J.B. Eaton (USGS Open-File Report 84-477, Attachment VIII), describes the focal mechanisms of several recent earthquakes of importance to understanding the seismic hazard to Diablo Canyon. This report gives locations, fault plane solutions and magnitudes for six recent earthquakes along the coast of California in the tectonic province near the Hosgri fault.

(b) The magnitude and numbers of events by themselves dramatically testify that the coastal region including the Hosgri fault is one of high seismicity: four of the earthquakes had magnitudes greater than 5.0 and all have occurred since 1978, a period of less than 10 years. The two events on either side of the Diablo Canyon site both had magnitudes greater than 5 and occurred since 1980, the most recent in 1983. Recently another earthquake (not listed in the Eaton publication) has occurred with epicenter near that for the 1980 Pt. Sal Earthquake. This most recent event occurred on June 20, 1984 and preliminary parameters are M ~ 4.7, Latitude 34° 57.92'N, Longitude 120° 44.25'W, and depth 9.4 km (J.P. Eaton, personal communication). The preliminary fault plane solution indicates predominantly thrust faulting, but with a somewhat larger component of strike-slip motion than the 1980 Point Sal earthquake. The epicenter is only a few kilometers from the 1980 earthquake and emphasizes the continuing high activity in the region of the Hosgri fault. With this continuing level of activity in the magnitude 4-1/2 to 5-1/2 range, it would be no surprise to have an earthquake of much larger size, as large as the Diablo Canyon design earthquake (M = 7.5), at any time. Efforts to describe the region as one of very low probability for such earthquakes fly in the face of the direct evidence of recent high seismicity.

(c) J.P. Eaton points out that

> "the earthquakes reported here show a steady change in character in accordance with the location of the earthquakes... For the choices of fault plane indicated above, the corresponding progression in style of faulting is from left lateral reverse oblique, through simple reverse, to right lateral strike slip."

The pattern of fault plane solutions reported in the Eaton paper outlines a coherent tectonic pattern in the region of the Hosgri fault, and indicates that a right lateral reverse fault with a significant amount of thrust motion can be expected in the region of the Diablo Canyon site.

(d) The pattern of fault plane solutions reported by Eaton is consistent with two recent publications in Crouch, J.K., and Bachman, S.B., eds. (1984) "Tectonic and Sedimentation along the California Margin", Pacific Section Society of Economic Paleontologists and Mineralogists. The first paper "Post-Miocene Cenozoic Tectonics along the Central California Margin, by James Crouch, Steven Bachuran and John Shay (Attachment V) is discussed in section 5 above. This paper documents evidence for a thrust component of fault motion in this region, as well as a strike-slip component. This geologic evidence is consistent with the fault plane studies of Eaton.

The second paper "Vector Constraints on Quaternary Deformation of the Western United States East and West of the San Andreas fault," by J. Bernard Minster and Thomas H. Jordan (Attachment IX) indicates, given reasonable constraints, that [from the abstract]

> "we show that deformation west of the San Andreas must involve 4 - 13 mm/year of crustal shortening orthogonal to this fault and 6 - 25 mm/year of right lateral motion parallel to it... If all strike slip motion is taken up on the San Gregorio-Hosgri fault system, then the rate of strike slip projected into the N20^{o}W trend of the San Gregorio fault trace must be no less than 8 mm/yr and no more than 27 mm/yr. Motion orthogonal to the San Gregorio is not resolvably different from zero but is constrained by geological and seismic data to be compressive; our analysis implies it can be no larger than 7 mm/yr."

Thus three independent investigations using very different techniques are all consistent with a tectonic model in which the region of the Hosgri fault is in transition from a major component of thrust faulting to the south to predominantly strike-slip faulting to the north. The high seismicity, along with the plate motion studies indicate continuing tectonic deformation.

(8) A recent paper published in Science (1984): "Seismic Potential Revealed by Surface Folding: 1983 Coalinga California Earthquake" by Ross S. Stein and Geoffrey C.P. King (Attachment X) has pointed out the difficulty of recognizing active subsurface thrust faults when easily deformable surface sediments are present. In the abstract they say "Three larger earthquakes (up to magnitude 7.5) during the past 20 years are also shown to have struck on reverse fault concealed beneath active folds." The report suggests that "because the peak ground motion associated with thrust earthquakes appears to be two to three times higher than observed for normal slip events of the same size (3), active folds should be regarded as sites of critical earthquake risk". They also state that "the 1400-year-long historical record of earthquakes in Japan is equally well correlated with actual faults and active folds (24)." The 1964 Niigata, Japan earthquake, M = 7.5, was associated with an offshore zone of folds and short faults (indicated in their Fig. 3).

This new evidence for the existence of concealed thrust faults capable of generating earthquakes of at least M = 7.5 has an important bearing on the seismic hazard evaluation of the Diablo Canyon site. Because of the recent evidence of thrust faulting in this region given by Crouch et al. (1983), the hidden subsurface slip on these faults may be much greater than that directly manifested at the surface. There is no known reason why concealed thrust faulting of the type observed for the Coalinga earthquake could not occur near the Diablo Canyon site. Because of this, without detailed study, it is not possible to eliminate the possibility of a concealed thrust fault even closer to the Diablo Canyon than suggested by Crouch et al. The folds and minor faults indicated in the Preliminary Geologic Map Offshore from the San Luis Range, South-Central California by H.C. Wagner (Plate 2, USGS Open-File Report 74-252) could be indications of concealed thrust faults with surface projections as close as 2-3 km offshore from the Diablo Canyon site, and dipping under the plant to even closer distances.

9. All of the matters herein are known to me of my personal knowledge or of my personal opinion based on my education and experience. If called as a witness, I am competent and would testify thereto.

James N Brune

James Neil Brune

Subscribed and affirmed to before me

this 10th day of July, 1984

____

My commission expires: ____________________.

State of California)
County of San Diego) ss.

On July 10, 1984, before me the undersigned, a Notary Public for the State of California, personally appeared James N. Brune, proved to me on the basis of satisfactory evidence to be the person whose name is subscribed to the within instrument, and acknowledged that he executed it.

OFFICIAL SEAL
PATSY C. PARSONS
NOTARY PUBLIC - CALIFORNIA
PRINCIPAL OFFICE IN
SAN DIEGO COUNTY
My Commission Expires January 2, 1987

Patsy C. Parsons

Notary Public

Available in DSB

LIST OF ATTACHMENTS AND REFERENCES FOR JAMES NEIL BRUNE AFFIDAVIT OF JULY 9, 1984

ATTACHMENTS

ATTACHMENT I - Publications list and biography of J.N. Brune.

ATTACHMENT II - A.F. Shakal, R.W. Sherburn, and D.L. Parke (1984). CDMG strong-motion records from the Morgan Hill, California earthquake of 24 April 1984, Report OSMS 84-7, Office of Strong Motion Studies, Sacramento, Calif.

ATTACHMENT III - CDMG (1984). Plots to accompany Tape MORGANHILL 1984-INTERIM, a partial set of strong motion data from the Morgan Hill, California Earthquake of April 24, 1984, Office of Strong Motion Studies, Sacramento, Calif.

ATTACHMENT IV - Bakun, W.H., M.M. Clark, R. Cockerham, W.L. Ellsworth, A.G. Lindh, W.H. Prescott, A.F. Shakal, and P. Spudich (1984). The 1984 Morgan Hill, California, Earthquake: A Preliminary Report, submitted to Science.

ATTACHMENT V - J.K. Crouch, S. B. Bachman, and J.T. Shay (1984). Post-Miocene compressional tectonics along the central California margin, in J.K. Crouch, and S.B. Bachman, eds., Tectonics and sedimentation along the California Margin: Pacific Section Society of Economic Paleontologists and Mineralogists, (to be published).

ATTACHMENT VI - Anderson, J.G. and R.S. Simons, eds. (1982). The Mexicali Valley earthquake of 9 June 1980, EERI Newsletter 16, 79-105.

ATTACHMENT VII - Munguia, L. and J.N. Brune (1984). Simulations of strong ground motion for earthquakes in the Mexicali - Imperial Valley, to be published in Geophys. J. R. astr. Soc..

ATTACHMENT VIII - Eaton, J.P. (1984). Focal Mechanisms of near-shore earthquakes between Santa Barbara and Monterey, California, USGS Open-File Report 84-477, Denver, Colorado.

ATTACHMENT IX - Minster, J.B. and T.H. Jordan (1984). Vector constraints on Quaternary deformation of the western United States east and west of the San Andreas fault, in Crouch, J.K. and S.B. Bachman, Tectonics and sedimentation along the California Margin, Pac. Sect., S.E.P.M. (to be published).

ATTACHMENT X - Stein, R.S. and G.C.P. King (1984). Seismic potential revealed by surface folding: 1983 Coalinga, California earthquake, Science 224, 869-872.

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY & LICENSING APPEAL BOARD

In the Matter of PACIFIC GAS AND ELECTRIC COMPANY (Diablo Canyon Nuclear Power Plant, Units 1 and 2)	Docket Nos. 50-275 O.L. 50-323 O.L.

CERTIFICATE OF SERVICE

I hereby certify that on this 16th day of July, 1984, I have served copies of the foregoing JOINT INTERVENORS' MOTION TO REOPEN THE RECORD ON SEISMIC ISSUES, mailing them through the U.S. mails, first class, postage prepaid, to the attached list.

Christina Concepcion

CHRISTINA CONCEPCION

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